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Redesigning urban infrastructures: New infrastructure design
imaginaries and practices

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Abstract

According to Rubio and Fogué (2013, 1039), cities are witnessing a “technological and infrastructural invasion” associated with new low-carbon and sustainable technologies. In this context, infrastructure has (re-)emerged as a topic of debate in design theory and practice. One strand of this debate which, the thesis argues, constitutes a new infrastructure design imaginary suggests that new infrastructures should be designed as “multifunctional” systems, taking account of potential ecological, aesthetic and cultural benefits. It is suggested that design could facilitate new affective relationships between people, infrastructures and ecological systems, thereby contributing to sustainability. Now that new approaches to design are being adopted in some places and circumstances, there is an opportunity to investigate their assumptions, logics and effects and whose interpretation of design and aesthetics is given legitimacy. As such, the overall aim of this thesis was to explore contemporary meanings and practices of infrastructure design. This has encompassed an investigation of what types of infrastructure are being designed, what model of design is adopted and who the “infrastructure designer” mobilised might be. Evidence has been collected in two stages through a total of 42 interviews, first, in a scoping phase with a sample of infrastructure design professionals and, second, in two case studies of stormwater design, Hans Tavsens Park and Korsgade in Copenhagen and “Grey to Green” in Sheffield. The case studies explore where, how and why new visions of infrastructure design are being realised and describes the actors, institutions and agendas which influence the infrastructure design process. The key finding of the case study research is that understanding infrastructure design visions and practices requires exploring the material, institutional and economic context for design. Investigation of the context for design demonstrates that seemingly avant-garde design strategies have, in both cases, become implicated in socially-exclusive processes of transformation. Overall, the research foregrounds and explores an under-researched and under-valued dimension of urban development. It establishes a conceptual framework to guide future research in a field that is likely to become more important. Its key contribution is to provide new perspectives and in-depth analysis of both contemporary visions of infrastructure design and on the infrastructure design process.

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Chapter 1 Introduction

According to Rubio and Fogué (2013, 1039), cities are witnessing a “technological and infrastructural invasion” associated with new low-carbon and sustainable technologies. Our visions of the urban future are populated by a whole array of new infrastructures from autonomous cars and decentralised energy generation to new landscape-based systems of water management. This threatens to disrupt the conventional separation of public and infrastructural spaces (Williams, 1990) and creates new architectural, landscape and urban design challenges of managing the relationship between public space and technology. In this context, the thesis describes the changing place of infrastructure in the urban imagination and in design practice, discussing how it features both as threat and opportunity and how this relates to broader social perceptions of the place of technology and “nature” in cities. In terms of the field of research, this means engaging with the topic of infrastructure design, broadly defined by an interest in the impact of infrastructural networks on urban public space.

This research topic initially arose from several topics of debate in the literature. These include the idea that the everyday experience of urban space is mediated and produced by infrastructures, including by what Larkin (2013, 334) terms their “poetic mode”, referring to the evocative power and cultural resonance of technology in urban space. Seemingly mundane infrastructures are in fact a fundamental constituent of people’s aesthetic experience of life in cities (Graham & McFarlane, 2014) and on this basis should be recognised as an integral aspect of urban design. The direction of inquiry was further influenced by previous research on the topic of infrastructure design by authors such as Dobraszczyk (2006; 2007), Murphy (2016), Schwenkel (2015), Kaika (2005), Kaika and Swyngedouw (2000), Gandy (1999; 2003; 2011) and Barry (2009). These authors have documented the varied and contested meanings associated with technology in urban space, whether symbolic of modernity or a now unwelcome reminder of attempts to dominate nature. They have demonstrated the complicated entanglement of infrastructures, aesthetics and ideology, noting that infrastructures are intentionally designed, strategically aestheticised or selectively rendered in/visible and that design complements different political objectives often related to representing the city either as a space connected to or distinct from nature (Gandy, 2011). The thesis adopts these insights to interrogate contemporary design. The research topic and the analytical approach further

develops on critical analyses of the approach to design in infrastructure projects in fields such as low-carbon technologies, climate change adaptation and green urbanism (Foster, 2010). It has been motivated to interrogate from the outset whose interpretation of aesthetics is granted legitimacy in projects within the broad framework of urban sustainability.

How infrastructures might be designed in the contemporary era has emerged as a topic of normative concern amongst a range of authors, practitioners and policy-makers and this provides the context for the research. This increasing interest can be situated as a manifestation of the widespread legitimacy of design in various fields of public policy (Kimbell, 2011), including urban environmental policy (Cowley et al., 2018; Cowley, 2018) as well as a response to new design challenges of accommodating new low-carbon or sustainable infrastructures in urban space. This topic has been taken up in different categories of literature and, associated with this, there are divergent interpretations of what it might mean to design infrastructure and what the value of design might be. According to guidelines such as those by the UK's Design Council (2012), a "design-led approach" involves mitigating the visual aesthetic impact of existing infrastructural typologies such as power stations or roads. Others such as Brown (2014) and Shannon and Smets (2010) propose an alternative relationship between design and infrastructure, emphasising the opportunities of new sustainable typologies; Brown (2011, 19) suggests a "new infrastructural paradigm" of "multipurpose constructions aligned with natural systems, integrated into social context, and designed for a changing climate".

Yet more radical (and abstract) interpretations of the role of infrastructure design are described or proposed by authors such as Engelmann and McCormack (2017), Scott (2010), Mattern (2013), Markussen (2013), Lukens (2013), Geoghegan (2015) and Rubio and Fogué (2013; 2015). One example is Rubio and Fogué's (2015, 143) discussion of the "unfolding capacities of design" whereby a designer's objective is to "to propose and generate new entities and relations" such as new configurations of the human and nonhuman, whether technological or ecological. One aspect of this is the possibility of design to creatively interpret and problematise how people relate to infrastructures and their underlying ecological systems or to facilitate new more productive, reflexive and empowering modes of interaction (Lokman, 2017). Many of these ideas, both radical and otherwise, are shared by landscape theorists in the field of "landscape infrastructure" such as Allen (1999), Strang

(1996), Hung and Aquino (2013), Bélanger (2016), Rosenberg (1996; 2015), Carlisle and Pevzner (2013) and Salomon (2017). This entails recognition of the relationship between infrastructure and landscape and, by association, that of aesthetics. It posits that new forms of professional and non-professional expertise should be involved in planning and design because recognising infrastructure as a question of aesthetics invokes “far more complex and powerful ways of knowing the world than utilitarian problem solving” (Williams, 2016). Last, it incorporates the idea that designers should leverage the potential expressive power of new infrastructures and set out to promote awareness of how infrastructures work, what their ecological consequences are and to challenge conventional expectations of aesthetic value (Meyer, 2008).

These conceptual developments, although diverse, arguably represent an attempt to define a new infrastructural aesthetic. Following a systematic review of the literature, the thesis describes these developments as constituting a new infrastructure design imaginary defined by specific ideas regarding the relationships between infrastructure and public space, between aesthetics and ecological sustainability and regarding the roles and expertise of designers. These features are discussed and problematised in depth in Chapters 2-4 below. The argument made is that these ideas have ambiguous implications for the future of public space in cities which will likely depend on both the intentions of designers as well as the broader context in which design operates. The research problem is, therefore, the uncertain implications of new infrastructures, whether “sustainable” or otherwise, and associated new approaches to design associated with the concept of a new infrastructure design imaginary. This is a practical problem of the potential conflict between infrastructure and design and the research is motivated by a normative concern on the part of the author with the social and ecological value of urban public space. Linked to the recognition of the significance of the context for design, the analytical approach of this thesis is to understand design as a social and “situated” process (Kimbell, 2011), contrasted with one which overestimates the agency of an individual “autonomous” designer (Cunningham, 2016). Following this approach, design is understood as the product of a broad coalition of actors which is likely to be characterised by uneven power dynamics.

The thesis engages with two primary literatures. These are, first, the work of design theorists writing on the topic of infrastructure, especially those associated with the concept of ‘landscape infrastructure’ and, second, the overlapping literatures on urban political

ecology and urban infrastructures. The thesis is therefore situated at the intersection of the social sciences and design disciplines, a feature which is related to a primary motivation throughout which has been to take seriously the utopian and normative visions of designers who propose new forms of interaction between people, nature and infrastructure and are arguably beginning a critical and urgent task of challenging our imaginations of the future of cities and the place of nature within them. However, the thesis is equally motivated by a need to subject these visions and the resulting projects to theoretically-informed and critical scrutiny rather than unquestioningly accepting the claims of their proponents.

The research contributes to the emerging literature on landscape infrastructure by adding detailed empirical research to a body of writing which has so far been composed by proposals or analysis of conceptual rather than realised projects informed solely by the judgements of authors (e.g. Lokman, 2017; Salomon, 2016; Rosenberg, 2015). The research also contributes to the existing literature on urban infrastructures; many aspects of the development and management of infrastructure are “blackboxed” (Graham and Marvin, 2001) in the sense of being removed from academic or public scrutiny, a reality which extends to design processes which are often the product of anonymous, corporate conglomerates (Pawley, 2008; Easterling, 2014; Turpin, 2008). For this reason, there are few existing studies on the design process for contemporary infrastructure projects which take into account either the aspirations of designers and other actors and/or the conditions in which they operate. A major contribution of the research is its in-depth investigation of the infrastructure design process using case studies of urban stormwater management and drawing on different types of evidence.

1.1 Urban stormwater management

Following iterative development of the research design, urban stormwater management was identified as an appropriate sector of infrastructure in which to investigate new approaches to design. The implications of the transition from the broader field of infrastructure to that of stormwater are discussed in the Methodology and in Chapter 7. Within this field, new systems of urban stormwater management are suggested to have a range of ecological, social and aesthetic benefits through improvements in water quality, reductions in energy consumption and in provision of new green spaces for biodiversity,

recreation and education (Backhaus and Fryd, 2013). The field has also witnessed the reframing of design as a question of “cultural sustainability” (Nassauer, 1997) through emphasis on the potential symbolic and aesthetic significance of new stormwater landscapes; according to authors such as Gandy (2013b), Echols and Pennypacker (2008) and Dreiseitl (2005b), there is an opportunity to define a new infrastructural aesthetic which would provide for more dynamic forms of interaction between people and infrastructure including possibilities for learning and change in the ecological imagination. However, such emphasis on the value of new forms of aesthetics could be also be problematized as a response to competing demands on urban space, in other words as providing a narrative to justify the appropriation of space for infrastructural uses. Generally, the question of stormwater aesthetics, including the degree to which they should seek to challenge conventional perceptions of landscape aesthetics, is yet to be resolved (Backhaus and Fryd, 2014).

There has been little systematic analysis of stormwater aesthetics and very few, if any, studies on the design process which take into account the intentions and aspirations of designers and other stakeholders. New approaches to stormwater management are an emerging typology which have not yet been widely implemented in urban areas. There is a need to understand and critically assess their value before they become standardised and their production routinised in a similar manner to other infrastructures. Responding to these gaps in our understanding, the major empirical chapters of the thesis are based on evidence from two case studies of urban stormwater management projects. These case studies are the redevelopment of Hans Tavsens Park and Korsgade in Copenhagen, Denmark and “Grey to Green” in Sheffield, UK.

1.2 Research aim and objectives

These ongoing struggles to define and justify a new aesthetic, both in the field of urban stormwater management and in broader discussions of infrastructure design, provide the context for the research. The overall aim of the thesis is to investigate meanings and practices of infrastructure design. This encompasses issues such as how the relationship between infrastructure and design is understood, whether as complementary or conflicted, what types of infrastructure become objects of design intervention, what model of design (whether superficial or otherwise) is adopted and what are the characteristics of the

“infrastructure designer” mobilised in contemporary theory and practice. One further aspect of this overall aim is to understand contemporary meanings, or imaginaries, of infrastructure design in the sense of determining to what extent these are different from previous iterations.

The objectives of the research are

- to make a contribution to the literature through the development of a conceptual and analytical framework for the investigation of infrastructure and design,
- to provide an in-depth analysis of the infrastructure design process, including the distribution of power to influence its outcomes and the types of expertise involved,
- to explore the value of the concept of a new infrastructure design imaginary for understanding contemporary design practice.

1.3 Structure of the thesis

Following the introduction, Chapter 2 defines the key concepts in the thesis, most notably infrastructure and design. It provides a nuanced account of how the relationship between infrastructure and design has previously been understood and articulated. It begins to define a set of parameters to define the extent and reality of change towards a new infrastructure design imaginary. Chapter 3 describes what is meant by a new infrastructure design imaginary and situates it as a response to a conjunction of urban ecological challenges resumed by the concept of infrastructure design in the Anthropocene. This imaginary is characterised by the conceptualisation of infrastructure as an interface through the design of which new forms of productive conceptual and material interaction between people and nonhuman world can be facilitated. Chapter 4 outlines the author’s understanding of the situated character of infrastructure design and provides an outline of the infrastructure design process. This draws on relevant fields of research such as the politics of urban ecological policy and sustainable design. Chapter 4 also discusses urban stormwater management and design, with which the majority of empirical research in the thesis is concerned. It explores the emergence of this sector as a key site of innovation in design and contributes to situating stormwater design relative to the broader field of infrastructure design. Chapter 5 provides the research methodology, describing the iterative development of the research design. This is linked to the selection of urban stormwater management as a sub-sector of infrastructure in which to investigate design.

The methodology describes the method of selecting case study projects and what they represent in the context of the thesis. Chapter 6 gives evidence from the first stage of data collection involving a survey of infrastructure design professionals. This includes findings on the relevance of the new infrastructure design imaginary for practice as well as providing grounds for reflection on the complexity of the research topic. Following this, Chapters 7 and 8 provide evidence from Copenhagen focussing on the urban and local level respectively. These chapters describe the model of combining large-scale infrastructural change with landscape and urban design. They explore what the influences on the visions and practices of stormwater design in Copenhagen might be and describe how and why these visions and practices have been contested. Chapter 9 describes the “Grey to Green” case study in Sheffield focussing on the evolution of design as response to financial and institutional constraints. Each of the case study chapters (7-9) simultaneously discusses parallels between design in the instances investigated and the concept of a new infrastructure design imaginary including to what extent this explains their contestation.

Chapter 2 Infrastructure and design

As outlined in the introduction, this thesis explores contemporary meanings and practices of infrastructure design. This has recently emerged as an important topic because it is situated at the intersection of diverse and seemingly new ecological and technological, amongst other, pressures. It is manifest in ongoing debates in various fields of design theory, such as that of “landscape infrastructure” (Rosenberg, 2015), to define a new infrastructural aesthetic.

However, rather than beginning with the contemporary moment and risking an ahistorical approach, the aim of this chapter is to provide depth to the inquiry in the rest of the thesis by exploring previous meanings and practices of infrastructure design including how these might have changed over time. A secondary aim of the chapter is to begin to outline a set of parameters that provide structure to the argument, further developed in Chapter 3, on the novelty of the contemporary infrastructure design imaginary. In this chapter, these parameters appear in outline form as themes which recur throughout the discussion. These themes are, first, how the visibility or invisibility of infrastructures has been interpreted or problematised, second, a changing politics of infrastructure design, specifically an ecological critique of existing design practices, and, last, perceptions regarding the forms of expertise which should be involved in infrastructure projects.

The overall argument of this chapter is that, while invisibility and utilitarianism are often considered defining characteristics of infrastructure (e.g. Star, 1999), many forms of infrastructure have been consciously and intentionally made visible, designed and aestheticised, that this has often occurred in specific circumstances in which infrastructure is intended to perform a symbolic or political function and, last, that the literature on this topic can be usefully applied to interrogate contemporary and apparently novel approaches to infrastructure design.

The structure of the chapter is as follows: Sections 2.1 and 2.2. begin to establish a conceptual framework by defining what is meant by infrastructure and design in the context of the thesis. This is important due to the complexity of the terms and the variety of their uses. Section 2.1 also highlights some of the conceptual challenges of juxtaposing infrastructure and design. Section 2.2 describes change in the definition and scope of

“design” and specifies what types of design are studied in this thesis. Section 2.3 reviews the literature on previous examples of infrastructure design focussing on the circumstances, both historical and geographical, in which infrastructures have come to be designed. It argues that explanation requires attention to their symbolic, narrative and political functions. This section also explores the frequently referenced idea that infrastructures have become increasingly (and problematically) “invisible”. Last, Section 2.4 gathers some of the limited available evidence on the topic of the “infrastructure designer” relevant to beginning an investigation of who designs infrastructure.

2.1 Infrastructure

According to Williams (2012), infrastructure is a “promiscuous term” which has various and flexible uses. The term is of relatively recent origin, beginning to be used in the late 19th and early 20th century; it was imported into English from French where it had been used to describe the logistical and organisational work required prior to the construction of railways (Carse, 2016). According to Bruegmann (1993, 11), in comparison with other broadly synonymous terms such as “public works”, infrastructure gained credibility in the late 19th century because “it sounded more technologically up-to-date and politically and socially neutral”.

Carse (2016, 27) suggests that current common usage of the term is to denote the “vast, complex and changing systems that support modern economies and societies”. A similar definition is provided by architectural theorist Martin Pawley (1998, 7-9) who defines infrastructures as “the systems and networks that sustain modern life... the hidden networks that provide us with transport, energy, nutrients and information that are the real riches of the modern world”. Kaika and Swyngedouw (2000) add that infrastructures mediate between cities and ecological systems because they are a fundamental part of the process of transforming nature into useable products such as treated water. Elsewhere Swyngedouw and Kaika (2014, 464) describes infrastructures as “metabolic vehicles” which permit “the incessant and accelerating movement of all types of nature into, through and out of the city”. This relatively intuitive definition of infrastructure as a system of urban technologies ultimately reliant on the transformation of natural resources external to cities and which are intrinsic to the process of urbanisation is the sense in which the term is used throughout the thesis.

However, it is also important to note some complexities of defining infrastructure both generally and those which emerge in discussions of design. Notably definitions of infrastructure rely on the idea of its functionality, utility and affordances rather than describing a definable, static entity, for example Carse (2016) draws attention to the fact that the term is a collective noun and one which suggests the existence of heterogeneous parts that combine to support a higher function. Star (1999) describes infrastructures as “relational”, in other words suggesting that what is defined as infrastructure depends on the perspective of the observer; the author (1999, 380) notes that “for the railroad engineer, the rails are not infrastructure but topic”. Larkin (2013) develops this insight by arguing that setting boundaries to what counts as infrastructure reflects assumptions on the part of the observer regarding what technology, ecology, system of knowledge or other aspect of an infrastructural network is essential and which superfluous. According to Larkin (2013, 330), “the act of defining an infrastructure is a categorizing moment [which involves] selecting what one sees as infrastructural, and thus causal, and what one leaves out”. Although seemingly abstract, this represents a useful insight when entering upon a discussion of design; some of the design practices studied in the thesis can be understood as involved in strategically rendering in/visible different aspects of technological, social or ecological substrates of infrastructures and representing them as important or causal, for example the technological fetishism diagnosed by Kaika and Swyngedouw (2000) as a feature of modernist infrastructure design and discussed in more detail in Section 2.3 below.

2.1.1 The infrastructural imagination

Infrastructure carries a much broader range of cultural and imaginative associations than simply functional utility. These are often bound up with the fact of its, at least in the modern era, being buried underground and therefore invisible (Williams, 1990). Amongst these associations are ideas of huge scale, complexity and fundamental incommunicability. For example, Gitelman (1996, 153) reports on the difficulty of representing infrastructure through text by studying the preparation of a 1930s field guide to New York’s underground infrastructure, noting that “there is an admission that at some level, infrastructure is unknowable”. This is further taken up in the discussion by Garver (1998) of the difficulty of accessing and documenting contemporary underground infrastructural spaces for the

photographic essay *Underground New York: The hidden infrastructure of the city* (Greenberg, 1998) and a similar message could be inferred by the narratives of danger and adventure surrounding attempts to gain access to infrastructural underground spaces involved in urban exploration (Garrett, 2013). Williams (1990, 83-84) reports on the manner in which underground infrastructural spaces have been perceived which has varied historically from “wholly-beautiful, sanitised” and well-lit spaces of safety, to an awe-inspiring version of the industrial sublime, to dirty and disordered. According to Rubio and Fogué (2013, 1035), one lasting conception of infrastructures has relied on their othering from the safe, clean and above-ground realm of public space: “[U]rban space is organised around a clear discontinuity between, on the one hand, public urban surfaces... and on the other, an invisible subterranean city populated by different technological inhabitants”.

Related to the above, a recurrent theme in descriptions of infrastructure is the idea of invisibility and inaccessibility, that infrastructure is both hidden from sight whether buried underground, behind defensive barriers or disguised through architectural artifice (Larkin, 2013). This is often related, either implicitly or explicitly, to the idea that infrastructure does not figure in the popular imagination or is misunderstood. Assumptions about visibility/invisibility extend into academic writing on the topic of infrastructure; for example, the visual metaphor of blackboxing is frequently used by academic authors to describe the condition of infrastructures as both hidden underground and removed from public consciousness (e.g. Graham and Marvin, 2001). Elsewhere Appandurai (2014, xii) describes the process of academic research on infrastructure as the “rendering visible of a normally hidden reality”. Noting this perceived conjunction of invisibility and unknowability is useful both in defining what infrastructure means in a broad sense but also because the premise of rendering infrastructure visible, both literally and metaphorically, is an important aspect of contemporary design debates (as discussed in Chapter 3) and therefore it is useful to examine the origins of the topic.

The topic of in/visibility requires further discussion of how previous literature has conceptualised infrastructures; in other words, when authors refer to visibility or invisibility, what forms of infrastructure are implied. To paraphrase Marshall (2012, 54), one way of understanding the spatial configuration of infrastructures is to distinguish between “nodes” and “linear elements”. Nodes here refer to central production facilities such as railway stations, water treatment facilities and power plants contained in buildings

where linear elements, by contrast, are the interconnected webs of pipes, energy lines, internet cables or roads stretching between nodes. Analysis of relevant literature (for example as reviewed in Section 2.3 below) demonstrates that what constitutes infrastructure design often refers to the architecture of infrastructural buildings, in other words nodes, or to the erection of landmarks or memorials to commemorate significant developments. This is perhaps most clearly stated by Kagner (2013) who notes that “in order to build a relationship to an infrastructure project one needs to objectify or to attach an icon or a monument to it”. Elsewhere, this is reflected in terminology such as “infrastructural architecture” (Martin-Gómez et al., 2017), “terminal architecture” (Pawley, 1988), infrastructural “landmarks” (Kaika & Swyngedouw, 2000) or the “neighbourhood furniture” of energy transmission towers described by Castán Broto et al. (2014, 193). According to Kaika and Swyngedouw (2000, 129), in late 19th and early 20th century cities, “concrete shrines embodying the networks were sticking out of the city landscape; they provided the best form of ‘landmarks’ in the image of the city”. The authors continue to argue that these isolated landmarks shaped how people imagined and related to the wider infrastructural network. More broadly, this reflects the (perhaps inevitable) selectivity with which design has interacted with and represented infrastructure in the sense of highlighting some aspects and neglecting others, a reality which highlights the partiality of the concept of infrastructure design as implying a degree of comprehensiveness which does not necessarily exist. The discussion also highlights some of the complexities of describing infrastructures as visible or invisible if only some fragments are purposively selected and aestheticized. The sense in which infrastructures can be described as visible or invisible is further discussed in Section 2.3 below.

2.1.2 Landscape as infrastructure

A final issue regarding the definition and types of infrastructure studied in the thesis is the emergence of the concept of “landscape infrastructure” or “landscape as infrastructure” associated with theorists such as Pierre Bélanger (2009; 2012; 2016). This represents an important body of literature dealing with questions of the intertwined ecological and cultural significance of infrastructures and it is analysed in detail in the following chapter (see Section 3.3). The discussion here merely aims to clarify the terminology used in the thesis.

A fundamental tenet of the landscape infrastructure literature is a recognition of the relationship between infrastructure and landscape, in other words that global infrastructural networks shape and produce both urban and rural spaces and therefore have important consequences for landscape aesthetics and ecologies. However, as implied in the concept of landscape as infrastructure, it further implies a complex definition of infrastructure itself as entangled with ecological systems. Observing these conceptual developments, Braun (2014, 58) notes that “the environment – in the sense of nonhuman nature – is itself increasingly understood and treated *as* infrastructure” [emphasis in original]. In terms of how this has been reflected in design practice, Lokman (2017) observes that projects designed following landscape infrastructure principles range from “cyborg” systems that merge technological and ecological elements to the wholly ecological.

These developments, therefore, imply a degree of conceptual elision between infrastructure and ecological systems. Although not intending to impose a neat separation between infrastructure and nonhuman nature (a misconception that infrastructure studies and political ecology have laboured to correct), the intention here is to clarify that the sense in which “infrastructure” is used in the thesis remains that defined above as systems of recognisably technological elements. This distinction re-emerges as relevant in the case studies of design practice where there is a tendency to emphasise and selectively render visible the ecological, rather than the technological, underpinnings of new combined ecological and technological systems and the thesis requires a vocabulary with which to make these distinctions which would not be possible if infrastructure and landscape were conceptually elided.

2.2 Design

Design is the second key concept in the thesis. This section aims to provide an overview of its common usage and perceived significance and to discuss potential change in its meanings. As with infrastructure, it is difficult to provide a singular precise definition that is used throughout the thesis. As noted by Cowley et al. (2018), design is infrequently discussed in social science literature. However, it and related concepts of “design thinking”, “design-methods” or a “design-led approach” have recently emerged as an almost omnipresent preoccupation of various subsections of literature and public policy, often

through an assumed connection to innovation (Sunley et al., 2011; Vinodrai et al., 2007). According to Latour, (2009, 2), design “has been spreading continuously so that it increasingly matters to the very substance of production... design has been extended from the details of daily objects to cities, landscapes, nations, cultures, bodies, genes... to nature itself”.

According to a UK government think-tank on the design industry, the All-Party Parliamentary Design and Innovation Group (APDIG, 2013), defining design is a persistent challenge. This refers to uncertainties regarding the professions and economic sectors involved as well as the difficulty of locating design when it is embedded in a wider production process. One definition suggested is that “design is everything... one can argue that a surgeon, for example, designs solutions to medical problems” (Moultrie, 2013, 2). A second is the definition of industrial design provided in the UK’s Standard Industrial Classification system as “creating and developing designs and specifications that optimise the use, value and appearance of products, including the determination of materials, mechanism, shape, colour and surface finishes of the product, taking into consideration human characteristics and needs, safety, market appeal in distribution, use and maintenance” (Design Council, 2018). According to either of the above definitions, all infrastructures are likely to be designed to some extent. The latter indicates that design might involve some consideration of “human characteristics”. However, neither usefully narrows the field of study or represents this author’s interests within the topic.

Another conventional and intuitive definition is provided by Latour (2009, 2-4) who describes design “in its weakest form” as a “not-so-serious profession” concerned with adding a superficial veneer of taste, style or aesthetic enhancement to the products of “much more serious professionals” such as engineers. This locates design as one relatively insignificant aspect of a wider production process. Within this framework the scope for design intervention is limited to minor changes justified on the basis of aesthetic appeal and the designer’s expertise is accordingly restricted to this narrow set of considerations. Such an understanding is arguably apparent in the UK Design Council’s guidelines (2012) on “a design-led approach to infrastructure” which suggests that the role of design is to work with existing standard infrastructural typologies, giving examples such as power stations or incinerators, and to mitigate their negative visual impact on the local environment. It is

equally apparent in various 19th century examples of infrastructural buildings which were “encased” (Kaika, 2005, 8) in neoclassical forms, as discussed in Section 2.3 below.

2.2.1 New models of design

A further approach to design, if not definition, is provided by both Latour (2009) and Cowley et al. (2018). This involves several points of contrast with the conventional definition provided above in terms of the objects and scope of design and who is identified as the designer. Cowley et al. (2018) note the widespread and enthusiastic uptake of the term in a range of different fields and seeks to interrogate its resonance. The authors argue that this is the result of recent conceptual developments in theories of design which, it is argued, provide a useful framework for responding to complex challenges that require new methods of problem solving. According to Kimbell (2011), “design responds to the idea that established ways of thinking about managing and organizing are not adequate to deal with... any number of global challenges from climate change, to resource scarcity to peak oil”. Certain of these conceptual developments are highlighted below because they prefigure key themes and concerns of contemporary writing on infrastructure design. First, there is the emergence of the concept of infrastructure as an “interface” which can be more or less productively designed. This is an important aspect of the new infrastructure design imaginary identified in the following chapter (see Section 3.3.1). There is a lack of useful analytical literature specific to infrastructure on this topic and, therefore, it is useful to investigate the interface as it features in the broader design literature. The second of these key themes is an altered understanding of design expertise in theories of infrastructure design which, again, it is useful to situate in the broader literature.

According to Kimbell and Blomberg (2017, 81), design is conventionally understood as “tied up with the production and use of material and digital objects, yet these days it is no longer defined by them... over the past two decades the emergence of practitioner and research fields associated with the design of interactions, services, experiences and systems has opened up anew the question of the object of design”. Secomandi and Snelders (2011, 3) refers to this shift as a change in the object of design from material products towards that of intangible services, processes and interfaces, referring to the interactions “between people, technologies and actions”. The contemporary emphasis on “interfaces” is also discussed by Cowley et al. (2018, 8) who describe it thus: “what is designed is primarily,

then, not a physical object so much as a set of intended relations”. This interpretation of interface design as the design of intended relations provides a useful starting point to analyse the emerging application of the concept of the interface to infrastructure in Chapter 3.

A second feature of contemporary theories of design is changing interpretations of design expertise whereby the designer is no longer understood as applying scientific and standardisable methods to arrive at an ideal solution. According to Cross (2004), design is characterised by ill-defined problems which do not have an obvious means of solution. Therefore, the ideal design process is increasingly conceived as iterative and “abductive” where the problem solving process, rather than the initial problem statement, ultimately defines the solution (Cross, 2004; Cowley et al., 2018). According to Cowley et al. (2018, 6), this is related to the idea that the designer is not a rational expert imposing an ideal solution on passive objects in the surrounding world, rather “the designer is more explicitly recognised as an embodied and entangled part of the material and social world. It paves the way for, or reflects, a shift in mainstream understandings of design as unlikely to yield beneficial social outcomes when imposed from above... [T]he agency of the designer is thus decentred... [and] the user is no longer ‘designed for’ but becomes a fundamental part of the process itself”. This is, therefore, associated with proposals to facilitate the participation of potential users in a design process. From the perspective of analysis, according to Kimbell (2011), decentring the agency of designers leads to a more “situated” understanding of design where a range of factors such as social or institutional setting are acknowledged to influence the ultimate product. An understanding of design as situated forms the basis of the analytical framework as outlined in Chapter 4 and of the research design which takes designer’s intentions as an important but not all encompassing source of explanation.

A recognition of epistemological complexity, associated with the idea that an ideal solution cannot be established from the outset, is taken as a key strength of Latour’s (2009, 5) interpretation of design: “it is an antidote to hubris and to the search for absolute certainty, absolute beginnings and radical departures”. However, De Block (2016), in a study of contemporary developments in ecological design theory, critiques precisely this aspect of Latour’s argument insisting on the necessity for radical departures underpinned by an explicit political vision. De Block (2016) further notes that radicalism is in fact often

apparent in design but that this is often limited to technical or ecological rather than socio-economic change. Elsewhere, Cowley, (2018, 2) argues that the contemporary relevance of “design thinking” in the fields related to urban sustainability reflects a retreat from the (useful) idea that human agency and technology can and should be applied to solve socio-economic and ecological problems; it “rob[s] us of the human agency required to tackle overwhelming problems such as climate change”. Informed by this overall framework, the epistemologies and forms of expertise amongst “infrastructure designers” are discussed in more detail in Section 2.4 of this chapter and in Chapter 3 (Section 3.5).

2.2.2 Architecture, landscape architecture and urban design

The above discussion of different definitions and approaches to design has obviously been presented in relatively abstract terms, generalising across professional disciplines and different scales of design. This is, to some extent, because practices which represent, aestheticise and publicise infrastructure, thereby influencing how it is understood, are not limited to the spatial design disciplines of architecture, landscape architecture and urban design or to the scale of urban space, but rather include mediums such as literature (Williams, 1999), visual representations, for example mid-nineteenth century photography of the Paris sewers as described by Gandy (1999) and critical and conceptual art projects (e.g. Geoghegan, 2015). Elsewhere, Barry (2009, 69) describes the multiple means of representing and therefore, rendering visible, oil pipelines in Armenia which includes their material form as mediated by engineers or designers, but also extends to practices of environmental monitoring whereby “visibility would primarily exist in terms of numbers on a balance sheet” meaning that new pipelines, although underground, would become “visibly invisible” through extensive surveillance and data gathering.

There are also new approaches to infrastructure design which cut across different sectors of design activity including through the redesign of infrastructures in domestic spaces. For example, Rubio and Fogué (2015) discuss domestic interfaces which aim to help consumers visualise energy consumption as examples of design which envisages new relationships between people and infrastructure and therefore parallels the thematic concerns of the thesis. Equally, Braun (2014) identifies some similar dynamics underpinning both the design of new real-time fuel consumption gauges in cars and that at the scale of landscapes in proposed climate change adaptation projects in New York. This is useful to situate the

subject matter of the thesis as a topic of contemporary relevance. However, the primary objective of the thesis is to understand infrastructure design at the scale of public space and the city, or that of buildings and landscapes, where it generally falls within the remit of architects, landscape architects and urban designers. Design is therefore understood primarily as referring to these spatial design disciplines. The following section reviews literature on the historical evolution of the relationship between infrastructure design and public space through this lens.

2.3 Historical context and the politics of infrastructure design

Infrastructure and design are not conventionally linked terms given the associations conjured by the term infrastructure which include utilitarianism, invisibility and inaccessibility. However, this conceptual separation depends on several assumptions regarding context, both historical and geographical. This section discusses the varying degrees to which infrastructures have been designed in different historical contexts, with particular attention to the complex use of concepts of visibility and invisibility to describe the historical evolution of design. This emphasis on visibility arises due to the entanglement of infrastructure design with that of infrastructure's visibility and because many previous studies have often understood historical change as occurring along a trajectory of diminishing visibility and diminishing attention to design. Further, authors have interpreted the visibility of infrastructures as a proxy for whether and how they feature in popular consciousness; according to Kaika and Swyngedouw (2000, 122), the cultural and symbolic significance of infrastructure is "closely associated" with their visibility. Rendering infrastructures visible (and aesthetic) features of urban space is a key principle of contemporary literature on infrastructure design and becomes a criterion to assess change towards a purported new infrastructure design imaginary (topics which are discussed in the following chapter). A review of analyses of how the visibility of infrastructure is perceived to have changed and to what effect is therefore important to establishing the background and justification for this imaginary.

In terms of issues such as attention to design, aesthetics and visibility, various sources note the varied relationships between infrastructures in urban space in different historical periods. Existing relevant literature often focuses on iconic examples of Victorian and modernist architecture from the mid-19th to mid-20th centuries in key sites such as Paris,

London and New York (which highlights that infrastructure design has a specific geography). According to a report by Environmental Defence and landscape architects MS Studio (ED & MS Studio, 2007, 10), “America’s historic infrastructure facilities were once objects of immense civic pride and sometimes monumental beauty.... [T]hese facilities also served as potent symbols of common purpose and progress in a young and rapidly growing nation. Clean water, sanitation and power were not yet taken for granted, in fact the public eagerly celebrated their arrival. Magnificent structures offered testament to the crucial value of these services to people’s lives and livelihoods and the sacrifices required to create them”.

Some examples which have featured in academic literature include San Francisco’s Golden Gate Bridge (Rodriguez, 2000), the New Deal era Hoover Dam (Turpin, 2008; Wilson, 1985), railway station design in the USA (Chappell, 1989) and Gandy (1999; 2003) and Kaika’s (2005) studies on the elaborate iconographies of the Paris, New York and Athens’ water systems. Examples from the UK include Dobraszczyk’s (2006; 2007) investigations of the architecture and symbolism of the Abbey Mills and Crossness pumping stations built as part of London’s first underground sewerage system in the 1860s and Merriman’s (2004) description of the new modernist landscape of the M1 motorway and its service stations. Elsewhere, Boyd and McLaughlin (2015) document the role of architects in early to mid-20th century infrastructural projects in Ireland, such as hydro-electric dams and bus stations, describing them as influential in defining a national visual aesthetic of modernity. Examples from socialist and post-socialist countries include Hatherley’s (2016) descriptions of the elaborate and varied design of metro stations in the former Soviet Union, Schwenkel’s (2015) discussion of ‘spectacular’ water infrastructure in socialist Vietnam, Hervig’s (2015) photographic essay of Soviet bus stops or those featured in online photograph collections such as the “Socialist Modernism”¹ or “Utilitarian Architecture”² pages on Instagram. Other studies have focused on the aesthetics of certain generic infrastructural typologies such as Webster (1995) on the suspension bridge, water towers photographed by Bernd and Hilla Becher (1998), Turpin’s (2008) discussion of changing aesthetics of dams and Pawley’s (1998) enthusiasm for the petrol station on the basis of its synthesis of function and aesthetic.

¹ <https://www.instagram.com/socialistmodernism/?hl=en> (28/8/18)

² <https://www.instagram.com/utilitarianarchitecture/?hl=en> (28/8/18)

It is often argued that what has defined previous approaches to designing infrastructure is a clear synthesis of form and function and that this reflects a less ambivalent or conflicted relationship between society and technology (Pawley, 1998) or between design and infrastructure. However, what can be drawn from the above review is rather an appreciation of the distinct periodisation and varied interpretations of the relationship between infrastructure and design. This is linked to the idea that the intention of design has not necessarily been to promote an authentic understanding of infrastructure but occasionally to render it palatable to established aesthetic conventions. For example, discussing the Athens water supply system, Kaika (2005, 82) argues that the designers incorporated neoclassical references to ancient Greece to symbolically connect the new infrastructure to notions of democracy and freedom and construct water infrastructures as “temples of progress”. This was important given the early 20th century context of conflicted social perceptions of urban technologies with “intermingled feelings of fear and fascination” (Kaika, 2005, 35). In this context the author (2005, 8; 84) argues that the “encasing of urban infrastructure in neoclassical forms [was] a means to sanitise and render progress more palatable to the public and “to make new technologies and their urban landmarks more “noble” and more in tune with the bourgeoisie”. According to Kaika and Swyngedouw (2000), this later gave way to a machine aesthetic characterised by a more unambiguous celebration of technology in urban space. Illustrating this shift, in 1928 architecture critic Siegfried Giedion (c.f. Dobraszcyk, 2007, 353) dismissed the historicised aesthetic of 19th century industrial buildings as “contaminated” by “decorative sludge”. Equally, the unambiguous perspective of Gordon Kaufman, the architect appointed to oversee the design of the Hoover Dam, was that “the works of the engineer... must strike by their mass and proportion rather than by trifling details and minutiae of ornament” (c.f. Turpin, 2008, 131).

Based on this discussion, it is apparent that infrastructure design has involved varying degrees of emphasis on principles such as authenticity or that form should express function. What is further insightful is the argument put forward by Kaika and Swyngedouw (2000) on the diffuse and complex relationship between form and issues such as meaning or aesthetic and symbolic value. Describing the aesthetics of modernist infrastructures, they (2000, 129) argue that “their beauty lay in the promise they were carrying for a better future and a more equal society”. Larkin (2013) also highlights an occasionally ambiguous

relationship between function and aesthetic value whereby some infrastructures are intended to have a cultural or symbolic effect which may be disconnected from their usefulness (if not their apparent function). For example, the author (2013, 335) cites Todorov's (1994) judgement of Soviet factories as "built not to produce commodities [but] symbolic meanings.... They result in a deficit of goods but an overproduction of symbolic meanings".

2.3.1 The politics of infrastructure design

What is apparent from this discussion is the importance of concepts such as narrative, ideology and symbolism to explanations of infrastructure design. A related point is that it is impossible to separate discussions of design from those of socio-cultural and political context and the role of design as both reflecting and reinforcing certain political visions. However, the politics of infrastructure design and closely related concepts such as "the technopolitics of visibility" (Schwenkel, 2015, 521) have been interpreted in different ways, from representing progressive and utopian aspirations to more critical assessments. An example of the former is the concept of a "political-aesthetic of togetherness" suggested by Murphy (2016, 83); describing the modernist proposals for "megastructures" of large, modular housing blocks, the author argues that "[u]nlike in conventional housing, where heating and plumbing and waste infrastructure are all hidden, megastructure was in the last instance an attempt to make clear the functions and systems that are constantly required to live in a city at all. We should understand it not as an indulgent fantasy but as a political aesthetic of togetherness, immune to the deliberate aesthetic atomisation that would so often occur in architecture in the decades to come".

Alternatively, and more widely expressed in social science literature, is a more critical interpretation of the politics of infrastructural visibility or the "technopolitics of visibility" such as that provided by Schwenkel (2015, 520) who argues that visually emphasising new infrastructural technologies both in public and in domestic spaces was an attempt to make apparent the power and benevolence of the state, in this case that of the socialist state of 1980s Vietnam where "planners showcased urban infrastructure as a spectacular socialist achievement". Schwenkel (2015) observes that the visual rhetoric of spectacular infrastructure was not accompanied by improvements in provision of services. Although derived from a particular geographical and historical context, this argument has obvious

resonance with interpretations of the politics of infrastructural visibility as a form of “technological fetishism” (Kaika & Swyngedouw, 2000) as discussed below.

Various works by Gandy (1999; 2003; 2011), amongst others, have demonstrated that a key aspect of the politics of infrastructure design are the relations between social or urban worlds and “nature” which they symbolise. Oliver (2000) argues that part of the symbolism of early infrastructure projects was that of rationalising and dominating nature. Describing the construction of London’s Thames Embankment in the 1860s, the author (2000, 236) argues that “the embankments’ construction was an expression of the cultural perception of the Thames” which was ultimately manifest both symbolically as well as in its concrete function, for example through the emphasis placed on values of solidity and order in the construction of the river walls. According to the author, the walls (2000, 236) “were a sign, concretely and figuratively, to epitomize post-Enlightenment rationality, which made the crooked-irrational into the straight-rational of modernity”. The contribution of modernist infrastructure design to symbolising control of nature is further emphasised by Kaika and Swyngedouw (2000). They (2000, 121) argue that in this period infrastructures became “fetishized” referring to the idea that the consequences of their visual prominence and interlinked cultural significance was that the technologies themselves were identified as the source of newly abundant commodities such as drinking water or electricity, rather than the social or nonhuman labour involved in producing these commodities.

2.3.2 Narratives of invisibility

Discussions of 19th and early 20th century infrastructure design frequently evoke a contrast with the contemporary city where, according to Kaika and Swyngedouw (2000, 121), “urban networks... are largely hidden, opaque, invisible, disappearing underground, locked into pipes, cables, conduits, tubes, passages and electronic waves”. Similar narratives of increasing invisibility as a defining characteristic of contemporary infrastructure are repeated by authors such as Star (1999), Mattern (2013), Rubio and Fogué (2013), Garver (1998) and Appandurai (2014) as well as amongst design theorists interested in the topic of infrastructure such as Pawley (1998), Bélanger (2016), Allen (1999) and Strang (1996). This shift is attributed to various different causes including changing disciplinary roles (see next section) and technological change (Murphy, 2016). According to Kaika and Swyngedouw (2000), it is due to a set of related cultural and economic changes, notably the failure to

realise a vision of social progress through increasing technological development and the declining resonance of a narrative of domination over nature.

This narrative of a trajectory from visibility to invisibility must be nuanced in light of the above discussions of representing infrastructures and taking into account the heterogeneity both historically and geographically of design and of infrastructural networks themselves. In terms of the geography of design, Appandurai (2014, xii) distinguishes between “vertical cities” of the Global North where infrastructures are buried underground and “horizontal cities” of the Global South where they are on the surface and “everything is available to the gaze”. According to Trovalla and Trovalla (2015, 333), such cities are also characterised by more reflexive relationships between people and infrastructural technologies characterised by everyday maintenance and adaptation which “put inhabitants in a state of constant improvisation and experimentation”. These exceptions notwithstanding, the idea that infrastructure has become increasingly invisible is a powerful narrative encapsulating complex changes in the built environment and culture.

Diagnoses of invisibility, their assumed political-ecological consequences and proposed responses are also essential to understanding the background to the new infrastructure design imaginary discussed in the following chapter. Despite the valid critiques of the cultural forms superseded by this shift, the consequences of the declining visibility of infrastructure are also frequently identified as problematic because they have, it is suggested, led to a new and even more misleading imagination of the relationship between city and nature; according to Kaika and Swyngedouw (2000, 121), “this hidden form... renders the tense relationship between nature and the city blurred... [and] contributes to severing the process of social transformation of nature from the process of urbanization... The nature/city connection that was still present in the old forms and flows, demonstrating ‘man’s’ control over nature, became totally severed, and, with it, the link between product and production process”. That the literal invisibility of infrastructure translates into a lack of popular understanding, especially as it relates to the relationship between “city” and “nature”, or between social and ecological systems, has become an influential trope among design theorists and it represents a starting point for many critiques of contemporary practice and proposals for alternative approaches. These debates are reviewed in the following chapter.

2.4 Infrastructure designers and expertise

An important theme or parameter which provides structure to the argument developed in the following chapter regarding the emergence of a new infrastructure design imaginary is that of changing forms of infrastructure design expertise. Drawing on the limited number of relevant sources, this section reviews background literature on the topic of “infrastructure designers”. The question of how or why this might be subject to change is discussed in Section 3.5 of the following chapter.

It is widely acknowledged that infrastructures are socio-technical systems that, in addition to technologies, are constituted by systems of knowledge including both the educational resources required for their production and maintenance as well as cultural norms regarding their usage (Star, 1999). Associated with this point is the argument made by authors such as Carse (2016, 28) that infrastructures denote a specific form of “calculative” or “infrastructural reason” which reflects “the modernist desire to render social and environmental heterogeneity manageable and amenable to standardised solutions”. These forms of expertise are further often associated with particular professional disciplines, most commonly that of engineering (De Block, 2016). They are regarded as problematic for various reasons including an inability to respond to local ecological or social conditions (Pincetl, 2016) and a tendency towards anti-democratic and hierarchical forms of organisation. Rubio and Fogué (2013, 1036) argue that infrastructures constitute a “subpolitical sphere” of cities which is “engineered by different forms of expert knowledge and operates largely beyond the democratic control and accountability of citizens”. The reliance on expert, standardised forms of knowledge has also been problematised from a design perspective; Bélanger (2012) describes an existing epistemological paradigm and set of criteria for measuring success which limit the scope for new approaches to design. According to the author (2012, 278), these include established “measures and metrics” in the discipline of engineering which emphasise “control”, “efficiency”, “economy” and “standardisation”.

This commonly accepted narrative of engineering as incompatible with design has been criticised by De Block (2016) as self-referential and historically uninformed. It can clearly be nuanced through an appreciation of the heterogeneity of previous approaches to designing infrastructure, some of which have been referenced above. This is further apparent in

architecture critic Reyner Banham's (1998, 8) assessment of the modernist water storage towers photographed by Bernd and Hilla Becher: "While they stand, their sheer variety bears salutary witness to the rarely appreciated fact that, far from being dominated by a reductive discipline of purely instrumental rationality, the high period of heavy industry was one of almost unlimited variability and richness".

It is further notable that literature on iconic examples of infrastructure design frequently is able to identify and analyse the role, influence and ideas of an "infrastructure designer" in a manner that is less conceivable in the case of contemporary projects. Examples include the discussion of the work of architect Gordon Kaufman on the Hoover Dam discussed in Wilson (1985) or the interaction and conflicts between engineer Joseph Bazalgette and architect Charles Driver regarding the design of Abbey Mills and Crossness pumping stations (Dobraszczyk, 2007). A later historical shift is described by Turpin (2008) who, at least as it pertains to his subject of dam engineering and design, identifies a transition in the figure of the dam designer from an identifiable individual actor often encompassing different forms of technical and aesthetic expertise, to the present context where identifying a singular actor as responsible for design is increasingly difficult. This shift is largely attributed to the increasing complexity and scale of projects and an associated profusion of contractors and sub-contractors.

This ability, apparent in the works cited above, to identify a designer or designers and associated opportunities to analyse their vision and role, represents a marked contrast with the current conditions of anonymity and potential constrained circumstance in which infrastructure designers operate. Easterling (2014) describes the contemporary planning and design of infrastructures as routinised and semi-automatic, oriented around the replication of existing forms and leaving little space for creativity. In her analysis, the lack of understanding of detailed aspects of design is an important dimension of the blackboxing of infrastructure. This discussion, therefore, demonstrates the probable accuracy of critiques such as that by Bélanger (2012) even if they are limited in historical scope. More generally, it highlights that there is little understanding of infrastructure designers, their characteristics, vision and role in a design process.

2.5 Summary and implications

This chapter has introduced the key concepts that form the basis of this thesis, those of infrastructure and design. These terms are typically imagined as unrelated with infrastructure represented as hidden, inaccessible and removed from everyday experience, much less a key contributor to the aesthetics of urban space. However, the chapter has demonstrated the varied history of the relationship between infrastructure and design which is bound up with changes in political/ecological imaginaries and changing visions of modernity and progress. This has highlighted the existence of both complementary and conflictual relationships between infrastructure and design which have varied in line with broader shifts in social perceptions and aesthetic conventions regarding the place of both technology and nature in urban space.

The chapter also began a discussion of the parameters which structure the argument on the emergence of a new infrastructure design imaginary developed in Chapter 3. In this chapter these have only appeared in outline form as a set of recurring themes. The first two, taken together, are discussions of the alternative visibility/invisibility of infrastructure and the introduction of an ecological critique to discussions of contemporary infrastructure design. The chapter has outlined that invisibility is a key aspect of the way in which infrastructure is both defined and imagined. This is often located as the outcome of a historical trajectory which began with iconic and monumental 19th and early 20th century design and has culminated in a contemporary condition of infrastructures becoming increasingly hidden underground. The ecological critique has entered into the discussion through its reference to Kaika and Swyngedouw's (2000) argument that the invisibility of infrastructures contributes to severing a visual connection between city and nature and thereby affects how people imagine their relationship to nature. This has been noted as a powerful trope which provides a starting point for many contemporary proposals for new approaches to design. The context, substance and implications of these proposals are discussed in more detail in the following chapter.

A further theme is that of infrastructure design expertise. The most basic point made has been to highlight the lack of literature on infrastructure designers, their characteristics, vision and role in a design process. The chapter has discussed the designer and the associated question of what forms of expertise they embody drawing on both the design

and infrastructure literatures (in Sections 2.2 and 2.4 respectively). These provide contrasting explanations of what being a designer entails taking into account issues such as modes of reasoning and problem-solving, measures of success and who else might be entitled to influence decision-making. Related to the question of influence, one obvious tension is between established models of expert decision-making described in the infrastructure literature and new conceptualisations of design as a collaborative process. The idea that there are multiple different ways to interpret an increasing emphasis on design expertise in the context of infrastructure projects is applied to the discussion of proposals for new approaches to infrastructure design in the subsequent chapters.

Chapter 3 Infrastructure design in the Anthropocene

“This book does not need to get into the deep waters of “nature” and “society” or the social psychology of perception. What we know from experience is that some forms of modern “intrusion” are accepted and some are not... The main point to take away from this for my purposes is the complexity of these dimensions of infrastructure” (Marshall, 2012, 57).

Contrary to Marshall (2012), this chapter engages in a discussion of the aesthetics of infrastructure by describing current attempts to rethink the relationship between design and infrastructure which, it is argued, constitute a distinctive infrastructure design imaginary. As becomes apparent through the discussion, the context of the Anthropocene is important. Strictly defined, this refers to humanity’s role as the Earth’s primary actor of geological change but has been adopted to describe a conjunction of ecological crises including but not limited to climate change (e.g. Revkin, 2016) in which context sustainability has become a key principle of the spatial design disciplines. The concept is useful in this case because it neatly summarises the context for infrastructure design, described by Poirier (2012, 118) as a pervasive “environmental anxiety” as well as the ill-defined set of problems, both technological and social, to which it is constructed as a solution. A description and analysis of new approaches to infrastructure design which engage with this context is the primary objective of the following chapter.

The previous chapter has highlighted the heterogeneity of previous approaches to infrastructure design, a reality which complicates any aspiration to identify categorical change. The argument in this chapter manages this complexity by identifying three parameters for the evaluation of the reality and/or extent of change. These are a critique of the invisibility of infrastructure, a changing politics of infrastructure design and, last, a change in the forms of expertise foregrounded in discussions of infrastructure design. These are major themes throughout the following chapter and are addressed systematically in the final summary.

The structure of the chapter is as follows: Section 3.1 discusses the contemporary significance of infrastructure in the urban and ecological imaginations. This is associated with the recognition of a need to manage the impact of new urban technologies on the

built environment but is also linked to more abstract debates regarding how people do or should relate to existing and future infrastructures. Section 3.2 elaborates on how different design disciplines are engaging with infrastructure with a shared impetus to problematise its invisibility, but notes that this masks different interpretations of the role of design. Section 3.3 discusses the field of “landscape infrastructure” as encapsulating some key conceptual developments, notably an emphasis on infrastructure both as landscape and as an interface. Section 3.4 introduces aesthetics as an important concept and one which facilitates an investigation of the (ecological) politics associated with contemporary infrastructure design through discussion of proposals for unsettled or challenging landscape aesthetics. Section 3.5 discusses and problematises normative proposals for design expertise to be foregrounded in infrastructure projects. Last, 3.6 summarises the discussion and argues that the conceptual developments which the chapter has discussed represent the emergence of a distinctive infrastructure design imaginary.

3.1 Urban infrastructural futures

The contemporary moment of the Anthropocene is arguably characterised by the emergence of infrastructure as a key concern in academic and political debate. Marshall (2013, 127) defines the present era as characterised by “infrastructuralism” referring to the idea that “more infrastructures are needed” to meet challenges of economic development and environmental degradation, especially that of decarbonisation. The emphasis on infrastructure extends across the political spectrum with both progressive and reactionary manifestations. The latter is apparent in the Trump vision of “brown infrastructure capitalism” (Panitch, 2016) while the former is illustrated by the proliferation of techno-utopian socialist or communist visions, for example Srnicek and Williams (2015), Frase (2016), Brassier’s (2014) call for a new Promethean project, Bastani’s (2017) concept of “fully automated green communism” or Battistoni’s (2014) concept of “cyborg socialism” which begins to articulate a socialist vision of the types of systemic, large-scale, technological and social changes required to cope with climate change.

Of more direct relevance to the design of public space is Rubio and Fogué’s (2013, 1038) diagnosis of a new “infrastructural invasion” which they argue is disrupting the conventional separation between public space and underground, infrastructural spaces: “some of the infrastructures that were once confined to a subterranean or peripheral

existence have slowly re-emerged from the ground, invading and reconfiguring contemporary urban landscapes". The authors (2013, 1038) identify this infrastructural invasion with mega-projects such as "large-scale transport networks and hubs, the creation of technological and informational hubs [and] the emergence of new forms of 'green urbanism'". This can also be linked to the creation of new enclaves of differentiated and marketised access to infrastructures such as those documented by Graham and Marvin (2001) and the urban ecological enclaves which offer bounded spaces of security from ecological disturbances for those who can afford it (Hodson & Marvin, 2010). These spaces introduce access to infrastructure as a crucial mark of distinction both materially and symbolically.

One version of the urban imagination is reflected in "eco" or "sustainable cities" which envisage significant degrees of infrastructural change as a prerequisite to 'sustainable development'. This is one dominant vision of the urban future and is apparent in high-profile eco-city developments such as Masdar. In their self-representation, these sites make a rhetorical claim that increasing the technological complexity of urban space can coincide with high-quality urban and landscape design and architecture. There are also various examples of collaborations between high-profile designers and the commercial stakeholders involved in marketing new infrastructures which seek to demonstrate the contribution these might make to design. These include speculative projects on mobility by Foster + Partners and Nissan (Foster + Partners, 2016), by Bjarke Ingels Group and Audi (Jordana, 2010), an interactive report by design consultancy IDEO which visualises the "Future of Automobility" (IDEO, nd.) and publications such as the "Future of Highways" report by engineering consultancy Arup (2014). However, the possibility of conflict between such technologies, whether autonomous vehicles, decentralised energy generation or new systems of water management and the social value of public space, are often not discussed.

Although sharing an emphasis on infrastructure as well as the relevance of sustainability within design in the Anthropocene, a more nuanced and well-developed vision of the relationship between infrastructures and design is apparent amongst a further range of theorists including but not limited to designers. Their priorities extend to questions of the relationship between new and existing infrastructural typologies and conventional design concerns such as the "physical, economic and historical preservation of cities" as well as

how infrastructure design processes might be better organised (Salomon, 2016, 54). In addition, beyond the superficial beautification of existing infrastructural typologies, contemporary theorists extend the scope of infrastructure design to proposals for new infrastructural typologies which might correspond to an ambitious design agenda. This is associated with proposals for multifunctional and landscape-based systems which, it is suggested, provide a range of social and cultural, as well as ecological, benefits (Brown, 2011; 2014).

In the context of the Anthropocene, the relations with nature which are both embodied and symbolised in different forms of infrastructure have also become a topic of discussion. This has previously been discussed as a key feature of modernist infrastructures both in explaining their cultural resonance at a specific point in time as well as their subsequent re-interpretation as symbolic of a problematic narrative of domination over nature. In contrast, according to influential authors such as Naomi Klein (e.g. 2014, 394) and Murray Bookchin (c.f. Guy & Farmer, 2001), it is necessary to develop alternative forms of technology which both embody and symbolise non-hierarchical and non-extractive relationships both within the social world and with nature. Similar themes have been taken up amongst infrastructure design theorists and this marks the emergence of immaterial processes of interaction between people and technology and their socio-cultural impact as part of the remit of designers. This is illustrated in more detail in the discussion of infrastructural interfaces in Section 3.3.

This brief introduction has attempted to contextualise the current emphasis on infrastructure design as a response to the ecological problematique which is linked to the emergence of infrastructure as a topic of widespread interest and its identification both as an opportunity and threat. In summary, questions of the relationship between infrastructure and landscape, aesthetics and design are beginning to be discussed in the design and social science literatures. The following section documents one aspect of this ongoing discussion which is the diverse range of infrastructure design practices which are unified by a shared critique of the invisibility of infrastructure.

3.2 Problematizing invisibility

“We cannot have a conversation about something whilst it remains unseen...”

(stacktivism.com, nd.).

“The relation between what we see and what we know is never settled” (Berger, 1973, 7).

The first quote above defines the philosophy of “stacktivism”, defined as “a term that attempts to give form to a critical conversation and line of inquiry around infrastructure and the relationships we have to it” (stacktivism.com, nd.). The identification of a link between the literal or metaphorical invisibility of infrastructure and “the relationships we have to it” defines a key shared theme of work on infrastructure design across different design disciplines. This discussion is not intended as comment on whether such analyses are correct, specifically in their uses of the concept of invisibility (the limitations of which have been discussed in Sections 2.1 and 2.3 of the previous chapter); rather it aims to investigate this strand of argument because it potentially implies change in the role of design and designers.

It is important to note, given the objective of the chapter to understand the distinctiveness of the infrastructure design imaginary, that problematizing the invisibility of infrastructures has been a theme in previous writing on urban and landscape design. Notably, Kevin Lynch (1975) prefigured many of the key themes in the contemporary infrastructure design literature in his essay “Grounds for Utopia” which discusses the relationships between infrastructure, landscape and culture. In Lynch’s (1975, 41-42) proposed ideal configuration, the workings of infrastructures are perceptible and accessible to everyone with related effects the ecological imagination: “the landscape is made more transparent, or clues to its hidden functions are left on view. Economic processes are normally exposed. The connection between production and consumption is as immediate as possible... Everyone is trained to read a place, just as they are trained to read a book. Reading a place means coming to understand what is happening there, what has or might happen, what it means, how one should behave there, and how it is connected to other places”. It is also relevant to note that invisibility has often been discussed in relatively simplistic terms. Thayer (1994), for example, constructs the problem as wholly technological, arguing that increasing technological complexity separates people from nature. His conception of an

ideal landscape is one which is “transparent”, where people “have a sense of how they are hooked into all those technical umbilicals we still depend on” (1994, 303). This is underpinned by an assumption that literal visibility translates into knowledge, attachment and an altered sensibility towards the natural environment summarised by Officer’s (2013, 11) argument that “to see is to know and to know is to care” which arguably oversimplifies the development of a sense of connection to nonhuman nature for various reasons including because it neglects aesthetics as discussed in 3.4 below or a discussion of the role of design as creatively reinterpreting and representing processes that are conventionally hidden.

3.2.1 New infrastructural architectures

Two contemporary projects which diverge from a conventional understanding of infrastructure design and illustrate some of the thematic concerns of the broader literature, are BEI-Teesside (Figure 1), an unrealised proposal by Heatherwick Studio for a waste-to-energy power station in Stockton upon Tees in the UK and Amager Bakke, another waste-to-energy facility designed by the Bjarke Ingels Group which is currently under construction in Copenhagen, Denmark (Figure 2). According to Poirier (2012, 118), both of these projects represent “a shift in architecture’s longstanding hierarchies” because considerable design expertise has been expended on infrastructural functions “normally exiled outside of city limits or concealed underground”. Equally, in the promotional material for each project they are consciously represented as departures through their rethinking of the literal and metaphorical invisibility of infrastructure.

The description of BEI-Teesside by its designers notes the lack of attention to the design of contemporary power stations and suggests that this reflects a discomfort with the ecological consequences of generating electricity. As such, Heatherwick Studio envisage their project as reinterpreting historical examples of the infrastructural architecture of power stations to reflect the context of a changing energy system: “We have an opportunity to make new power buildings updated to fit this age. It is exciting to be working with BEI to redefine this type of building and celebrate energy production again” (c.f. Etherington, 2009). The designers’ intentions were, therefore, “to get away from the idea that a power station must be isolated from society... and instead create a public space of civic and recreational value” (Heatherwick & Rowe, 2012, 160). The idea that the project

should be a civic and recreational resource was manifest through the proposal for a “living museum” (Heatherwick & Rowe, 2012, 161) for learning about energy generation.

In the case of Amager Bakke, there is a similar objective to reinterpret the power station typology and to engage the public with waste management and the production of energy. This has been manifest in several different aspects of the design such as allowing views into the interior workings of the plant (Brinkley, 2018). Most notably, previous iterations of the design included a smoke-stack which would produce an illuminated smoke-ring whenever a certain quantity of CO² was emitted from the facility, corresponding to an aspiration to render visible the environmental impacts of providing infrastructural services. This corresponds with the architect Bjarke Ingels’ philosophy of “hedonistic sustainability”, that of rendering ecological sustainability “fun” and unchallenging in the sense of ensuring it does not require changes to existing patterns of consumption (Ingels, 2011).

Despite representing a contrast with conventional approaches to infrastructure design, the role of design in both projects can be described as relatively superficial in the sense that it is concerned with disguising conventional infrastructural typologies whose relationship to the sustainability agenda is arguably very superficial. In the case of Amager Bakke, this is indicated by Brown’s (2014, 109) description of the project’s design as “a diversionary tactic” in the sense that it is not linked to any change in energy or waste systems. In the case of BEI-Teesside this is more explicit; while the aspiration of both designers and developers was to symbolically connect the project to the idea of a changing energy system (Hartman, 2010; Etherington, 2009), according to Poirier (2012), “this is undermined by the actual program of the building: producing power from the palm industry by-products, shipped from Southeast Asia”. As such, the relationship between design and infrastructure evident here can be described as conflictual in the sense that design expertise is required in order to mitigate the otherwise negative aesthetic consequences of infrastructural development. Further, in terms of the interpretation of design, this fits the description by Latour (2009) of applying a veneer of style or aesthetic appeal, in this case to connect each project to a narrative of sustainability.



Figure 1 New infrastructural architectures: BEI Teesside waste-to-energy facility (credit: Heatherwick Studio).



Figure 2 New infrastructural architectures: Amager Bakke, Copenhagen (credit: Bjarke Ingels Group).

3.2.2 “The unfolding capacity of design”

A second category of projects includes those which engage with infrastructure from a more critical perspective for reasons which include, but are not limited to, ecological impact. A shared theme is that of overcoming infrastructural invisibility in a metaphorical sense by reintroducing infrastructure as a topic of debate. A range of terms are used to describe projects of this type including “design fiction” (Knutz & Markussen, 2014), “eco-critical aesthetics” (Geoghegan, 2015) or Rubio and Fogué’s (2015, 143) description of the “unfolding capacity of design” as that of “broaden[ing] the range of bodies, spaces, and material” that feature as matters of concern in political debate.

Within the general framework of infrastructure, relevant projects include those indirectly concerned with ecology such as the various attempts documented by Mattern (2013) to describe and represent the material basis of digital infrastructures such as internet cables, satellites and data storage facilities (also see McLaughlin, 2015). These projects share a concern with undermining the pervasive discourse of “dematerialisation” (Mattern, 2013; Shaefer, 2013) that surrounds digital technologies and which suggests that current development trajectories based around digital economies are a solution to ecological crises. Similar themes are apparent in an art installation by YoHa, titled *Coal Fired Computers* (2010) (Figure 3). This is described by Geoghegan (2015) as making “visible the work, labour, data, disease, and environmental degradation that powers and produces our information machines” by representing the continued reliance of supposedly clean technologies, such as computers, on electricity generated from coal which has both socially and ecologically destructive consequences.

The potential of design to creatively reinterpret and represent what is otherwise invisible is also apparent in two further projects, “Invisible-5” (Scott, 2010) and “Nuage Vert” (Evans, 2008). The former comprised a landscape tour of a road in California where the experience of travelling through the landscape was overlaid with interpretation via an accompanying audio track. The concept was to take advantage of the potential of multi-sensory, direct experience but allied with a recognition that “places are not thoroughly graspable through the senses” but constituted by hidden histories, social relations and materials such as, in this example, extractive infrastructures and “hidden airborne toxins” (Scott, 2010, 39; 42). “Nuage Vert” attempted to visualise the energy consumption of a suburb of Helsinki by

illuminating the cloud emitted by a local power station. The cloud expanded and contracted in dynamic interaction with the energy use of residents. Among the challenges for the artists was the delocalised nature of the infrastructural networks; the spatial integration of energy grids meant the interaction between emissions and representation was metaphorical rather than literal and as such the role of the designer was to explore ways to creatively represent what would otherwise be invisible (Evans, 2008). Both projects further correspond to Rubio and Fogué's (2015, 143) definition of the "unfolding capacities of design" in inviting the viewer to participate in interpreting the project rather than imposing a singular interpretation. This question of open-ness to interpretation is further discussed in the Section 3.4 below on aesthetics. Prior to this, the following section discusses the concept of landscape infrastructure as encapsulating several key aspects of the contemporary infrastructure design imaginary.

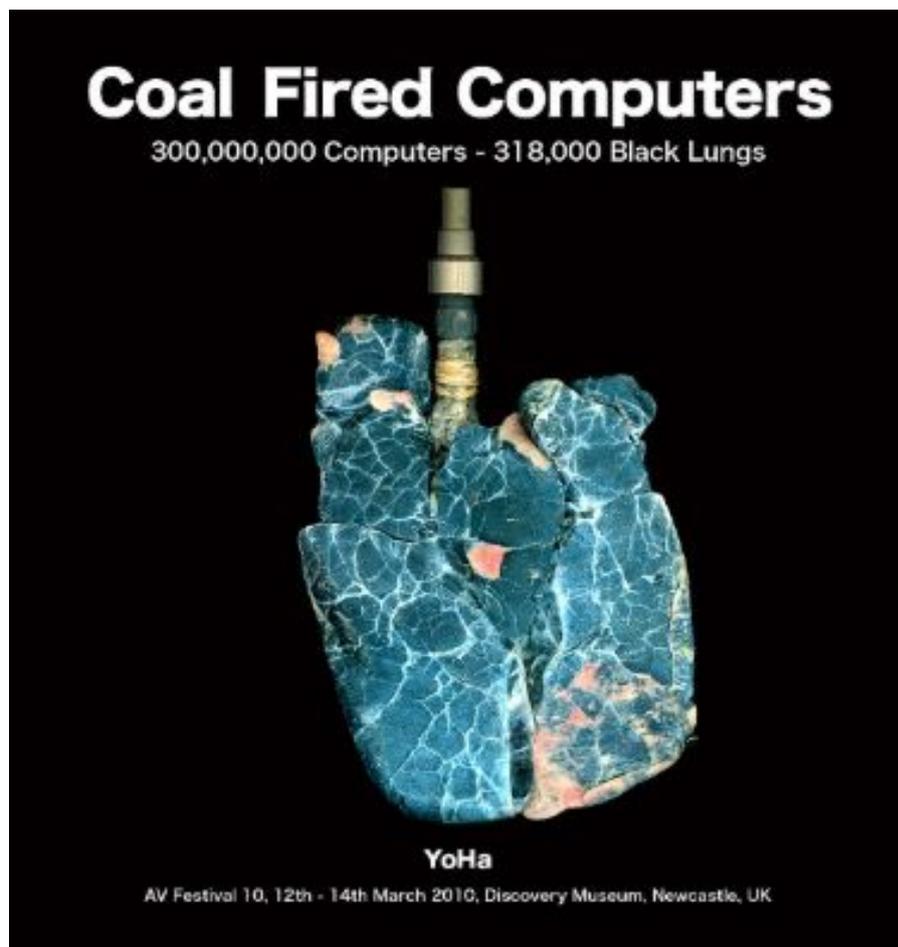


Figure 3 The unfolding capacity of infrastructure design: "Coal Fired Computers" (credit: YoHa).

3.3 Landscape infrastructure

Rethinking the design of infrastructure, including a critique of invisibility, represents a shared concern in different design disciplines. However, this thesis is primarily concerned with the public space of cities and therefore concentrates on how this process is manifest in spatial design disciplines. One field of design theory which has involved productive discussions of infrastructure and design is that of “landscape infrastructure” as described in works such as Rosenberg (1996; 2015), Hung and Aquino (2014), Shannon and Smets (2010), Officer (2013), Carlisle and Pevzner (2013), Angelil and Klingmann (1999), Nijhuis and Jauslin (2015), Salomon (2016), Lokman (2017) and the influential writings of Bélanger (2009, 2012; 2016). Within this body of literature key relevant themes include problematising the invisibility of infrastructures, a related conceptualisation of infrastructures as an “interface” and proposals for a new political aesthetic of infrastructure design.

A straightforward definition of landscape infrastructure is provided by Rosenberg (2015, 195) as “an integrative approach that proposes to address functional issues together with ecological, aesthetic and social concerns”. However, landscape infrastructure does not comprise an entirely homogenous or distinct body of literature, rather is closely linked to other fields such as “ecological” or “landscape urbanism” (De Block, 2016; Vicenzotti, 2017). The discussion here draws on a set of influential authors, primarily those listed above. In terms of further defining the field, a key tenet is a recognition the co-evolution of infrastructures and landscapes, in other words that global infrastructural networks shape and produce both urban and rural spaces, that they have important consequences for landscape aesthetics and ecologies and should be viewed as questions of landscape or, by extension, aesthetics. According to Williams (2016), landscape infrastructure’s contribution is the application of epistemological positions associated with the concept of landscape and the design disciplines; the concept of landscape “relates to both the art of landscaping and that of painting, and therefore evokes far more complex and powerful ways of knowing the world than utilitarian problem solving... The landscape orientation looks at the world as a human being looks at it: an individual with a point of view, taking it all in at once, part of the life of the place and time, part of the landscape, not its imperial overlord”. The epistemological position implied by this definition is discussed further in Section 3.5.

Key design practices associated with this field include, in North America, Michael Singer Studio (ED & MS Studio, 2007), Field Operations and SWA (Hung and Aquino, 2013). European equivalents are more difficult to identify as the terminology of “landscape infrastructure” or closely related equivalents are less frequently used (Vicenzotti, 2017). A short sample could arguably include West 8 (Tepper, 2011), Ooze Architects and several Danish practices specialising in stormwater management including SLA Landscape, Third Nature and Atelier Dreiseitl. A further notable point is the apparent integration of theory and practice with some leading practices directed by widely cited theorists such as James Corner (Field Operations), Herbert Dreiseitl (Atelier Dreiseitl) and, to a lesser extent, Stig Lennart Andersson of SLA Landscape Architects who is a theorist of relevance to the Copenhagen case study investigated in the thesis.

According to Rosenberg (2015), the three interrelated principles of landscape infrastructure are decentralisation, adaptation to local context (both social and ecological) and multifunctionality. This is reflected in the forms of infrastructure with which authors in this field are concerned, such as “hybrid” (Vicenzotti, 2017) or “cyborg” (Lokman, 2017) systems, which combine ecological and technological elements. As such De Block (2016, 268) notes that “design strategies are increasingly merging technological infrastructural function with natural ecological structures”. Projects cited as examples of landscape infrastructure come from a range of domains including food production (Roncken et al., 2011), transport (Nijhuis & Jauslin, 2015; Hung, 2013), energy generation (Hung and Aquino, 2013) as well as many examples of urban water management involving both wastewater treatment (Meyer, 2011) and protection from flooding (Angelil and Klingmann, 1999; Tepper, 2011; Salomon, 2016; Lokman, 2017; Rosenberg, 2015). However, the above descriptions in terms of primary function are necessarily simplifications given that most projects aspire to multifunctionality, defined as the identification of synergies between different functions (Rosenberg, 2015).

On the basis of the examples above, it is apparent that many landscape infrastructure projects are in the broad field of “sustainable” infrastructures, often linked to issues of climate change adaptation and mitigation. This raises issues of the institutional context for design which are discussed in more detail in the following chapter. The preponderance of certain forms of landscape-based or hybrid infrastructures also indicates a potential change in the scope of design whereby designers are arguably becoming more engaged in the

fundamental question of what forms of technology are required. This contrasts with the reactive model of superficial beautification described, for example, in Section 3.2.1. Last, the technological content of the landscape infrastructure vision has aesthetic and experiential and material implications because it involves change in the characteristics of the “interfaces” (see below) or spaces for interaction between people and infrastructures from the scale of buildings to that of urban spaces and landscapes. This is reflected in Section 3.4 which notes that theories of aesthetics in landscape infrastructure are most directly influenced by landscape design theorists.

A final issue in the definition of landscape infrastructure is the question of scale. One vision proposed by Rosenberg (2015) is of decentralised, locally-adapted and therefore small-scale projects. However, other authors envisage engaging with infrastructure as a means to extend their design vision to a larger spatial scale. According to Carlisle and Pevzner (2013), “in embracing infrastructure, designers are extending their agency to look not just at the pieces and parts of the city, but at the design of entire systems and their operations”. This is also illustrated by conceptual projects such as those by the Transport Infrastructure and Public Space Laboratory at the University of British Columbia (TIPSlab, nd.) to visualise and inform transformations in urban landscapes following systemic infrastructural changes, such as transport automation. This issue of scale arguably represents a tension between design and infrastructural logics which is not resolved in the landscape infrastructure literature, although De Block (2016) observes that despite pretensions to the contrary, most practical examples of landscape infrastructure projects are small-scale and piecemeal interventions.

3.3.1 Invisibility and interfaces in landscape infrastructure

Returning to the key themes of the discussion, the topic of infrastructural invisibility and a related conceptualisation of infrastructure as an interface constitutes an important discussion within the literature on landscape infrastructure. According to Bélanger (2012, 278), “infrastructure is the interface by which we interact with the biological and technological world”. Lokman (2017, 61) similarly defines infrastructure as “the interface between human and natural systems”. The emergence of the interface as an object of design has previously been discussed in Section 2.2 of the previous chapter where it was noted that, according to Cowley et al. (2018, 8), interface design involves the creation of

“intended relations” between people and technologies. Elsewhere, Johnson (1997, 14) describes the interface as “a kind of translator, mediating between the two parties, making one sensible to the other”. Hookway (2011, c.f. Mattern, 2014) defines an interface as the “the zone or threshold that must be worked through in order to be able to relate to technology”. According to Mattern (2014), what is important about interfaces is that their role as a translator and mediator which can either enhance or minimise the user’s agency to interact productively with technology.

The idea of interface provides useful if abstract means to discuss infrastructure design. It represents an attempt to develop a terminology to describe the interactions between people and infrastructures, the problems associated with conventional design and to assist the articulation of more productive alternatives. According to Bélanger (2012, 278), the current form of the infrastructural interface is one which obscures rather than illuminates the connections between social, technological and ecological systems because infrastructures “have reached the point of invisibility, often obscuring the connection with the software of social environments and biophysical resources”. In contrast, Rubio and Fogué (2013, 1044) propose the creation of an alternative typology of “active interfaces enacting a *specific* regime of cohabitation which connects and makes co-present in the space... seemingly disconnected social, natural and technological agents” [emphasis in original]. Lokman (2017, 63) develops this argument, suggesting that designers should create new forms of interaction between people and infrastructure by “creating dynamic interfaces” such as a “system that increases our perception and engagement with the surroundings”. This implies a degree of reciprocity and feedback, suggesting that design could lead to active rather than passive forms of interaction whereby both users and technologies are transformed.

There are evident gaps in this discussion such as an articulation of what forms of landscape aesthetics might ensue from the application of interface design principles to urban infrastructures and public spaces (rather than its more conventional application to digital technologies). The following section discusses in more detail the vision of infrastructural aesthetics proposed by landscape infrastructure and other theorists.

3.4 New infrastructural aesthetics

Hitherto, the chapter has outlined some common themes from recent literature on infrastructure design. The following section aims to develop on this argument by discussing the conception of aesthetics amongst landscape infrastructure and other design theorists, specifically the suggested relationship between aesthetics and ecological sustainability, which is key to the argument that there is a changing politics of infrastructure design. The concept of aesthetics is intuitively related to that of design (see Section 2.2 of the previous chapter) but up to this point it has not been examined in detail. Therefore, Section 3.4.1 first outlines what is meant by aesthetics in this context.

3.4.1 Defining aesthetics

According to Soper (1992, 121), the concept of the aesthetic is “perhaps more than any other employed in philosophical discrimination, is the most volatile and difficult to fix. It is no easy task to determine the respective terrains of the rational or the ethical, or to say exactly where cognition gives way to some more intuitive or sensual mode of apprehension... the aesthetic sits uneasily between the mental and bodily poles that it sets out to synthesise; as the achievement of their unity, it appears as a mode of experience-cum-understanding that is transcendent to either, and entirely *sui generis*”. This description highlights an important feature of aesthetics as occupying a complex space between sensation and cognition. Recognising this complexity provides a means to interrogate different interpretations of environmental or landscape aesthetics which often emphasise either knowledge or sensory experience to explain why some places are judged to be aesthetically valuable and others are not.

According to Castree (2005), aesthetics is one of various forms of knowledge through which nonhuman nature is understood. The author (2005, 17) adds that aesthetics is conventionally understood as having nothing to do with what is good, right or just and rather is purely concerned with what is “sensually satisfying”. This contrasts with Soper’s (1992) definition and with that adopted by authors such as Eagleton (1990) and Dean and Fisher (2014) who see aesthetics as a fundamental component of ideology. Similarly, according to Goonewardena (2005, 47), political ideas need an affective or aesthetic appeal in order to be convincing because “ideas without sensations – feelings, affections,

passions and all the rest of it – do not work too well as ideology”. This interpretation also provided the framework to interrogate infrastructure design in Chapter 2 where it was recognised that the aesthetics of infrastructures, in the sense of issues such as iconography and visibility, were an important element of their political legitimacy. The following section discusses the different ways in which aesthetics is understood in contemporary discussions of infrastructure design. Subsequently, Section 3.4.3 discusses one understanding which could be described as a new iteration of the political aesthetic of infrastructure design which emerges both from discussions of visibility and of the relationship between aesthetics and sustainability.

3.4.2 Aesthetics and infrastructure design

One interpretation of aesthetics applied to infrastructure is that it provides an alternative epistemology and progressive framework for infrastructure planning and design (e.g. Salomon, 2016). This emerges from recent work which argues that what constitutes aesthetics should be redefined; according to Engelmann and McCormack (2017, 242), “more than just a limited domain of judgment or taste, in much recent work within and beyond geography, the aesthetic is taken to constitute a heterogeneous field of sensing distributed across the capacities of different bodies, both human and nonhuman”. This implies that what constitutes aesthetics cannot be solely defined by an elite. The relationship between such an understanding of aesthetics, as a mode of apprehension and infrastructure design, as a mode of action, is not immediately apparent. One exception is Salomon’s (2016) argument that the significance of aesthetics thus understood is its implications for defining the ideal infrastructure design process, including the forms of expertise involved. This perspective is discussed in more detail in Section 3.5.

In addition to constructing aesthetics as a mode of experiencing and understanding the world, Engelmann and McCormack (2017, 242) argue that the affective power of aesthetics, understood in a broad sense, can be applied by artists and designers to enhance “our capacities to be affected by and to sense, feel, and imagine elemental variations in the world we inhabit. Enhancing such capacities, we argue, is crucial to make the conditions of the present palpable as a prelude for the articulation of different forms of ethical-political awareness”. This identification of a connection between aesthetics and sustainability reflects an important topic of discussion in the broader literature, for example Bennett’s

(2004, 361) argument that aesthetics contributes to sustainability by cultivating “a certain love of the world, or enchantment with it”. This idea has also been taken up in the infrastructure design literature and, as discussed in the following section, this forms the basis for the argument that there is a new ecological politics of infrastructure design.

3.4.3 Challenging aesthetics and the politics of infrastructure design

The objective here is to discuss what visions of landscape or infrastructural aesthetics, arising from the current emphasis on problematising infrastructural invisibility, are proposed by infrastructure design theorists. The argument here draws on authors who might not use the terminology of infrastructure design or landscape infrastructure but are widely referenced in that field (e.g. Meyer, 2008). It describes the idea that infrastructural aesthetics have a function to promote “cultural sustainability” defined by the alignment of aesthetic preferences with ecological value (Nassauer, 1997). This arguably represents the transposition to the field of infrastructure of established architectural and landscape design concepts. These include “eco-revelatory design”, described by Karvonen (2011, 139) as practices which “highlight the connections between the human and the nonhuman through a process of revealing and marking” or the “eco-aesthetic” model of architecture described by Guy and Farmer (2001, 143) whereby “the role of sustainable architecture is metaphorical and, as an iconic expression of societal values, it should act to inspire and convey an increasing identification with nature and nonhuman world”.

One example of infrastructure design informed by these principles is provided by Rosenberg (2015) who identifies interlinkages between what are termed the socio-cultural and ecological benefits of landscape infrastructures. The author (2015, 195; 199) argues that projects corresponding to the principles of site-specificity contribute to “deepening local identity” because “in a site specific approach landscape structure is maintained and given visibility and prominence. In cultural terms, this approach promotes a sense of place attachment”. Other authors suggest that designers should challenge conventional aesthetic preferences and promote the acceptance of ecologically sustainable landscapes and infrastructures (e.g. Meyer, 2011; Van Roncken et al., 2011). Saito (2004) describes this as the role of design in promoting “a new aesthetic sensibility” which “should be facilitated and nurtured by our experiencing and living with those mechanisms which are its major players, such as wind turbines, solar panels, constructed wetlands, and

natural storm drainage”. Similar to the argument made by Bennett (2004) above, this is judged necessary because, according to Meyer (2008, 10), rational argumentation in favour of sustainability is a failed enterprise and what is required are “attitudes, feelings, images and narratives”.

As previously highlighted in Section 3.2, there are some relatively simplistic and literal interpretations of what transposing principles of visibility into infrastructure design practice might mean (e.g. Thayer, 1994). In contrast, Evans (2008) describes the particular relevance of aesthetics to the project “Nuage Vert” as being “the avoidance of a simple moralistic message, but rather [the project] tries to confront the city dweller with an evocative and aesthetic spectacle, which is open to interpretation and challenges ordinary perception”. Elsewhere, Reimer (2010), Meyer (2008) and Roncken et al. (2011) refer to the concept of the landscape sublime as an overwhelming aesthetic impression which requires reconfiguration of pre-existing ideas to reconcile sensory input and cognition. This reflects Gandy’s (2011, 62) observation that there has been a recent expansion in concept of the sublime from its conventional application to nature towards “encompass[ing] the scale of human artifacts in the landscape such as machines or vast industrial installations”. Perhaps the most detailed discussion of a landscape infrastructure aesthetic (or an aesthetic of infrastructural visibility), is provided by Lokman (2017) who argues that this aesthetic resides in the interface or interactions between people, technology and ecological systems which landscape infrastructures facilitate. The author (2017, 72) describes several conceptual landscape infrastructure projects and diagnoses “new spatial and material conditions, exchanges, and temporalities that enrich the experience of everyday life; promoting an aesthetic that is predicated on relationships between dynamic things and systems, not static single objects alone”. In terms of how this might relate to management of infrastructures, the author (2017, 63) emphasises concepts such as “responsivity” and “feedback” which would “change the way users perceive their context” and allow for more sympathetic and adaptive management.

Infrastructural projects following these principles have not been widely implemented or researched. Nevertheless, it has been noted that the spaces produced by following these principles are not likely to be universally valued. According to Reimer (2010, 24), “the future eco-scape is not necessarily a sphere where you feel ‘at ease’, but a performative and unsettled space in constant transformation and change”. This is also implied in Meyer’s

(2008, 15) description of the role of design as the translation of “cultural values into memorable landscape forms and spaces that often challenge, expand, and alter our conceptions of beauty”. This raises an obvious question of whose cultural (and social or economic) values these represent. It arguably situates the designer as an arbiter of cultural values and potentially contradicts a widely expressed aspiration to reinterpret design as a more inclusive and collaborative process (see Section 2.2 of the previous chapter). In addition, this model also arguably represents aesthetics as closely related to cognition as it relies on an understanding of the ecological value of certain infrastructures or landscapes and entails a claim that aesthetic appreciation follows knowledge. As noted by Gandy (2013a), in a discussion of the aesthetics of urban wildernesses, this knowledge is likely to be unevenly distributed throughout society. Finally, it is also important to consider certain pragmatic considerations which might provide an impetus for the valorisation of challenging aesthetics. From one perspective, this provides a justification for “intrusive” infrastructural developments which might otherwise be rejected. Following this narrative, opposition to development could potentially be dismissed as motivated by outdated aesthetic preferences or a lack of awareness of ecological benefits.

Generally, these questions are difficult to resolve in the abstract and require an analysis of specific function of design in a given context and of the distribution of decision-making power. The following section of the chapter expands on some of these questions by discussing who, according to contemporary theorists, should be involved in designing new infrastructures.

3.5 Infrastructure designers and expertise: contemporary context

“The reorientation of infrastructure from concrete and steel to soil and vegetation mobilises a new expert... guided by what Kirchhoff et al. (2013) describe as the new ‘superscience’ of landscape ecology geared at bridging the divides between the natural and social sciences and the humanities” (De Block, 2016, 369).

As discussed in Section 2.4 of the previous chapter, the planning, design and management of infrastructures in the past has been associated with specific forms of expertise and by extension with particular disciplines such as engineering (Star, 1999). Many authors, writing from a design perspective, attribute the social and ecological damage caused by

infrastructures to these disciplines, their associated performance criteria and modes of reasoning (e.g. Bélanger, 2012). In contrast, contemporary ideas such as “a design-led approach to infrastructure” (Design Council, 2012) imply a repositioning of design expertise in the internal hierarchy of infrastructure projects. Building on this context, this section reviews changing interpretations of who should design infrastructure and what forms of expertise they should apply. This ongoing process is a key parameter for the development of the argument on the novelty of the contemporary infrastructure design imaginary.

As highlighted by Guy and Farmer (2001, 141), there are different models of sustainable design associated with “differing sources of environmental knowledge through which we come to experience and understand the environment”. According to the authors, some of the poles towards which these forms of knowledge are oriented include knowledge as alternately local or global, technical or socio-cultural and, last, as derived from democratic processes or from expert sources. As such, design expertise in this section is not conceived as unitary. A primary tension is described between inclusive and exclusive interpretations. The latter is primarily identified with a trend towards technocratic management including within the framework of landscape infrastructure.

3.5.1 Aesthetics as an inclusive planning framework

One trend in the broader design literature is towards an expanded interpretation of the designer and concepts such as collaborative and participatory approaches (Cowley et al., 2018). This is also, to an extent, apparent in the infrastructure design literature which has a shared aspiration to problematise logics of efficiency and standardisation (Bélanger, 2012) which are conceived as unresponsive to local conditions, whether socio-cultural or ecological (Rosenberg, 2015). However, what is suggested as an alternative varies from a vision of a now extended range of technocratic professionals including designers and ecologists (see Section 3.5.2 below), to more inclusive alternatives that incorporate non-professional expertise. One example of the latter is Lokman’s (2017, 72) proposal for “co-management strategies that rely on multi-stakeholder participation”.

This perspective is more fully developed in Salomon’s (2017) discussion of the significance of interpreting infrastructure from the perspective of aesthetics. Salomon (2016) defines aesthetics as “subjective” and “inclusive” rather than limited to visual perception, formal

properties or style. According to the author (2016, 54), the relevance of aesthetics for infrastructure is that it provides “an alternative, non-hierarchical framework for conceptualizing and producing it”. The non-hierarchical nature of aesthetics is, Salomon (2016, 55) argues, related to the difficulty of clearly defining and quantifying an aesthetic experience which “makes it difficult to rank one above the other”. Conceptualised as such, aesthetics provides a progressive and democratic framework for infrastructure planning. On the other hand, it is unclear to what extent this definition characterises the conceptual design proposals analysed in Salomon’s essay which rely on the author’s interpretation of their value based on a set of visual representations. Notably, his interpretation of a lack of hierarchy as it is applied to describe the case study projects refers to the fact that priority is not given to one function within a multifunctional programme rather than describing the decision-making process.

As described above, there is further interpretation of the designer as engaged in an “ethical-political” project (Engelmann & McCormack, 2017, 242) of challenging conventional aesthetic preferences. Meyer’s (2008) interpretation of the design as manifesting ecologically-informed cultural values in the built environment clearly implies a designer who acts, as described above, as an arbiter of these values. The forms of expertise and knowledge informing such value judgements, at least insofar as they apply to infrastructure, have not been subject to research. However, it is relevant to note an implicit conflict between this perspective and that provided by, for example, Rosenberg (2015) who situates the (landscape) infrastructure designer as responding to local social and ecological conditions.

3.5.2 Ecological expertise

Authors such as De Block (2016) have noted the ambiguous understandings of expertise within relevant fields of literature such as landscape/ecological urbanism. As discussed in Section 2.4 of the previous chapter, De Block (2016) argues that the histories of infrastructural expertise as narrated by contemporary design theorists are frequently simplistic. He notes that the forms of expertise which informed the early development of modern infrastructures included both the social and ecological, for example referencing studies of the interaction between housing and disease transmission, which were applied to support comprehensive socio-ecological reforms. Regarding contemporary design

theory, De Block (2016, 378) argues that current theories of knowledge of the social world emphasise concepts such as complexity, adaptation, open-endedness and that this is linked to an “indeterminate political position” of retreat from a radical political vision. What is further important about De Block’s (2016) argument is that (as discussed in Section 2.2) it links this position to the broader design literature, such as Latour (2009), which reflects the significant degree of overlap between that body of literature and that on landscape and infrastructure design. Last, De Block (2016) argues that the forms of expertise applied to understand “nature” in current design theory are radically different from those applied to the social world, and rather seek to take nature as a guide for the development of society; he describes (2016, 370) a new generation of projects “not driven by historic precedent or community opinion, but... data coming from landscape ecology”. This position is further supported by Vicenzotti’s (2017) analysis of the use of the term landscape in landscape urbanism. The author (2017, 81) suggests that “naturalized notions of landscape” whereby it is “reduced to a phenomenon that can be mapped and explained in terms of quantitative, nomothetic, generalizing science” predominate over recognition of its aesthetic and imaginary dimensions.

As indicated by De Block’s (2016) critique, the question of expertise in this context is further closely related to epistemological assumptions regarding the relationship between the natural and social worlds. This is often constructed as a binary of two distinct categories with the “nature” considered to be adequately governable by natural science and therefore a distinct realm of expertise to the social or political. This philosophical position provides the basis for the “depoliticisation” of urban ecological politics which becomes a technocratic and managerial question and ultimately excludes anyone whose perspective is not reconcilable with this framework (Swyngedouw & Kaika, 2014). In contrast to this ontological and epistemological separation, the authors (2014) insist on the political character of questions of urban environmental governance and, more generally, on the interrelated character of nature and society.

3.5.2 Financial logic for design

Cowley et al. (2018) argue that contemporary design is characterised by a retreat from the idea of design as a scientific enterprise with quantifiable metrics for analysing success. On the other hand, some interpretations of the role of design are driven by an overtly financial

logic which sees design as a primary site of value-addition and a method of differentiating products in a market setting. For example, according to Lash and Urry (1994, 15), “the design component comprises an increasing component of the value of goods”. Under such a model, though “users” might participate in a design process this would be in their capacity as the objects of market research and dependent on their future status as “consumers” (Björgvinsson et al., 2010).

An interesting feature of contemporary discussions of infrastructure design is that design has re-entered the managerial lexicon albeit seemingly referring to product or service, rather than spatial, design disciplines. This is apparent in discussions of HS2, a major high-speed rail project in the UK, where a key principle of the design vision is the improvement of customer experience (HS2, 2018). This process is elsewhere apparent in discussions of new forms of transport provision which, it is presumed, will be shared rather than ownership based. In this context, it is suggested that these systems require better “user experience design” (Pritchard, c.f. NESTA, 2015). However, this phenomenon and any associated changes in the characteristics and role of designers have not been subject to research. Aside from specific forms of infrastructure, in this case transport, which have a clear market-based logic for improved design (in some senses of the term), there may also be financial logic relevant to infrastructure design at the scale of public space. This topic is discussed in more detail in Chapter 4 (Section 4.4).

3.6 Summary: a new infrastructure design imaginary?

This chapter has discussed contemporary attempts to rethink the relations between society, infrastructures and nature in the context of the Anthropocene. It is argued here that there is an emerging, distinctive infrastructure design imaginary, albeit one which is evidently not entirely new nor wholly internally consistent. As summarised below, this is characterised by a shared concern with the in/visibility of infrastructure, a new political-ecological aesthetic and changing ideas of who should be involved in design. The detailed description and analysis of this infrastructure design imaginary as constituted by these thematic concerns is the primary contribution of the chapter.

In contemporary discussions of infrastructure design, there is a widespread concern with the invisibility of infrastructures because it is assumed that this is closely related to how

infrastructures do (or do not) feature in the popular imagination with assumed problematic consequences for social and ecological awareness. A variety of recent projects illustrate a new approach that seeks to render infrastructure a visible feature of urban space.

However, these projects are characterised by different interpretations of the role of design with contrasting superficial and radical models described in Sections 3.2.1 and 3.2.2. As described in Section 3.3, a critique of conventional infrastructure design and the forms of interaction between people, technology and ecological systems which this engenders, is also a key feature of work in the field of landscape infrastructure. Within this field, the important concept of the infrastructural interface has emerged to describe conventional forms of interaction as well as to aid the articulation of more productive alternatives.

A second and closely related feature of the contemporary infrastructure design imaginary is the changing politics of infrastructure design through the emphasis on a distinctive political-ecological aesthetic or, as described by Engelmann and McCormack (2017) through the reconceptualisation of aesthetics as a means to promote a new ethical-political awareness. This has been most clearly articulated in discussions of landscape design by authors such as Meyer (2008) and translated into discussions of infrastructure through the development of landscape infrastructure as a supposedly integrated and multidisciplinary mode of practice. However, the concept of challenging aesthetics can also be problematised on the grounds of its legitimacy and role, for example if applied to legitimise cases of controversial or intrusive development. More generally, it raises questions of the distribution of decision-making power in the design process.

Finally, the contemporary imaginary is characterised by a critique of existing forms of “infrastructural reason” (Carse, 2016) and proposals for a more multidisciplinary, integrated and, in some cases, inclusive, approach which, it is claimed, aligns with that of design. As apparent in the work of Salomon (2017), an emphasis on inclusivity is closely related to a broad definition of aesthetics as a mode of understanding the world which is not limited to any expert or professional group. However, the review has also highlighted that the understanding of design is not entirely consistent and in some cases, problematic. An important example is De Block’s (2016) critique of landscape/ecological urbanism due to its application of different epistemologies to the natural and social worlds.

These three interlinked themes of invisibility, the politics of infrastructure design and expertise, are taken to represent a distinctive contemporary infrastructure design imaginary. This imaginary posits a distinctive, non-conflictual relationship between design and infrastructure but this is premised on a range of assumptions regarding the approach to design, what forms of infrastructure this might involve and the acceptability of new infrastructural aesthetics. Its description provides the basis of much of the rest of the thesis which can be understood as an extended discussion of where and why new approaches to infrastructure corresponding to this imaginary are being implemented and with what consequences.

One obvious response to the argument is to question the assessment of novelty. Should the contemporary infrastructure design imaginary be regarded as distinctive? From one perspective, the degree of novelty could be regarded as very limited. The review has drawn on relatively established fields of design theory such as ecological/landscape urbanism and landscape infrastructure. As such, the discussion is a summary of existing knowledge. In addition, the range of theorists and design practitioners who have engaged with the themes discussed clearly exceeds a timescale of what could be termed contemporary. These include Lynch (1975) or F.L. Olmsted, whose 19th century projects are frequently referenced as early examples of a landscape infrastructure approach (Vicenzotti, 2017). Also relevant are previous discussions of challenging aesthetics and their relation to cultural sustainability such as Nassauer (1997) and Selman (2010).

In contrast to the idea that the argument here is simply a survey of existing knowledge, it has also drawn out conceptions of design and aesthetics which often are not clearly or directly discussed in the literature and has put them in an historical and cultural context. Regarding the question of novelty, the assessment of the distinctiveness of contemporary design theorists relates to its systematic engagement with infrastructure. It also incorporates both a qualitative and quantitative dimension reflecting the degree to which the key themes are commonly discussed in different design disciplines (e.g. see Section 3.2.2 for examples from a range of fields of design). In addition, these issues can be linked to the context of the Anthropocene, the practical design challenges raised by an “infrastructural invasion” and the more abstract challenge of redesigning the relationships between society, infrastructure and nature.

Chapter 4 Infrastructure design in practice

The following chapter links the conceptual discussion of infrastructure and design in previous chapters with the factors that might influence “actually existing” design processes. As such, the chapter responds to the overall aim of the thesis to explore both meanings and practices of infrastructure design. In the thesis, design is understood as a “situated” process. Within the design literature, a situated understanding of design is one which recognises that design is a social process, that it is influenced by issues such as its institutional, cultural and material context and that designers, as well as actively shaping the world around them, are themselves shaped by their surroundings (Kimbell, 2011; 2012; Sunley et al., 2011). Developing on this framework, the chapter introduces questions of what broader range of actors, institutions and agendas might become relevant through the implementation or infrastructure design process. It explores possible constraints and opportunities for designers arising from the institutions, structures and overall context in which they are located. Last, discusses where new approaches to infrastructure design are located through a discussion of how design is imagined and practiced in the sector of urban stormwater management, which is also the sector in which the empirical case studies explored in the thesis are situated.

The first part of the chapter (Section 4.1) develops a framework for understanding and analysing “actually-existing” (Shelton et al., 2015) infrastructure design processes. However, there is limited literature on this topic. Within the infrastructure design literature, for example, many authors focus entirely on abstract principles (e.g. Carlisle & Pevzner, 2013) or on conceptual proposals which preclude discussion of implementation (Salomon, 2016; Lokman, 2017). Within social scientific studies of infrastructure design, design is often described as the outcome of broader structural processes of economic and cultural change, with less attention to the minutiae of a given design process (e.g. Kaika & Swyngedouw, 2000). For this reason, this chapter draws on a range of literature to identify and outline key elements of the infrastructural design process. This includes, most importantly, Swyngedouw’s (1999) description of infrastructural change which is used to generate an initial set of factors or variables whose relevance for understanding infrastructure design processes are explored and tested in the Sections 4.1.2-4.1.3. These variables are, respectively, the material realities, in the sense of types of infrastructure, with which designers are engaged, the institutional settings in which design expertise is

situated and the potential role of economic development and financial logics as providing an impetus towards the adoption of new approaches to infrastructure design.

The remainder of this chapter (Section 4.2) explores the implications of a transition from investigating the design of infrastructures to design of urban stormwater management systems, the field in which the empirical case studied investigated in the thesis are situated. The purpose is to discuss to what extent the conceptual framework, both the diagnosis of a contemporary infrastructure design imaginary and the outline of the infrastructure design process, is relevant to this specific subfield of infrastructure design practice and, as such, potentially relevant to understanding the case studies. A further and related intention is to discuss why stormwater design has seemingly emerged as a site of innovative design. To this end, Sections 4.2.2 and 4.2.3 discuss to what extent theories of design and design expertise in the field of sustainable stormwater management parallel what has been defined as the contemporary infrastructure design imaginary. Subsequently, Sections 4.2.4– 4.2.6 discuss influences on the stormwater design process. More specifically, these sections explore how stormwater design might be situated in terms of the framework developed in Section 4.1 by discussing the institutional, material and economic contexts for stormwater design.

4.1 Conceptualising the infrastructure design process

One important conceptualisation of infrastructures describes them as a network of interlinked social, technological and ecological elements, defined by Swngedouw (1999) as “socio-natural” and “hybrid” systems.³ The historical process whereby these configurations come to exist is described by Gandy (2006, 62) as the “the production of urban nature” which refers to “a simultaneous process of social and bio-physical change in which new kinds of spaces are created and destroyed, ranging from the technological networks that give sustenance to the modern city to new appropriations of nature within the urban landscape”. This is further discussed by Swyngedouw (1999, 447) who defines a given infrastructural configuration (that of the Spanish “waterscape”) as the result of “the production of socio-nature” referring to the dialectical relations between a diverse range of

³ It is important to clarify that the concept of hybridity is applied by Swyngedouw (1999) to describe all types of infrastructural systems. It has more recently been repurposed by authors such as Lokman (2017) to describe “landscape infrastructures” which incorporate visible ecological elements in urban space.

influences such as “chemical, physical, social, economic, political and cultural processes”. Elsewhere this is restated as including ‘bio-chemical processes, material, cultural, ideological and representational practices, social relations, language and discursive constructions’ as well as knowledge and scientific practices (Swyngedouw, 1999, 448-9). As discussed throughout the rest of the chapter, the wide range of influences identified here is used as a starting point for a discussion of the infrastructure design process.

One of the structures identified above by Swyngedouw (1999) is that of cultural practices. Analysis of current cultural, as well as representational and discursive, practices of design have occupied the majority of the discussion thus far, in the sense of its exploration of practices of debating, producing and, in some cases, implementing normative proposals for new forms of infrastructure design. One important aspect of the discussion has been to describe and analyse one strand of these debates which has been described as constituting a contemporary infrastructure design imaginary. The idea of the extent to which these ideas are regarded as valuable is evidently one of the key variables relevant to understanding where, why and how new approaches to design emerge.

However, Swyngedouw’s (1999, 449) argument further suggests that the relevance of cultural practices, such as design ideas, depends on their interaction with other contingent influences on the design process or more specifically, that they are “inscribed” by the unequal power relations that characterise processes of infrastructural change. As previously discussed, infrastructure design has been widely acknowledged as a political (aesthetic) issue through its rhetorical and ideological functions which have been leveraged to serve the interests of powerful groups, for example by facilitate otherwise unwelcome infrastructural developments (e.g. Gandy, 2001; Kaika, 2005). Gandy (2001) describes the role of design within water infrastructure projects in New York as rhetorically representing infrastructural projects as a wider public benefit when, in reality, their development was driven by a desire to support the expansion of the urban economy. From the outset this suggests one, albeit very vague, way in which infrastructure design might be situated, in the sense that it is structured by the power relations shaping broader processes of change in a given infrastructural network. This provides an important element of the context within which design, and designers, operates and, therefore, is a reality that any investigation of design must take into account. At the same time, Swyngedouw’s (1999)

position is of a dialectical relationship between cultural and other practices, in other words it is not entirely pre-determined by, for example, the social relations of production.

However, this evidently leaves unresolved questions of how this relationship between power and design might operate in any more detailed sense and, more generally, what further insights might be derived from this overall description of infrastructural change in order to understand the infrastructure design process. To this end, some of the diverse influences which Swyngedouw (1999) identifies are explored in the following sections.

4.1.1 Material context for design

The second potentially relevant variable which might be extracted from Swyngedouw's (1999) analysis is that of the 'material'. This is understood here as referring to the material realities with which designers are faced, primarily the forms of infrastructure which they are engaged in shaping, and which inevitably provide constraints and opportunities. This emerges as significant due to the characteristics of the contemporary infrastructure design imaginary which is as a complex technological-aesthetic vision whereby new approaches to design are often seen as co-dependent or interrelated with the adoption of new forms of infrastructure, most notably hybrid or landscape infrastructures such as new systems of urban water management (see Section 3.3 of the previous chapter). Compared to other categories of infrastructure, for example power stations, this evidently provides a very different context for the implementation of design ideas such as those encompassed by the concept of the contemporary design imaginary; the visible and above-ground character of landscape infrastructures potentially lends itself to (or requires) rethinking how people might interact with infrastructures and ecological systems.

In addition, drawing on authors such as Barry (2009) and Larkin (2013), infrastructure design has previously been described as a process of selectively rendering visible specific aspects of infrastructural systems which are thereby identified as causal (see Section 2.1.2). A landscape infrastructure framework potentially introduces new opportunities to selectively highlight ecological or technological components of a given infrastructural network as important or unimportant whether this represents the reality of the system's functioning or not. This is further indirectly discussed in Section 4.4 which suggests that some examples of so-called sustainable design have superficial infrastructural functions

but, in reality, are motivated by economic considerations such as increased property values.

A final issue is the possibility of conflict over the uses of space which might be faced in an urban setting due to the implementation of landscape infrastructures which potentially require the appropriation of urban (green) space. This would evidently provide an impetus to find “multifunctional” solutions to reconcile competing demands. From a critical perspective, it has also previously been suggested (in Section 3.4.3 of the previous chapter) that valorising new forms of challenging infrastructure design on the basis of their contribution to cultural sustainability could provide an aesthetic justification for intrusive forms of infrastructure that would otherwise be judged unacceptable. To what extent any of these issues have influenced specific cases of design has not been discussed in the infrastructure design literature, although it has emerged as a key theme in sub-fields such as stormwater management as discussed in Chapter 7. The idea of infrastructure design becoming entangled with the planning of urban green space is further discussed below in Section 4.4 below on economic development and financial logics.

4.1.2 The designer: institutional context and design expertise

A further important ‘variable’ is that of expertise. In Swyngedouw’s (1999) argument this refers to issues such as whether infrastructures and “nature” are regarded as social or wholly scientific and, therefore, depoliticised domains of knowledge. In contrast, the starting point for this thesis are meanings and practices of infrastructure design which value design expertise and therefore it is useful to examine this category further. However, rather than discussing varieties and meanings of design expertise (see Section 3.5 of the previous chapter), the intention here is to explore how it might be institutionally located, in other words which institutions or agencies are responsible for design and how might this influence the approach adopted.

Some of the different institutional contexts or ways in which design expertise is located can arguably be situated on a continuum. One pole might be comprised of instances where design is not distinguished from a broader process of production. For example, as described in Section 2.2, all infrastructures may be designed in some sense of the term but such processes are not necessarily labelled design. This broadly corresponds to Easterling’s

(2014) argument that the production of many infrastructures is often understood as not having any relevance for design and therefore not scrutinised in such terms. The specific institutional context of such cases is not necessarily clear but, by definition, it is one in which a discrete design aspect of the production process, and therefore a designer, is not clearly identifiable. One exception (which proves the rule) is Pawley's (1998, 187) description of the architecture of logistics warehouses, what he terms "big sheds", and the firms responsible for their design "who are hardly known outside industrial circles. Such anonymity is part of the culture of 'Big Shed' architecture". In contrast, the opposite end of this continuum is identified by Hatherley (2011) in his description of signature infrastructural projects by high-profile architects such as bridges designed by Santiago Calatrava. In such cases the designer is very clearly signposted and is embodied in the figure of an external expert. Notably, Hatherley (2011) argues that such signature and iconic infrastructure projects are often central to processes of place-branding and regeneration, a point which is discussed in more detail in Section 4.4.

A further intermediate position is arguably illustrated in the UK Design Council's report on "a design-led approach to infrastructure" (Design Council, 2012). This suggests the appointment of a "design review panel" to approve a developer's proposal prior to an application for planning permission. A broadly similar approach is supported by planning guidelines for Nationally Significant Infrastructure Projects in the UK which encourage developers to take "independent professional advice on the design aspects" of their proposal (DECC, 2011, 51). Elsewhere, drawing on a study of the design of dams, Turpin (2008, 117) traces the emergence of the idea in the mid-twentieth century that engineers should seek to consult "those who are more expert on the question of aesthetics" such as landscape architects, a shift which the author associates with emerging preferences towards more naturalistic dams and reservoirs that would not stand out in a natural setting. This likely reflects the reality of most infrastructure projects, whereby design is arguably often understood as a set of reactive measures to mitigate the negative impacts of a development conceived and designed following a hierarchical set of principles prioritising cost-efficiency and utility and where it is clearly identified as the remit of a limited set of design experts. According to Bruegmann (1993, 12), in such instances "the finished product exactly mirrors the process: design looks like a superfluous afterthought".

While arguably providing a broad outline of how infrastructure design expertise might be institutionally situated, this does not directly address questions of what institutional arrangements might be associated with new approaches to design corresponding to the concept of a contemporary infrastructure design imaginary. Relevant theorists call for an expansion in the scope and remit of design and suggests new forms of project organisation whereby designers engage with questions of what kind of infrastructure is required and where, seeking to achieve a broad range of objectives including aesthetics and facilitating the participation of non-professional stakeholders in the design process. This aspiration is reflected in the arguments for new forms of project organisation but what this might mean has not been discussed in detail. According to Lokman (2017, 72), “future research is needed to explore how these [landscape infrastructure] projects can be fully implemented and realised”.

One relevant issue which has been discussed in the infrastructure design literature is the recruitment of external design expertise. The use of widely-publicised and high-profile “design competitions” is noted by both Salomon (2016) and Lokman (2017); the former (2016, 56) discusses four landscape infrastructure projects arising from entries to design competitions which, in his view, “in part accounts for their speculative and experimental nature”. Lokman (2017, 64) describes entries to the Rebuild by Design competition, a public-private partnership initiated after Hurricane Sandy “to solicit innovative design approaches” to reconstruction. According to Rebuildbydesign.org (nd.), the competition offers an institutional framework for multidisciplinary and experimental approaches to design: “the multi-stage competition guided participants through in-depth research, cross-sector, cross-professional collaboration, and iterative design”. In the broader design literature, there are conflicting opinions on the value of design competitions; Nasar (1999, 2) argues that it is inherently an anti-democratic form whereby “public clients relinquish responsibility to a competition jury... they accept the prejudice that elite judges should select the design”. In contrast, according to Chupin (2011, 174), “the competition process should be seen as a democratic opportunity through the infusion of a rich set of alternatives to a given problem by a public”. A similar assessment is provided by White (2014) using the example of an urban design competition in Toronto which included non-professionals in the decision-making process. However, how such processes are organised is evidently likely to be related to the logics guiding the overall design process, for example

whether it is driven by an aspiration to create an iconic or monumental project corresponding, as discussed in the following section, to an entrepreneurial agenda.

4.1.3 Economic context and new approaches to infrastructure design

The final aspect of Swyngedouw's (1999) argument discussed here is its emphasis on the role of economic expansion and/or changing models of economic development in processes of infrastructural development. The section below outlines the potential role of both financial logics and more general urban economic development agendas, such as entrepreneurial urbanism (Harvey, 1989), in providing one important aspect of the context in which new approaches to infrastructure design might be situated and which might affect how they are articulated. This further intersects with the idea of a potentially changing material context for infrastructure through discussion of the relationship between financial logics and concepts such as landscape infrastructure.

The work of Graham and Marvin (2001) is relevant in a general sense because it demonstrates the increasing role of financial or market logics in determining investment in the provision of infrastructures. Equally, as discussed in Section 3.5.2 of the previous chapter there is some evidence that new approaches to infrastructure design, in specific senses of product, service and user experience design, have been taken up in some sectors of infrastructure which are directly marketised. However, this does not provide much insight into the potential role of financial logics in examples of infrastructure design which involve the redesign of urban public spaces. Particularly in the case of landscape infrastructure, processes of infrastructural development may overlap with existing agendas and priorities relevant to the planning and management of urban green space. As such, the review below briefly resumes some of the critical literature on the role of financial logics as a driver of some relevant design practices.

There is an established critical literature on the nexus between concepts such as green urbanism, sustainable urban design and financial logics. These models of design have become incorporated into processes of competition within and between cities (Andersson & James, 2018), of property market speculation, for example as indicated by the concept of "green gentrification" (Cucca, 2017) and have been repurposed for the creation of spaces of green cultural consumption (Vormann, 2015). One notable example of the

reinterpretation of formerly infrastructural space is that of the New York Highline (a project by the practice of landscape urbanism theorist James Corner). This seemingly progressive model of urban greening is described by Foster (2010, 316) as “mask[ing] coincident and socially... [in]equitable transformations” primarily through its contribution to property speculation and its exclusion of marginalised groups via rigorous policing and social control. The author (2010, 331) situates the High Line within a model of urban economic development of knowledge-intensive industries and cultural production which welcomes (and selectively aestheticises) industrial decline as a potential source of renewal and as “open[ing] possibilities for sustainable urban futures”.

The conjunction of avant-garde ecological or green design and financial logics is also noted in several studies by Gandy (2011, 63) who describes an “urban pastoral aesthetic” of superficial green urbanism which does not reflect any significant changing relations between the city and nature; there is a “disjuncture between the production, representation, and consumption of landscapes”. This disjuncture may equally apply to projects with supposedly utilitarian, infrastructural functions such as urban wetlands or green building facades (Gandy, 2010) which, in reality, often use nature as superficial design strategy or a “metaphor” (Repishti, 2008) to conceal the continuation of fundamentally unsustainable patterns of consumption. Further, the urban pastoral aesthetic described by Gandy (2011, 63) has become a key cultural signifier and mechanism of boosting property values through its application in “luxury developments... to create elite refugia that betoken rarefied forms of social and cultural separation”.

Other forms of green urbanism and sustainable design can be framed as examples of “entrepreneurial urbanism” defined by Harvey (1989) as a shift in the priorities of urban governments from the provision of services to an entrepreneurial role which focuses on creating jobs and attracting inward investment. According to Harvey (1989, 14), this is manifest in different types of entrepreneurial action including physical regeneration strategies which often have “partial and limited” benefits. This lens is applied by Andersson and James (2018) to study green place-branding in Sweden. The authors identify competing “altruistic” and entrepreneurial drivers of change which are reflected respectively in more comprehensive policy-making which engages with substantial ecological problems or in tokenistic gestures which are more clearly motivated by place-branding. Urban

entrepreneurialism is one as yet unexplored avenue to investigate the emergence of sites of innovation in infrastructure design.

While these examples illustrate a general trajectory of a coincidence of interests between some sustainable design practices and economic development, they do not offer precise parallels with design practices corresponding to the concept of a new infrastructure design imaginary. This can be discerned, to a degree, in discussions of the role of economic development and financial logics as drivers of the adoption of unconventional landscape aesthetics and of new forms of infrastructural visibility. The former is indicated in Gandy's (2013a) discussion of the role of financial austerity applied to budgets for the management of urban green spaces as partially explaining the contemporary relevance of urban wildernesses and more generally, of unconventional or challenging landscape aesthetics. He argues (2013a, 273) that the "closely manicured municipal park, as it evolved in the nineteenth century, was a labour-intensive landscape that is now increasingly difficult to replicate. The inclusion of relatively autonomous elements such as semi-natural flood plains and other features in contemporary park design clearly has fiscal as well as ecological origins". The latter point, regarding the visibility of new forms of infrastructure, can arguably also be linked to Evans' (2011, 223) description of one critical interpretation of climate change adaptation as "a fancy dress parade of one-off projects". Such a diagnosis offers a point of comparison with previous discussions of the politics of infrastructural visibility as drawing on their potential to become aesthetic spectacles around which visions of urban modernity can be assembled (e.g. Schwenkel, 2015). It also highlights a coincidence in the aspirations of infrastructure designers and urban entrepreneurial policies, that of realising high-profile, iconic and highly-visible projects. This is, for example, suggested in Poirier's (2012, 118) description of new architectural treatments of waste infrastructure as premised both on the promotion of ecological awareness as well as the creation of "new urban centres articulated around new monuments".

4.2 New approaches to designing stormwater infrastructures

"Water has become a museum exhibit recently. This gives me pause for thought as, generally speaking, museums concern themselves with things that are not (any longer) part of people's everyday experience. And now water in its natural diversity falls into this

category, which for me is eloquent evidence of man's [sic] alienation from the elemental basis of his life" (Schwenk, 2005, 112).

The remainder of this chapter discusses visions and practices of designing urban stormwater management systems, the subfield of infrastructure design within which the empirical case studies investigated in the thesis are situated. The intention of the following discussion is, therefore, to explore the implications of this transition by discussing parallels and disjunctures between infrastructure design, the general category with which the thesis is concerned and stormwater design, a subfield of infrastructure design which may have its own particular dynamics.

What is regarded as best practice in the management of urban stormwater, from an environmental, social and economic perspective, has been subject to significant changes in the recent past towards more ecologically sustainable alternatives (Fletcher et al., 2015). This is linked to a range of challenges such as increased rainfall linked to climate change as well as existing water quality issues; climate change is causing increasingly frequent and intense rainfall in urban areas which cannot be feasibly managed by expanding existing systems of underground storm drains, most notably due to the prohibitive cost implications. In addition, there are established problems of the poor quality of urban stormwater entering watercourses caused by contamination from diffuse sources, the severity of which will only be increased by the effects of climate change (Chocat et al., 2001). Further, in the European Union improvements in water quality are required by the Water Framework Directive (Jones & MacDonald, 2007).

In response to these challenges, new paradigms of sustainable urban stormwater management have emerged (Chocat et al., 2001). These are described using a range of different terms (Fletcher et al., 2013). For the purposes of simplicity, the term 'sustainable drainage systems' (SUDs) is used in this chapter because it is a common term in the UK.⁴ There is basic agreement on the principles of a SUDs system as being "to mimic the natural drainage processes of an area" and that water should be managed as close to the source as

⁴ The term 'SUDs' is used in this chapter and in Chapter 10 on the Sheffield case study. In the Copenhagen case study (Chapters 7-8) this term or a close equivalent was not used either by interview participants or in planning and policy documents. In the description of the case study, the terminology used is a subject of analysis.

possible, for example onsite, rather than in large-scale or centralised systems (Kirby, 2005, 115). Beyond this, it is important to note that SUDs do not entail one definite set of management practices, rather it is often described as a 'toolbox' for the management of urban stormwater. The toolbox of SUDs measures includes green roofs, rain gardens, bioswales, dry and wet basins and other 'green' solutions for urban stormwater management (Backhaus & Fryd, 2013, 52).

A key feature of the SUDs model is the identification of changing paradigms of stormwater management as an opportunity to realise social and further ecological objectives as well as better water management, for example, by creating new green spaces for biodiversity or recreation. The objectives of a SUDs approach are often defined as related to water quantity, quality and "amenity" (Apostolaki et al., 2006). According to the UK's National SUDs Working Group (2004), amenity in this context includes the provision of public open spaces and wildlife habitats and, as a result, SUDs are often identified as offering synergies with improvements in landscape and urban design. However, some authors argue that the relationship between SUDs and aesthetics should not be regarded as linear or unproblematic. Echols and Pennypacker (2008) highlight the contrast between the extensive literature on technical features of SUDs and the lesser degree of attention to precisely how they might contribute to amenity. Slegers and Brabec (2014, 48) argue that many SUDs-type systems implemented to date have been "functionally designed with little regard to design aesthetics". Similarly, Czerniak (2013, 26) claims that "civic concerns" are often not sufficiently considered in the design of new stormwater systems. Last, Backhaus and Fryd (2013, 52) note that while SUDs-type systems are often suggested to have aesthetic, recreational and educational benefits, in fact they are "an emerging field in landscape architecture... [and] represent an area of design practice that is still searching for appropriate aesthetics". Drawing on these authors and others, the following section discusses what has been identified as an appropriate aesthetic in this field.

4.2.1 Stormwater aesthetics

A contemporary infrastructure design imaginary has previously been described in Chapter 3, a key feature of which is the idea that infrastructure design can be used to re-establish a sense of connection between people, infrastructures and nature which is thought to have been lost (Rosenberg, 2015). Related design principles are those of rendering

infrastructures visible and understandable as well as challenging conventional interpretations of aesthetic value. Developing on this framework, the literature review has further sought to investigate whether and how stormwater design theorists have approached these issues.

In the social science literature, it has been noted that SUDs potentially entails reconfiguring these relationships between people, infrastructure and nature to be more dynamic and interactive; according to Jones and MacDonald (2007, 534), new approaches to managing stormwater “are reconfiguring the relationship between water and cities”. The authors define SUDs as a new model of disciplining water in urban space where, rather than being buried or imprisoned underground, it is subjected to new forms above-ground and visible regulation. Further, it is a disciplinary regime which complicates the traditional division of responsibilities for managing water by requiring the public to collectively participate in water management, for example, by proactively reducing runoff from private property by installing water butts (Jones & MacDonald, 2007). Elsewhere, Gandy (2013b, 43), in a discussion of changing paradigms of urban water management, discusses how new configurations of space might influence the social world by “creating different kinds of relationships between people, technology and water that might reduce current levels of consumption and encourage new forms of socially and environmentally engaged urban citizenship”.

How the relationships between people and infrastructure might be mediated by design have also been directly discussed by SUDs design theorists; there is an assumption that SUDs, when implemented as a surface and therefore visible form of infrastructure in an urban context and when subject to appropriate design intervention, can contribute to creating new forms of interaction between society, infrastructure and nature. This has been described by concepts such as “eco-revelatory design”, defined by Karvonen (2011, 139) as landscape design that “highlight[s] the connections between the human and the nonhuman through a process of revealing and marking”. The author (2011, 139) identifies SEA Street, a retrofit SUDs project on a public street in Seattle, as an example and claims its effect is to “increase[e] residents’ understanding of the natural processes in which they live”. Echols and Pennypacker (2008, 270) promote the concept of “artful rainwater design”, one aspect of which is an aspiration to “celebrate rainwater in site design” and to educate the public through visible stormwater features. These might include open drainage

channels such as those illustrated in Figure 4. The authors (2008, 273) distinguish between design strategies designed to impart a defined “lesson” or alternatively those which are more open-ended in terms of possible interpretations and occur “less didactically, as an enriched experience of place”. Similarly, Slegers and Brabec (2014), drawing on the work of Meyer (2008), expand on the significance of SUDs aesthetics, arguing that aesthetic landscape experience leads “to recognition, empathy, love, respect and care for the environment”. This point can arguably be interpreted in terms of the distinction previously made between aesthetic impressions which are open to interpretation (Salomon, 2016; Engelmann & McCormack, 2017) and design projects intended to provoke narrowly defined behavioural changes such as the example described in Section 6.4.2 of the previous chapter.

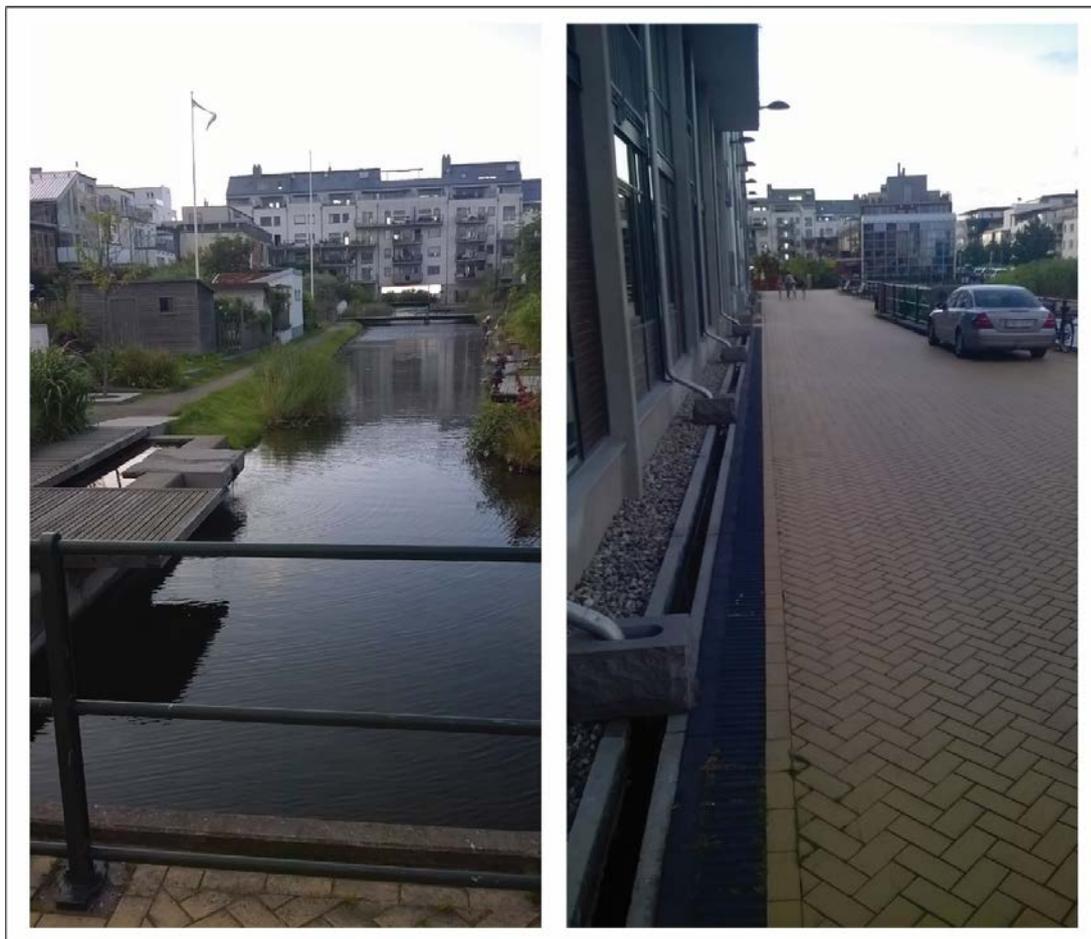


Figure 4: Visible stormwater: sculpted/open rainwater channels, Malmö, Sweden.

These principles have been both theorised and implemented by the influential ‘waterscape’ designer Herbert Dreiseitl. Dreiseitl’s work, along with that of his contemporaries, is described by Karvonen (2011, 32) as “demonstrating a gradual reconciliation between the

scientific and artistic camps of landscape architecture and ecological planning". Dreiseitl (2005a, 9) argues that modern cities are characterised by a problematic relationship with water where its visible presence is restricted to a decorative role in fountains and ponds. In contrast, "all the essential water management, like for example rainwater removal, drinking water provision and sewage disposal, is dealt with functionally, scarcely visibly and without any aesthetic sense" meaning it is "accessible and comprehensible only to specialists" (Dreiseitl, 2005a, 9). He continues that this is a problem because it leads to a lack of environmental awareness among the public and a lack of political action to protect water resources: "in future we should be increasingly concerned with being able to experience water and gain insights into how to handle it sustainably". As such, he (2005b) recommends that design practice must begin to address these more complex themes by overcoming the conventional separation between the aesthetic and functional roles of water. Schwenk (2005) also discusses some of the work of Dreiseitl's landscape architecture practice, Atelier Dreiseitl, in terms of how they contribute to environmental education, indicating a distinction between design and more explicitly didactic practices. The author's argument draws on an example of an installation staged in a disused cooling tower demonstrating the water cycle. According to Schwenk (2005), a key feature of this project was the designers' creative representation using various types of media of natural phenomena which would not otherwise be visible or perceptible, and that this was combined with the aesthetic and expressive force of direct sensory engagement with water.

In terms of the practical implementation of these principles, Slegers and Brabec (2014) argue that the idea of emphasising the water management functions of SUDs has not been translated into practice. Drawing evidence from case studies in the USA and Germany, they argue that "the structures and planting palette did not create legibility around the conveyance of water" because swales are subtle rather than steep-sided and the plants selected were not those "associated with water related landscapes" (Slegers and Brabec, 2014, 52-54). In contrast, Backhaus and Fryd (2013, 58), in a study of the aesthetics of twenty European projects, argue that where designers have set out to accentuate a stormwater management functions, this has resulted in unsuccessful projects (when assessed on the grounds of visual aesthetics and relying wholly on the authors' own judgements) because the systems are dry outside periods of heavy rain and are therefore perceived by the authors as "unsettled" and illegible. They (2013, 58) conclude that

“normatively, open stormwater management systems should be as unobtrusive and inconspicuous as possible”.

4.2.2 Stormwater design expertise

In addition to changing design outcomes, a further key feature of the contemporary infrastructure design imaginary, as defined in Chapter 3, was the idea that new forms of expertise should be involved in infrastructure projects as suggested in concepts such as “a design-led approach” (Design Council, 2012). Similarly, while underground infrastructures for stormwater conveyance were regarded as “the domain of the engineer” (Darlow et al., 2003, 32), the range of disciplines and forms of expertise necessary to successfully implement SUDs is considered to be much broader, requiring ecological as well as landscape and urban design expertise; according to Dreiseitl (2005b, 45), sustainable urban water management requires collaboration between multiple disciplines: “the questions posed and the themes addressed go beyond the bounds of a single subject... this can only succeed when everyone involved in the planning process really does use interdisciplinary working practices”. According to Darlow et al. (2003), this refers to disciplines such as landscape architecture and ecology amongst others.

However, it is important to interrogate what it means for new forms of expertise to become involved in stormwater management and design. According to Karvonen (2011), many instances of interdisciplinarity merely increase the number of specialist disciplines involved in SUDs projects and in fact represent the continuation of a technocratic management paradigm by subsuming “nature” as a further variable in a system which must be quantified and rationally managed. This is contrasted with more democratic and collaborative management where residents’ and other non-professionals’ views are taken into account. For example, Karvonen (2011) attributes the success of the SEA Street project (discussed above) to an extensive process of collaboration with residents regarding planting and other changes to the streetscape. However, the former interpretation is arguably apparent in some of the previously cited studies of SUDs design such as Backhaus and Fryd (2013), Echols and Pennypacker (2008) and Slegers and Brabec (2014). In these cases, the assessment of aesthetic value projects relies on the authors’ judgement rather than, for example, the views of residents or other stakeholders. Related to this, the definition of what constitutes aesthetics is relatively limited as “the visual appearance of

the project, for example, as can be observed and documented through a camera lens during a site visit" (Backhaus & Fryd, 2013, 53). In Slegers and Brabec (2014, 58) the understanding of aesthetics is that it is expressible in terms of a set of transferable and expert-defined criteria derived from previous academic research which relate exclusively to form and visual aesthetics.

As a summary of the previous two sections, SUDs design theorists express an aspiration to re-engage people with, to paraphrase Schwenk (2005), the elemental basis of their existence. These approaches to design have clear parallels with the concept of a contemporary infrastructure design imaginary in the sense that what are proposed are systems which are visible and which create an affective connection to water and water infrastructure. In addition, similar to commentary on new approaches to infrastructure design, it has been observed that this might result in unconventional and aesthetically challenging forms. Last, a further parallel with the broader infrastructure design literature is the suggestion that the forms of expertise involved in stormwater management need to be reconsidered with recommendations for professional interdisciplinarity and more democratic decision-making.

4.2.3 Institutional context for stormwater design

The following section describes some institutional questions relevant to understanding the circumstances in which the vision of design described in the previous sections might become realised. In terms of the institutional context for SUDs, urban stormwater management is described by Karvonen (2011, 4) as "a messy amalgam of human and natural" because stormwater management systems are often composed of existing features such as urban watercourses as well as more identifiably infrastructural components such as storm drains. One consequence is that the planning and management of urban stormwater management does not fully parallel that of other infrastructures because responsibility in many cases has not been rationalised and centralised, for example, by becoming the responsibility of a single utility. A SUDs approach introduces further complexity by requiring the over-ground urban environment to be repurposed as part of the stormwater infrastructure network. In England, where one of the case studies is located, urban stormwater management and, consequently, SUDs systems are the responsibility of a range of different actors and institutions, including private developers,

local authorities, private water companies and the Environment Agency (Ashley et al., 2013). In this context, it is difficult to map out what a typical planning process might look like, including where design might be located and therefore situate design in terms of the framework outlined in Chapter 4. In practical terms, how this may affect design is difficult to predict beyond observing that different institutions and actors may have different levels of interest in design, for example, if it is perceived to complement their broader responsibilities for urban planning or as an unnecessary additional cost. The case studies describe responsibility for stormwater management generally and aim to understand how this relates to willingness to invest in design.

One relevant point is that several examples of innovative infrastructure design cited in academic literature are broadly situated in the field of urban water management and further, that of urban climate change adaptation. These include proposals submitted to the New York Metropolitan Museum of Modern Art's "Rising Currents" exhibition (Braun, 2014; Salomon, 2016; Glausiusz, 2010) and the "Resilience by Design" competition Lokman (2017) (both of which were previously discussed in Section 4.3). This links the projects to a set of institutional frameworks to support innovation, namely, the competitions referenced above, which in turn are located in a specific context of climate change adaptation in New York post-Hurricane Sandy. This is an important point from the perspective of locating examples of innovative design because it links their emergence to that of climate change adaptation which is an agenda with broad cultural and political legitimacy and, therefore, one which has the potential to attract funding and realise a design vision. This situates urban water management, at least in some cities, as an area of design practice which is potentially distinct from other fields of infrastructure design in its likelihood of progression from vision to reality.

4.2.4 Material context for stormwater design

The case studies in Copenhagen and Sheffield investigated in the thesis are both examples of "retrofit" SUDs. This is a subcategory of SUDs projects which, according to Stovin et al. (2007, 1), "are intended to replace and/or augment an existing drainage system in a developed catchment" such as urban centres. On this basis, both projects can be contrasted with the more common typology (at least in the UK) of SUDs implemented as part of new, greenfield developments (Stovin et al., 2007). The urban context of retrofit

SUDs, when combined with a model of above-ground, visible stormwater management, has been identified as one potential impetus towards new approaches to design. In a passage which is worth quoting at length, Dreiseitl (2013, 74) discusses the pressures on stormwater design in an urban context:

“There is a competition for the use of space especially in dense urban areas and this conflict is getting more and more dramatic. Meaningful and resilient solutions that can cope with the different demands of hydrology and the needs of our modern urban life are required. The flow of water and the urban mobility of people are dynamic processes that can both be accompanied within plazas, streets and parks... We can give back to water the space it needs for safety in our settlements, but we have to tell the story of water playfully and create beauty so it can be handled in partnership and finally be accepted by the local people”.

What is recognised in the quote is that there is potential for conflict between infrastructural and other established uses of urban space, in which context appropriating the space for above-ground water management may become a challenge. The role for designers implied in Dreiseitl’s argument is as mediators to find solutions which, it is implied, will allow new and old uses to coexist un-problematically. However, in conjunction with material changes, there is a further implication that new narratives (“the story of water”) are required to change cultural values towards acceptance of new infrastructural landscapes and the appropriation of urban space. This arguably serves to re-contextualise the abstract formulations of re-engaging people with water which characterise the stormwater design vision described in Section 7.1 above in the sense that the ability of designers to leverage the affective power of water is understood as part of a pragmatic effort to ensure that new infrastructural uses of urban space are accepted. It further introduces a complex vision of aesthetics, (or “beauty”) as both the outcome of material changes as well as new narratives. In other words, it implies that a perception of aesthetic value will, to some extent, follow from knowledge of ecological value. This leads to a question of ‘who defines beauty?’ in this context which is followed up in the case study research.

4.2.5 Economic context for innovative stormwater design

Previous research has demonstrated that some potentially problematic aspects of supposedly ‘innovative’ stormwater design can be linked to the existence of broadly economic drivers of a design agenda. One relevant critique is provided by Zimmerman (2001) who problematises the cultural politics of creating simulacra of nature, what the author terms “staging nature”, in suburban, ‘sustainable’, residential developments referencing Coffee Creek, a project by Atelier Dreiseitl in Indiana, USA, as an example. The author’s argument is that a discourse of reconnecting people with nature through green design conceals environmentally harmful practices of car-oriented suburban sprawl. In fact, Dreiseitl’s (2005b, 77) own description of Coffee Creek gestures towards an obvious contradiction: “an estate intended to provide 1,200 residential units can only be built in an ecologically sustainable way with a cleverly designed system for the water technology infrastructure, but this infrastructure will not be visible - in fact the water will appear in natural stream beds, in ponds that run into each other over massive cascades piled up from natural stone slabs, producing a charming open space”. While justified on the basis of the aesthetics of public space, this contradicts Dreiseitl’s own ideas (discussed in Section 7.1 above) that design should promote awareness of the relationships between social and natural worlds as mediated by infrastructures. Instead, infrastructure has clearly been edited out of the understanding of the relationship between human and nonhuman promoted in the vision above. In this case, design arguably performs a contrary function of creating an illusory harmony with an artificial “nature” constructed towards socially exclusionary ends (due to its forming part of an exclusive suburban housing development).

This represents a conflict of vision over whether the aesthetic value of SUDs resides in the superficial greening of urban environments or, alternatively, as more fundamentally problematising the relationship between human and nonhuman worlds even if this results in unsettling forms of design. In fact, both of these contradictory visions have been articulated and described in the previous chapter, including within the work of a single author, Herbert Dreiseitl. This illustrates that what becomes identified as good design is potentially liable to evolve in conjunction with the context for design, with an important element of the context in the case of Coffee Creek being the existence of economic drivers of a design agenda.

A further study by Usher (2018) also provides important insights into some of the drivers of new approaches to stormwater design which, in the author's assessment include fiscal and economic considerations. Drawing on a case study of water management in Singapore, the author examines the utility to the state of new approaches to design which have rendered water and water infrastructures visible and aesthetic features of urban space and, thereby, aimed to engage people emotionally and materially in the management of urban water infrastructures. The author identifies a range of ecological and fiscal pressures which led to the breakdown of a previous centralised and hierarchical modernist model of urban water management in Singapore which had its material expression in underground, inaccessible urban waterways. Instead, the state has sought to restructure itself and enrol individual citizens in surveillance and management of the water system. One mechanism of this restructuring has been through improving the aesthetics, visibility and access to urban waterways and transforming them into spaces of recreation and ecological education. According to Usher (2018, 325), the intention of these changes has been to "engage the public and make them 'feel for the environment'" for example, by "bringing citizens into affective contact with water and its infrastructure". This is described as having a range of political benefits such as facilitating the diffuse exercise of power as well as coinciding with economic interests through creating new opportunities for waterfront property development. The author (2018, 331) concludes with a suggestion for further research on the "material efficacy of water for government", to which the case study research in this thesis at least partially responds.

4.3 Summary

The previous chapters of the thesis, especially Chapter 3, have largely focused on arguments about a putative shift in contemporary infrastructure design imaginaries. This chapter has altered the focus to infrastructure design practice. It has discussed interrelated questions of the influences on design practice and why and where (in sectoral terms) new approaches to infrastructure design might be adopted.

The first half of the chapter (Section 4.1) discussed the range of actors, institutional factors and social structures which could potentially influence design practice across different sectors of infrastructure. One important consideration has been the lack of a previous in-depth studies of the infrastructure design process. In their absence, the chapter has drawn

upon the broader infrastructure and urban political ecology literatures, notably Swyngedouw's (1999, 448) concept of "the production of socionature", to identify a range of issues which could potentially act as influences on the infrastructure design process. As such, the contribution of this chapter has been its elaboration of an outline or framework of influences potentially relevant to the adoption of new approaches to design. This has simultaneously highlighted points of productive inquiry through the case studies in the thesis are later interpreted. As illustrated in Table 4.1, it has been highlighted that a situated account of design must take account of cultural, material, institutional and economic contexts for design. Within each of these broad categories, a further range of 'variables' have been identified. This is not an exhaustive list but rather reflects those issues that have emerged most clearly from the literature. This table is reproduced at the end of each empirical chapter and in Chapter 10 (Conclusions), to highlight connections between the analytical framework and the evidence collected.

To summarise the contents of the table, it suggests a relationship between the material context for design and the adoption of new imaginaries and practices; the types of hybrid or landscape infrastructures envisaged in contemporary design theory could create both new opportunities and challenges for designers, for example by creating potential conflicts over the appropriation of urban green space for infrastructural purposes. Referring to the previous chapters, it highlights the existence of conflicting models of aesthetic expertise as well as noting some of the various ways in which design expertise could be institutionally situated within infrastructure projects. Last, it also notes the potentially significant role of economic power in shaping the production of infrastructural spaces. For example, there are a complex and conflicting range of economic interests which are potentially relevant to the specific model of landscape infrastructure due to its close association with processes of planning and managing urban green space. In addition, as suggested above in Section 4.1.3, the contemporary infrastructure design imaginary potentially coincides with financial and entrepreneurial agendas through a shared emphasis on infrastructural visibility and on new forms of challenging landscape design.

Influences on infrastructural development					
	Cultural, discursive, representational practices	Material	Who designs and what influences their thinking?		Economic development
Influences and variables potentially relevant to design	Are there parallels with the 'contemporary infrastructure design imaginary' defined in Chapter 3?	<p>What forms of infrastructure are the objects of design intervention?</p> <ul style="list-style-type: none"> • "Landscape infrastructures" (involving the appropriation of urban green space)? • What is the function of new discourses of design in cases of conflict over the appropriation of space? • What aspects of infrastructure are (selectively) rendered visible/invisible through design? 	<p>What does design or aesthetic expertise mean in a given context? (see Chapters 2 & 3)</p> <ul style="list-style-type: none"> • What disciplinary logics, associated performance criteria and metrics for success? (Bélanger, 2012) • What forms of knowledge are included in the infrastructure design process, e.g. professional and non-professional? 	<p>How is design expertise recruited and institutionally situated? (Kimbell, 2011)</p> <ul style="list-style-type: none"> • In-house and routine design processes (Easterling, 2014) • Specialist infrastructure designers (Hatherley, 2011) • Recruited by competition (Salomon, 2016) 	<p>What is the significance of infrastructure design from an economic development perspective?</p> <ul style="list-style-type: none"> • "Green regeneration" (Cucca, 2017) • Property values (Chappell, 1989; Gandy, 2011) • Urban entrepreneurialism and place branding (Harvey, 1989; Andersson and James, 2018)

Table 4.1: A heuristic for understanding the infrastructure design process.

The second half of the chapter (Section 4.2) discussed visions and practices of stormwater design and thus contributed to situating stormwater design within the broader category of infrastructure design. The discussion highlighted that there are parallels between design as theorised in the field of stormwater management and the contemporary infrastructure design imaginary defined in Chapter 3. This refers to the shared idea that the aesthetics and visual significance of urban infrastructures are related to how people imagine the relationship between society, infrastructure and nonhuman nature. It also refers to the shared idea that design should be more interdisciplinary and, albeit with varying degrees of emphasis, that it should include non-professional expertise.

The discussion has also identified influences on stormwater design practice and explored to what extent these are similar to or distinct from the material, institutional and economic factors identified in the outline of the infrastructure design process in Section 4.1. In terms of institutional context, many examples of innovative stormwater design have been situated in the institutional framework of climate change adaptation. This differs from other types of infrastructure design discussed hitherto and, in conjunction with other pressures, potentially explains why new approaches to design have been realised in this field.

Similar to the discussion of the material context for green or landscape infrastructure discussed in Section 4.1.1, the move to retrofit existing urban spaces with new stormwater systems has been identified as a driver of a design agenda; better design is one proposed response to conflicts over the appropriation of space for infrastructural uses. An effort to justify the appropriation of space for water management has also been highlighted as the potential origin of the current widespread adoption of visibility and interactivity as design principles by suggesting that such systems are valuable due to their contribution to 'cultural sustainability'.

Last, Section 4.2.5 highlighted that highly visible forms of green stormwater design may be motivated by economic interests in a similar manner to iconic and visible approaches to infrastructure design in other sectors. One key aspect of this discussion has been the identification of divergent and mutable views regarding the visibility of water infrastructure which, in the case of Dreiseitl's Coffee Creek project, have arguably evolved as a response to an aspiration to increase property values. This simultaneously relates to the broader

point that infrastructure design, even when oriented around principles such as visibility, is a selective process whereby some aspects of a system are highlighted and aestheticised (also see Section 2.1.3 of Chapter 2). In the case of stormwater management, what counts as rendering a system visible varies between superficial greening and more challenging aesthetics premised on problematising existing relations between people, infrastructure and nature. A recognition of the potential mutability of these principles and a related interrogation of what is made visible and why is a key feature of the empirical research in later chapters.

Chapter 5 Methodology

This chapter begins with a summary of the development of the argument to this point and a statement of the research aim and objectives. Section 5.2 describes the research philosophy. Sections 5.3 and 5.4 describe the evolution and consequent different stages of the methodology and research design, especially the choice of empirical focus. Section 5.5 introduces the case studies and discusses what they represent in the context of the thesis. Sections 5.6 and 5.7 describe methods of data collection and analysis and Section 5.8 reflects on the challenges and limitations of the methodology.

5.1 Summary, research aim and objectives

In Chapters 1-4, the thesis has delineated a field of research on the relationship between infrastructures and design including what is meant by the key concepts, why the topic is important and what further research is required. To provide a summary beginning with Chapter 2, the key points are the difficulty of separating infrastructure design from questions of ideology and cultural politics; design involves making claims about the relations between society, technology and nature and it influences how infrastructures are experienced and imagined. Previous studies demonstrate that infrastructural buildings and spaces have frequently been selectively aestheticised, scripted into compelling and politically relevant narratives and become symbols around which visions of urban modernity are organised. Chapter 2 also highlighted one important narrative of the increasing invisibility of infrastructures in urban space which, it is assumed, translates into a lack of awareness of their ecological and social consequences. This trope provides the starting point for many contemporary critiques of conventional infrastructure design practice and proposals for alternative approaches.

Chapter 3 described contemporary visions or meanings of infrastructure design in the context of the Anthropocene. This context is linked both to an “infrastructural invasion” of urban space as well as to a perceived need to rethink the conventional forms of interaction between people, infrastructures and ecological systems. Responding to this context, design theorists have conceptualised new forms of infrastructure as an opportunity from a design perspective whereby new active interactions between society, technology and nature could be facilitated. One important and illustrative conceptual development is the idea of

landscape infrastructure which represents a distinctive technological-aesthetic vision of new forms of hybrid infrastructural systems and spaces. Although it is not a unitary or consistent phenomenon, the changing imagination of the relationship between design and infrastructure arguably constitutes a new, or at least distinctive, infrastructure design imaginary. As described in Chapter 3, this is defined by a shared set of concerns which are a critique of infrastructural invisibility, a changing politics of infrastructure design through the concept of challenging aesthetics and the idea that multidisciplinary and non-professional forms of expertise should direct the infrastructure design process.

Finally, Chapter 4 described the understanding of design in this thesis as a social and “situated” process with a range of issues relevant to explaining where, why and how new approaches to design might be adopted. This includes the power dynamics shaping broader trajectories of infrastructural and urban change and the internal organisation of infrastructural projects, including processes of recruiting design expertise. More generally, the chapter contributed to a developing a framework for the interpretation and analysis of cases studies of design because it highlighted some of the multiple coinciding and conflicting interests potentially relevant to their production. Last, it highlighted the lack of in-depth prior research on the process of infrastructure design which could be drawn upon to develop a framework for analysis. As stated below, addressing this lack of research is one of the objectives of the research.

5.1.1 Aim and objectives

The overall aim of the thesis is to investigate meanings and practices of infrastructure design. This encompasses issues such as how the relationship between infrastructure and design is understood, what types of infrastructure become objects of design intervention, what model of design (whether superficial or otherwise) is adopted and what are the characteristics of the “infrastructure designer” mobilised in contemporary theory and practice. More specifically, this aim builds on the idea that there are ongoing struggles to define a new infrastructural aesthetic. One important strand of argument posits a complementary relationship between design and infrastructure whereby engaging with infrastructures provides new opportunities from a design perspective, from improved aesthetics to cultural change. This is premised on a wide range of assumptions regarding the role and capacities of designers, what forms of infrastructure might be designed and on

the acceptability of new infrastructural aesthetics. As previously stated in the introduction, one aspect of the aim was to investigate change in how the relationship between design and infrastructure is imagined to which the previous chapters have contributed through the description and analysis of an (arguably) new infrastructure design imaginary. As clarified below, a further aspect of this aim is to investigate the relevance of this imaginary for design practice and, as such, for the uses and meanings of urban space.

The research objectives are:

- to make a contribution to the literature through the development of a conceptual and analytical framework for the investigation of infrastructure and design,
- to provide an in-depth analysis of the infrastructure design process, including the distribution of power to influence its outcomes and the types of expertise involved,
- to explore the value of the concept of a new infrastructure design imaginary for understanding contemporary design practice.

5.2 Philosophical framework

This section sets out the author's understanding of the social world in order to make explicit the assumptions underpinning the research design. At a basic level, the subjects of research are social and political processes of making decisions on particular courses of action which entail the allocation of resources. This refers to processes of decision-making regarding the design of urban space which have implications for its symbolic and material properties. The thesis views these processes of designing (and of decision-making) as situated social processes in the sense that they are embedded in specific geographical, socio-economic and cultural contexts. This can be distinguished from other perspectives which "privilege the designer as the main agent in design" (Kimbell, 2011, 300) or, in architectural theory, view the architect as an autonomous agent (Cunningham, 2016). In contrast, this research aims to investigate the varied influences on the decision-making process in which the agency of the designer is understood in a structural context.

In terms of a research philosophy, the author's position is a critical realist one in the sense that it is a form of conceptualisation "that goes beyond the data itself" (Madill et al., 2000, 7). This can be distinguished from either positivist or constructivist epistemologies which,

respectively, suggest that 'reality' is limited to phenomena which can be empirically known and scientifically validated or, in the case of constructivism, suggest that human knowledge and discourse constitute reality (Fletcher, 2017). Rather, a critical realist perspectives views reality as "composed not only of events, states of affairs, experiences, impressions, and discourses, but also of underlying structures, powers, and tendencies that exist, whether or not detected or known through experience and/or discourse" (Patomaki & Wight, 2000, 223). As such it accepts the need for theory in order to understand the causal mechanisms which explain directly observable phenomena even if theories are only "truth like" (Danermark et al., 2002, c.f. Fletcher, 2017, 182). The legitimacy of interpreting observable phenomena in theoretical terms relies on rational analysis and argument to establish a relationship between data collected by the researcher and the analytical categories in the literature.

A second important and relevant philosophical question is that of structure and agency. As stated above, the understanding of design, referring to the actions of designers and other professionals such as planners, is that it exists in a structural context. In the case studies, potentially important aspects of the socio-economic and structural context include various forms of urban entrepreneurialism and neoliberal urban management (Harvey, 1989) as well as hegemonic and normative infrastructure design imaginaries. However, the position on structure/agency in the thesis is not an extreme structuralist or idealist perspective. It is broadly described by Carter and New's (2004) description of a realist position whereby social structures are understood as pre-existing features of the world which enable and constrain individual action, but individuals are also considered to have the ability to act in a manner which is not wholly determined by social structures. This is taken as coincident with Marx's (1852/1968, 96) position that people "make their own history... but under circumstances existing already, given and transmitted from the past".

5.3 Scoping phase and development of the research strategy

In order to address the research objectives, different methodological strategies were adopted which resulted in two stages of data collection. This section describes the first, scoping phase of the methodology which involved nine interviews with design practitioners and planners involved in infrastructure projects. This provided a broad survey of design practice in a range of different contexts. Ultimately, it generated useful findings on how the

relationship between design and infrastructure is imagined and on the different meanings of infrastructure design. The results from this phase of the research are presented in Chapter 6.

This section also presents reflections on the challenges of locating infrastructure design and, related to this, on the development of the research strategy; one intended function of the scoping interviews was to assist with the identification of potential cases of innovative infrastructure design which could be researched in more detail through a case study method. This was conceived as a means of identifying relevant projects and of interrogating what is perceived as innovative design. However, the identification of case studies ultimately did not emerge directly from these interviews and rather a purposive approach was taken to their selection. The case studies chosen were two projects in the field of urban stormwater management in Copenhagen and Sheffield, The transition is a theme of discussion throughout this chapter and the relationship between urban stormwater management and infrastructure design is discussed in Section 5.7.1 below.

The processes of recruitment and sampling for the scoping phase are described below in Sections 5.3.1 and 5.3.2 whereas the approach to interviewing and analysis is treated together with the case studies in Sections 5.5 and 5.6.

5.3.1 Recruitment of interview participants

The scoping phase of the research was intended to include a broad sample of architecture and landscape architecture practice and engineering consultancies, primarily but not exclusively in the UK, with a stated involvement in infrastructure projects. Appendix 1 gives a list of 30 firms which were contacted. These were identified primarily through online publications such as Architect's Journal, ArchDaily and Dezeen (the latter two list "infrastructure" as one of the categories under which projects are organised). Those contacted include firms involved in both conceptual design as well as those which have completed projects. Corresponding to the research objective of investigating the extent to which scope of design is changing, the sampling strategy covered a continuum of innovative to routine design. In terms of the former, there was an attempt to include firms whose projects reflected key themes of the contemporary infrastructure design imaginary (see Chapter 3), which, arguably includes practices such as Habiter Autrement, The Living

and Ooze Architects. The latter category of routine design included mainstream engineering consultancies such as Arup.

Despite a range of strategies being adopted over a period of approximately six months, it was difficult to recruit interviewees. In several cases responses or refusals were received which indicated that the topic of the research was not considered relevant. This could be taken to indicate that “infrastructure” was not a category used within these practices to organise projects or understand their work. In other cases, potential participants requested sample interview questions and subsequently declined to participate which is likely to be linked to the level of abstraction of some questions. Other possible explanations could include conventions regarding research within design firms which the author was not aware of or simply the lack of a personal introduction through a gatekeeper. Ultimately, nine interviews were conducted. The sample was somewhat biased in favour of interviewees at the intersection of research and practice who were willing to engage with the research topic (although it should be noted that what constitutes practice in this context is difficult to define due to the often indistinct separation between design theorists and practitioners and between speculative and more realistic design proposals).

5.3.2 Interview participants in the scoping phase

The scoping phase involved nine interviews with designers, researchers and planners with a professional involvement in infrastructure projects. In terms of their professional experience, there were three architects, one landscape architect, four design consultants and one transport planner. However, this description also simplifies the range of experience encompassed. For example, four of the participants were simultaneously engaged in academic research. Three interviews were with planning and design consultants on the topic of the relationship between urban design and new transport infrastructures such as automated vehicles. The majority were based in the UK but the sample also included two interviewees based in North America. A list of interview participants and their areas of expertise is given in Appendix 2.

This is evidently a diverse sample, both in terms of professional experience and geographically, which raises obvious questions about the degree of generalisation possible. What links the majority of respondents who provided useful data was an interest in

theorising infrastructure design as a general field which could be attributed to their linkages to academia. This suggests that “infrastructure design” is not a widely used category amongst practitioners and continues to be nested within practices which are not identified by those involved as design. Reflecting on the difficulties of accessing useful data at this stage provides the basis for useful findings, for example in Section 6.3.2 of the next chapter.

5.4 Case study research and selection

According to Flyvbjerg (2006), the advantage of a case study method is that it allows detailed investigation of a particular instance of the phenomenon under investigation, in this case the infrastructure design process. As specified in Section 5.1 above, one of the research objectives is to provide a detailed account of the infrastructure design process, including issues such as the range of actors and expertise involved, the relationship between design ideas and the project as realised and the role of socio-economic context in shaping design outcomes. On this basis a case study methodology was judged appropriate. A case study method is also widely used in relevant fields of research; in the literature on infrastructure design, case study projects are often used to illustrate and expand upon design principles (e.g. Rosenberg, 2015; Hung and Aquino, 2013); in analysis of infrastructure design in the social science literature, specific cases have been used as an entry point for examination of the logics underpinning broader trajectories of infrastructural development (e.g. Dobraszcyk, 2007; Gandy, 1999; Kaika, 2005); finally, in the critical literature on topics such as sustainable design, case studies allow for detailed investigation of issues such as the social and ecological impact of high-profile projects which are required when, like in Foster’s (2015, 316) description of New York’s High Line, progressive discourses “mask” uneven social consequences.

The case studies were selected following a set of criteria linked to the concept of a contemporary infrastructure design imaginary such as challenging the assumption that infrastructures should be hidden, proposing new forms of interaction between people and infrastructure and including new forms of design expertise. The case studies selected ultimately broadly corresponded to these thematic criteria as well as to the more pragmatic requirement of accessibility. Some further case studies which were suggested but were not available to research are discussed in Section 6.3.3 of the following chapter.

5.4.1 Hans Tavsens Park and Korsgade, Copenhagen

The first case study selected was the redevelopment of Hans Tavsens Park and Korsgade (HTPK) in Copenhagen, Denmark. In basic terms, this project aims to increase the capacity of a local park and streetscape to retain, infiltrate and convey excess stormwater from heavy rainfall in surface retention areas and channels to prevent flooding, rather than using the conventional solution of underground storm drains. The project forms part of Copenhagen's strategy to adapt to climate change which is predicted to cause more frequent and intense rainfall among other impacts (KK, 2011). In terms of its correspondence with the research topic, a key feature of the project is its conceptualisation of infrastructural change as a design opportunity to improve the aesthetic value of urban space and to promote new forms of interaction between the local community, infrastructure and "nature"; the fact that new water retention areas and channels will be visible landscape features has been incorporated into the design through programming for activities such as ecological education and collective maintenance of new green spaces. In procedural terms, it has involved local residents in the design process at various stages. The current design proposal is the product of a collaboration between the Danish landscape and urban design practice SLA and engineering consultants Ramboll amongst others. At present (August 2018) the project is in planning and design stages with an estimated completion date between 2020-2023.

Prior to the selection of this a case study, Copenhagen had already been identified as a site of innovation in design primarily as a result of its masterplan for stormwater management (KK, 2012). This was produced in collaboration with influential landscape design practice Atelier Dreiseitl and advocates the use of above-ground water management strategies on a combination of financial and aesthetic grounds. The concept of "climate change adaptation with added value"⁵ (TMF, 2015, 13) has been identified as a guiding principle, suggesting a synergistic relationship between design and infrastructural change. Subsequently, a set of international design competitions was held, including for HTPK, and these garnered entries from high-profile design practices as well as being widely publicised. Overall, the

⁵ "Klimasikker med mere værdi" (translation by interview participant).

stormwater masterplan recommends that approximately 300 stormwater management projects involving changes to existing streets and parks should be constructed over the next 20 years (KK, 2012). As such, the early projects are important in providing a model which will potentially be replicated throughout the city. In addition, due to the local government's agenda of promoting the export of Danish expertise in climate change adaptation (e.g. KK, 2015), these projects are also likely to become influential reference points in discussions of international best practice.

During an early stage of the research project the author was able to participate in a study tour to Copenhagen which also provided the opportunity for informal conversations with local government (Københavns Kommune) staff. They identified a small set of projects which had reached the planning and design stages and which corresponded to the research topic. Of this small set, HTPK was chosen as a case study for several reasons. These included the fact that the design and planning process was ongoing during the period of data collection (January to August 2017). It was assumed that this could provide opportunities to investigate the negotiation of design as it progressed and that the important actors would be easier to identify and contact. Second, the lead designers were appointed following an open, international design competition which provided an opportunity to investigate the process of recruiting and validating design expertise, including through comparisons with unsuccessful entries. Last, the HTPK project involves a wide range of international, national, urban and local stakeholders, both professional and non-professional. It was assumed that this would allow different interpretations of design to emerge and be available to the researcher.

5.4.2 "Grey to Green", Sheffield

The second case study investigated in the thesis is "Grey to Green" (GtG), an urban stormwater management project in Sheffield, UK which was completed in 2015. In terms of physical changes, the project involved construction of a series of planted swales which retain stormwater runoff from nearby streets, allowing some water to infiltrate into the soil while the rest is conveyed through the system and ultimately into a watercourse. The overall design is intended to contribute to the visual aesthetics and the amenity value of the local area through features such as a distinctive naturalistic planting scheme, increasing the amount of space available for pedestrians and cyclists and creating new public spaces.

GtG was selected following similar criteria as in the case of HTPK. However, given that one international case study had already been selected, it was decided for pragmatic reasons that the second study should be accessible and could represent an example of a more conventional approach rather than necessarily representing international best practice. As such, the primary correspondence between the project and the overall research topic was the reconceptualisation of infrastructure as a design opportunity, most notably through the centrality of the new system to a local regeneration strategy, and the project's unconventional naturalistic landscape aesthetics.

The project is significant for several reasons: it is often described as the longest linear sustainable urban drainage (SUDs) retrofit in the UK. While small-scale SUDs projects are relatively common in greenfield developments in the UK, there are far fewer examples of large-scale retrofits of existing urban centres with surface stormwater infrastructures (Stovin et al., 2007). In addition, the project has also been identified in national policy as an example of best practice which could be replicated in other major UK cities, primarily due to its combination of water management with urban and landscape design which created opportunities to access new sources of funding (DEFRA, 2016). A closely related point is that the project has been planned and implemented in conditions of financial austerity for local government which has resulted in reductions in funding for provision and maintenance of urban green space in Sheffield. How the ideas underpinning the project were reconfigured and adapted to fit this context of austerity is discussed in the empirical section.

In contrast with HTPK, GtG is of a significantly smaller scale both in terms of extent and of water management capacity. Further, rather than a typology to be replicated throughout the city or a pilot in a wider stormwater management strategy, it is a relatively isolated and opportunistic project. In further contrast with both the concept of a contemporary infrastructure design imaginary and the example of HTPK, there has not been a significant degree of non-professional engagement in the design process and there has been little discussion of the social or cultural aspects of infrastructure, in other words how people might interact with the new system. Generally, the approach to analysis of the case studies was not intended as directly comparative. However, as the investigation proceeded it was difficult not to compare the different design imaginaries, processes and contexts in each

city. The sources of ideas and influences on the design process relevant to explaining points of correspondence or lack of correspondence between GtG, HTPK and the broader contemporary design imaginary are discussed in the relevant chapter (Chapter 10).

5.4.3 Generalisation from the case study results

The case study projects perform multiple functions from infrastructural to the aesthetic. Here, they are described as cases of infrastructure design but they could equally be framed as instances of “green urban renewal” (Cucca, 2017) or urban climate change adaptation. Despite this complexity, it is important to specify what the case studies are claimed to represent, in other words what broader category they are taken to be cases of. The extent to which cases are either wholly representative of a broader category or relatively unique evidently determines the types of general conclusions that can or cannot be claimed (Flyvbjerg, 2006).

It is evidently important to recognise that the case studies are outliers within the broad categories in which they are situated, whether urban stormwater management, infrastructure design or urban regeneration. Each of the case studies is represented to a greater or lesser degree as an example of ‘innovative’ or experimental design, (albeit one which could potentially become more common in the future). This was supported by the difficulty of identifying and accessing projects during the scoping phase of research which had highlighted the relatively limited number of substantive examples of new approaches to infrastructure design. At the same time, both projects are positioned at the intersection of different institutions and policy agendas, such as stormwater management and urban regeneration, and are to some extent expressions of these broader forces. In the terminology of Geels (2002, 1260-1), the case studies are not “niche” developments because they are not fully “protected or insulated from ‘normal’ market selection”.

The thesis engages in two related stages of generalisation. The first dimension of generalisation is to situate urban stormwater management in relation to the broader literature on infrastructure design. As argued in Chapter 7, the design literature on urban stormwater management reflects many of the key themes of the contemporary design imaginary including the opportunities presented by surface, and therefore visible, stormwater systems for new forms of interaction between people, infrastructure and

nature. However, as also discussed in Chapter 7, there may also be pragmatic pressures towards adoption of new approaches to design in urban stormwater management that do not apply more generally, such as the need to appropriate urban (green) spaces for new infrastructural uses. How these drive change in the approach to design is discussed in the case study chapters. The second dimension of generalisation is to establish connections between features of the empirical case studies and the concept of a contemporary design imaginary. It is argued that the case studies represent, to a degree, practical examples of this imaginary and provide a means to examine its implications in practice. However, the empirical analysis also discusses contingent and locally-specific agendas, for example their function as urban regeneration projects, which more directly explain key features.

5.4.4 Major and minor case studies

There are significant differences between the case studies relevant to the methodology. First, there is the different status of the projects with GtG having been completed while HTPK remains at the planning and design stages. The case study research was conducted primarily between January and September 2017 which coincided, in the case of HTPK, with the end of a competition to recruit a lead design consultant, consultations on the resulting preliminary proposal and a process of seeking to secure funding. Conducting research during the early design phases created opportunities to investigate the influences on the initial plan and to observe how some of its principles have been contested. This was assisted by repeat interviews with some key stakeholders which demonstrated changing views and roles over time. It was also possible to visit the site and observe how it is used prior to redevelopment. On the other hand, it is not possible to make conclusive statements about which vision of design will ultimately emerge as successful and what the implications might be. In contrast, GtG was completed in 2015 following a streamlined planning and construction process. This created opportunities for site visits to observe the interaction between people and the redeveloped space, to investigate maintenance practices and for interviews to discuss perceptions of the project's successes and failures, but also foreclosed analysis of the emergence and stabilisation of the design proposals.

A second point of divergence is that the number of research interviews, documentary sources and other evidence collected by informal methods is much greater in the case of HTPK than GtG. This reflects important differences between the projects such as the

structure of the decision-making process: there was a larger range of actors, both professionals and non-professionals, engaged in the formal design process in the case of HTPK. This has created opportunities for design to be debated and contested in a relatively transparent manner. In practical terms, the amount of evidence collected is reflected in the degree of attention accorded to each case study in the empirical chapters with two chapters on HTPK and one on GtG.

5.4.5 Interdisciplinary research

Both of the case studies combine technical and social policy agendas relating to the implementation of new technological systems in conjunction with landscape and urban design objectives. Further, as highlighted above in Section 5.5.3, they have emerged at the intersection of different policy agendas and could be framed in a variety of ways. As such, they require reliance on different literatures and, generally, an interdisciplinary approach to research. The research has progressed by seeking to identify the diverse social and environmental policy agendas which coincide to produce the case study projects. This is required given the focus of the thesis on investigating the range of influences towards adopting a new approach to infrastructure design. This extends to such issues as the cultural and intellectual influences on key actors. It requires an understanding of how diverse policy agendas from urban regeneration, housing, green space planning, climate change policies and others influence the adoption and form of a design agenda. This has unsurprisingly introduced challenges in setting boundaries in order to retain a focus on what are the most important influences on the design agenda as well as for obvious reasons of feasibility. This has been managed primarily through the interview method which has been used to identify problematic or contested issues and led to further investigation of the origins of conflict where relevant. What interviewees identified as influences on design was used as the primary source of guidance and has led to the emergence of a rich and interconnected account of the design process.

5.5 Methods of data collection

This section describes the methods of data collection for both the scoping phase and case study research. The description of the case studies above has highlighted that these are complex cases in which there are a range of potential influences on the design agenda.

Second, the research objectives include providing an in-depth analysis balancing description of a design vision with that of its context. This follows the understanding of design as a situated process and more specifically, of infrastructure design as the outcome of a range of cultural, social, economic and material drivers of change. This calls for a range of research methods. The reasoning and some of the challenges are described by Gandy (2013a, 261) below in a comparable case study on the work of avant-garde landscape designer, Gilles Clément, which is worth quoting at length:

“[The sources range] from the reflections of the original designers to a series of ethnographic observations of the park and its surroundings. While we cannot consider the words of architects, planners and others as definitive in delineating the context, purpose or implications of a project of this kind, their recollections are nonetheless an indispensable dimension of the critical evaluation of their work. The analytical framework adopted here combines social scientific insights into the production of space with ideas drawn from urban ecology and the humanities. The combination of these different approaches for the study of urban space presents a series of challenges ranging from the mode of exposition to more deep-set barriers to the inclusion of aesthetic theory or art-historical approaches within the social sciences”.

Following Gandy’s (2013a) approach, significant attention has been given to the ideas put forward by designers which can provide evidence of thematic links between a contemporary infrastructure design imaginary and features of the case study projects. This has been achieved both through interviews with designers and through the use of other data sources such as document analysis and visual research methods. This approach contrasts with previous research on infrastructure design in disciplines of architecture and landscape architecture which have focused exclusively on the intentions of designers. In that literature, studies (e.g. Lokman, 2017; Salomon, 2016) often refer to conceptual proposals which precludes consideration of the translation of ideas into practice. In contrast, the approach to data collection in this thesis was expansive; in terms of interviewing it aimed to include all stakeholders engaged in the formal planning and design processes for the projects. As well as designers, it included other professionals such as planners and engineers and extended beyond professionals to include those included in formal processes of consultation, such as residents and community activists. The sample of interviewees in each case study is discussed below in Sections 5.6.2 and 5.6.3. As described

in Section 5.5.5, a range of documentary sources was also collected in order to provide a detailed understanding of the context for design.

5.5.1 Qualitative interviewing

The primary research method throughout the research was qualitative semi-structured interviewing. One major advantage of the method is its flexibility; it allows respondents to highlight their main areas of interest or concern in response to open-ended questions and for the conversation to follow up on these topics (Longhurst, 2003; Silverman, 2014; Mason, 2002). As highlighted in the empirical chapters, what were identified as problematic features of the case studies varied between interviewees from the physical configuration of space to the regulatory context and underlying logics with a significant degree of interrelation and in a manner that could not have been predicted in advance. At the same time, the use of semi-structured interviews provided a degree of consistency across interviews; key conceptual and practical questions covering themes related to the research questions were posed to most interviewees. Last, the research interviews were useful from a practical perspective because they provided access to information that was not available by other means. In terms of disadvantages, some relevant implications of relying on interviews are discussed in Section 5.7.2.

Between different stages of the research, there were significant differences in the register and terminology of interview questions. During the scoping phase, part of the objective of the research was to investigate the extent to which 'infrastructure design' is identified as a coherent sector of design practice and therefore it was relevant to investigate the terminology participants used to describe their work. During this phase, the interviews involved relatively abstract and general discussions (a standard question posed was "how do you understand the relationship between infrastructure and design?"). As indicated previously, this generated useful findings but also resulted in a bias amongst respondents towards researchers and theorists. In the case study research, the terminology used was adapted by necessity; interviewees understood their own roles and the significance of the project in different ways; for example, as a resident reacting to a threat to local green space or as a planner engaged in an urban regeneration initiative. The interview questions used in the case studies interrogated the participant's own role and perspective on the design process, generally leaving aside more abstract formulations (although answers in

this register have also been given). The thesis transposes the conceptual and analytical framework of 'infrastructure design' onto this more complex social reality. This introduces challenges of generalising from the issues raised because it is difficult to systematically establish parallels between the immediate concerns of participants and the general concept of a contemporary infrastructure design imaginary. This is discussed in more detail in Section 5.6 as a question of data analysis.

An example interview schedule from each stage of the research is provided in Appendices 3-5.

5.5.2 Hans Tavsens Park and Korsgade

Following the approach outlined above, in the case of HTPK an extensive series of 26 interviews⁶ was used to gain an in-depth and detailed understanding of the design vision and the mechanics of the design process as well as providing a broad overview of the different policy agendas at the local and urban level. The sampling strategy throughout was that of snowballing whereby each interviewee was asked to suggest further people who could usefully contribute to the research and this proceeded until no further relevant participants were suggested (Atkinson & Flint, 2001). Interviewees can be broadly divided into categories of those directly engaged in the HTPK project and strategic stakeholders at the urban and national scales. Appendix 6 provides details of HTPK interview participants.

Thirteen stakeholders directly involved in the case study project participated in formal research interviews. Most took place during three site visits between January and September 2017.⁷ Appendix 7 provides dates for the sites visits and details the data collection activities undertaken. Initially contact was established with one of the project coordinators who then provided introductions to a further range of stakeholders, both professional and non-professional. The sample of those directly involved in the project included three local residents involved in a formal consultation process and constituted as

⁶ There were twenty-three interviewees. Three of the most important project stakeholders were interviewed twice meaning that, in total, there were twenty-six interviews.

⁷ Some interviews were conducted via Skype due to difficulties of scheduling all interviews during site visits. Whether a given interview was conducted by Skype or in person is indicated in Appendix 6.

a semi-permanent focus group. This was comprised primarily of residents who had volunteered to participate in regular meetings. Repeat interviews were conducted with several of the key professional and non-professional participants which contributed to tracking the project's development over the period of the research. In terms of designers, interviews were conducted with at least one member of each of three consortia of design and engineering firms which were finalists in the "Nordic Built Cities Competition", an international competition to recruit a lead design team. Three interviews were conducted with staff of the companies which won the competition, including both design and engineering consultants. In terms of professional disciplines, the sample of project stakeholders included three landscape and urban designers, two engineers, two planners, two consultants, three residents and one architect, although it is misleading to precisely classify interviewees based on their disciplinary background because in some cases these were not uncomplicated. Several participants, for example, had joint qualifications in engineering and design.

Within the Copenhagen case study, a second category of seven interviewees were not directly engaged in the case study project but rather were strategic stakeholders at the urban level, responsible for developing policy agendas in the fields of climate change adaptation and urban and landscape design. These were identified by project participants as influences on decision-making regarding design in HTPK. A second subset of participants were two community activists with experience of other stormwater management projects in Copenhagen who were included to give background information on the model of stormwater design in Copenhagen. Due to the high profile of the HTPK project in Copenhagen, most of the participants in this category were able to comment on its significance.

All interviews were conducted in English with no obvious problems of communication which was likely related to the professional roles of many of the interviewees; several interviewees were not Danish and others worked in firms with international operations which required foreign language competency. Generally, Denmark has a high level of English proficiency with 86% of the population speaking English as a foreign language (European Commission, 2012). Despite this, language may have affected the selection of interviewees (see Section 5.7.3 below).

5.5.3 Grey to Green

A similar approach was adopted in the case of the GtG project of seeking to interview all stakeholders involved in planning and design. This was a relatively small and cohesive group. Again the primary method of sampling was snowballing. A total of 13 interviews were conducted, most of whom were directly involved in GtG whereas another subcategory was included to collect background information about landscape design and SUDs design in Sheffield. Appendix 8 provides details of the GtG interviewees.

Eight interviews were conducted with five professionals and three consultees directly involved in the case study, including the project planner, landscape architect and engineer. Of the professionals directly involved in planning, the majority were employees of public sector organisations such as Sheffield City Council. The three consultees were non-professionals representing both community and private interests. Two were members of an association of local businesses which was the primary body consulted during the design process. A second category of five interview participants were professionals not directly involved in the case study project itself but who had previously been involved in the planning and design of landscape or water-related projects in Sheffield or were able to comment on the significance of GtG. This included two consultants, an engineer, a landscape architect and a community representative.

5.5.4 On-site interviewing

An important feature of the research interviews was the role of places in shaping the direction and content of conversations. In both case studies, a significant portion of interviews were conducted on-site or very close to the case study area. The interviews were not planned as “walking methods” (Jones et al., 2008) but rather this emerged as a feature of interviews in response to the characteristics of interview participants and of the case study sites. In HTPK, many interviews took place in the public spaces encompassed by the project, either because they involved local residents or because the offices of some of the important institutions involved, such as the urban regeneration agency responsible for coordinating the project, were located in that area. This led participants to highlight features of the landscape, both present and planned, which they regarded as significant. It also led to several impromptu informal conversations with other relevant people who were

encountered in these spaces. In the case of GtG, several interviews took place on or overlooking the site and equally allowed topics to arise which would not otherwise have been highlighted. In order to record the significance of places, field notes were compiled immediately following all interviews which contained a specific heading of “location” under which reflections on the interview site and its relationship to content were recorded.

5.5.5 Document Analysis

The sources of evidence for the research include documentary sources of various types, including design proposals and associated images as well as planning and policy documents. Documentary sources were identified in various ways and performed different evidentiary functions. As in the quote from Gandy (2013a) above, the writings and proposals produced by designers are considered to offer important insights into the intellectual context for projects. The HTPK project has an extensive background literature, including the writings of S.L Andersson (2014), the founder of SLA (the lead designers for HTPK), reports by SLA to support their competition-winning entry (e.g. SLA & Ramboll, nd.; SLA, nd.) and other design guidelines such as those produced by Copenhagen’s local government (in collaboration with SLA) for climate change adaptation projects in the city (KK & SLA, 2016). In the case of GtG, the sample of documentary sources also incorporates writings by and about some of the project’s participants including by staff members at the University of Sheffield’s Landscape Department who acted as consultants. Appendices 9 and 10 provide a list of documentary sources for each case study.

In both case studies, the sample of documentary sources evolved in conjunction with the interviews; participants were asked to reference influences on their own approach, either previous projects or intellectual influences, which were then incorporated into the sample as illustrative of the range of influences on design. Other sources such as policy and planning documents were highlighted in interviews as providing background information. As such, the documentary sources performed different functions; some of the writings on design were fundamentally aspirational and providing an understanding of the design vision whereas others provided important factual information which was not available by other means.

A complicating factor in the case of Copenhagen was the non-availability of some documentary sources in English translations. While there are some online resources available in English which aim to publicise initiatives in Copenhagen to a global audience (e.g. stateofgreen.com), corresponding to this function many such sources are relatively superficial. In order to gain a full understanding of the planning and policy context of the case study, different strategies were adopted: first, where feasible translations of key sources were made by the author (where such sources are quoted the original Danish is provided in a footnote and unless otherwise stated all translations are by the author); second, two interviews were conducted with academics with relevant experience and these were used to identify knowledge gaps; last, the significant body of academic literature on Copenhagen available in English on topics such as urban regeneration (Cucca, 2017; Roy, 2018; Hansen & Karpantschhof, 2016), urban water management (Jensen et al., 2015; 2016) and stormwater management (Caspersen, 2016; Palomino, 2017) was also invaluable and is used both to provide background and to advance the argument throughout the relevant empirical chapters.

5.5.6 Visual methods

A further source used to understand the case studies were visual texts. According to Rose (2001), analysis of images is justified by the pre-eminence of the visual as a mode of communication and persuasion in contemporary culture (in fact, the phenomenon being researched, that of a concern for rendering infrastructures visible, takes place precisely within this context). Relevant visual sources in the case of HTPK include digital representations of what a future design proposal would be like. Most of these were contained within the documentary sources and are therefore listed in Appendix 9. Following Rose et al. (2014), the term 'visualisations' is used to describe these images. Visualisations convey the physical morphology of the future built and natural environments while also making affective or aesthetic claims through use of tone (Houdart, 2008) and represent the types of people and forms of behaviour regarded as appropriate in particular places (Rose et al., 2014). This latter point is directly relevant to the research given the emphasis on investigating forms of interaction between people and infrastructural landscapes. Rhetorical claims of this type made by visualisations have been investigated by close analysis of their content using qualitative thematic analysis, applying the same coding schedule as for interview and other documentary sources. Analysis of visualisations also

overlapped with the research interviews; they were frequently referenced unprompted in research interviews by participants to illustrate what they perceived both as positive and negative aspects of the proposals. That they were referenced in this manner demonstrates their importance in people's understanding of the project. Interviews with designers also involved discussion of the production of visualisations and their relationship to reality. This provided an entry point to discuss some of the challenges of design.

5.5.7 Site visits and participant observation

In addition to the formal methods of data collection described hitherto, evidence was also collected through site visits, observations of use of the case study sites and impromptu conversations. In the HTPK case study, data was collected during three site visits between January and September 2017 which allowed observation of the current usage of the space and surrounding area. The site visits also involved impromptu interactions with residents and others, including providers of social services and community activists. Some of these took the form of semi-structured conversations about the use and significance of the existing space and the participants' engagement (or lack of) with the ongoing redevelopment process. These are included in the list of interviews in Appendix 6. In the case of GtG, regular site visits were also conducted throughout the period of fieldwork and data was collected through observation of the usage of the case study site. For both case studies, data was recorded using field notes which, for example, reconstructed conversations in cases where audio recordings could not be made. This data was analysed in the same manner as that generated in other interviews.

5.6 Data analysis

This section presents the approach to data analysis, including both scoping and case study phases. Thematic qualitative analysis (Braun & Clarke, 2006) was the primary method of analysis, both of interview data and other sources, at all stages of the research. While this was the primary method, the specific challenges varied between stages of the research; as previously discussed, there were significant differences in both terminology and content of interviews between the scoping and case study phases of the research. The scoping phase involved discussions with academics and consultants who were willing to speak in abstract terms. The questions and answers have relatively direct correspondence with the research

questions and therefore less interpretation is required. The themes discussed include the challenges of defining the design dimension of infrastructure, the relationship between design and infrastructure and how this may (or may not) be subject to change over time. A greater challenge for analysis is interpreting the significance of the limitations of this stage of the research, including issues such as the difficulty of accessing a wider range of respondents. In this case, the primary sources of data are records of emails, letters and phone calls and their non-existent responses. These can only be analysed in a very subjective and provisional sense and by relying on the author's capacity for reflexivity.

In the case study research, the terminology was necessarily adapted to the case study projects and local context in order to be understandable and relevant to participants. This provides a means of grounding the conceptual framework of the thesis in specific material changes to urban space. However, it presents obvious challenges of interpreting the theoretical relevance of the observed realities if these are not terms in which participants understand them. The analysis involves interpretation of the significance of observed realities in theoretical terms imposed by the author (as justified in Section 5.2 by the adoption of a critical realist epistemology). There is evidently a significant degree of interpretation associated with this process in the analysis of data which must be acknowledged. Throughout the empirical sections, the presentation seeks to justify the author's interpretation by reference to previous literature.

The analysis has also taken account of the specific literature on analysis of texts, both documentary and visual. According to Atkinson and Coffey (2004), it is important to go beyond their literal content and interrogate questions such as authorship, intended audience, format and dissemination. The production and interpretation of architectural visualisations have already been highlighted above in Section 5.5.2. In terms of the texts analysed as part of the HTPK project, one obvious distinguishing feature is language of publication as was also previously discussed in Section 5.5.5. Overall, the analysis of texts overlapped with interviewing which provided insight into issues such as their traction and interpretation. All research data including interview material and other texts were incorporated into a single project database and analysed using the same system of qualitative thematic coding.

The detailed process of data analysis followed an iterative process. Field notes made immediately following interviews and notes taken during transcription served to provide a general outline of what the key themes might be. Two conference presentations in May and September 2017 both involved a presentation of preliminary findings from the case studies, essentially consisting of the emerging themes which were then investigated through a more detailed phase of data analysis. The detailed analysis involved the production and more systematic application of a coding schedule (although this continued to evolve and be adapted throughout). A detailed coding schedule was not prepared prior to engaging with the interview transcripts; instead, a series of detailed readings were accompanied by attempts to identify patterns which were systematised as codes and grouped into themes. The themes reflected the framing and background literature, using concepts such as “infrastructural visibility” and “the context for design”. The precise names and descriptions of codes and themes varied between case studies and the coding schedules were developed independently. The themes and codes used to interpret the data at each stage of the research are given in Appendices 11-13.

5.7 Limitations and reflections on the research strategy

The following section presents a series of reflections on the methodology. It considers what these choices mean for the findings and what alternatives were available.

5.7.1 Urban stormwater management

As discussed throughout the preceding sections, the research strategy evolved through an iterative process of scoping followed by the selection of case studies. The case studies did not emerge as paradigmatic examples of innovative infrastructure design identified by interviewees. A key question is why projects in the field of urban stormwater management were ultimately chosen as case studies given that the thesis did not set out to investigate this field. It is important to reflect on the process of selection as this can provide some basis for discussion of the relationship between the case studies, stormwater design and the broader field of infrastructure design, highlighting both similarities and differences.

From one perspective, the projects chosen became useful case studies for a range of pragmatic reasons which are not necessarily related to their being in the field of

stormwater management. This primarily refers to their accessibility to the researcher and can be attributed to issues such as the existence of key (public sector) stakeholders in each case who regarded it as part of their role to facilitate the research project by providing an introduction to other important actors. It can also be partially attributed to the existence in both cases of some form of formal public consultation mechanism which provided an entry point to the contestation of design. However, from another perspective, the fact that the case studies chosen were in the field of stormwater management and that they also met the criteria of correspondence with aspects of the contemporary design imaginary, is not necessarily coincidental. Rather, this might be attributable to specific design imaginaries and/or material pressures conducive to new approaches to design relevant to stormwater projects which are not more generally applicable. This topic is discussed in more detail in Chapter 7.

5.7.2 Researching aesthetics

A significant and relevant methodological debate is that of researching aesthetics. One currently influential approach to this is the set of research methods associated with new materialist ontologies. This arises from the privileged position of the affective/aesthetic within new materialist theory, for example Fox and Alldred (2015, 406) sum up one of the key objectives of new materialist social inquiry as “to reveal relations, affects and affect economies in assemblages”. This is associated with a specific interpretation of affect/aesthetics as a set of embodied experiences which are not necessarily articulated in linguistic or textual forms and, therefore, methodologies for researching aesthetics frequently involve ethnographic approaches. This approach has been adopted in studies broadly concerned with the aesthetics of infrastructures (e.g. Jones, 2005; Engelmann & McCormack, 2017).

While aware of these debates, the research strategy nevertheless followed a relatively conventional interview method for several reasons. Most importantly, this was an appropriate means to address the research objectives of understanding changing approaches to infrastructure design which relied upon understanding the intentions of designers and others as consciously perceived and practised, including their perceptions about aesthetics. The limitations should be acknowledged; a different research strategy might have generated different insights about how urban space is valued according to a

broader definition of aesthetics and extending to issues that might not be articulated in a research interview. Combined with an alternative sampling strategy, it might have led to identifying a broader range of actors as holders of aesthetic knowledge. At the same time, as highlighted in Section 5.5.4 above, the material environment of interviews did often contribute to shaping the content and direction of conversations and evidence thus generated has been incorporated into the empirical chapters.

5.7.3 Sampling bias

In both case studies there is evident sampling bias which should be acknowledged as an important limitation of the research strategy. Generally, the research strategy has involved interviewing professionals and citizens engaged in a formal design process rather than assessing to what extent other groups might have been excluded or what the barriers to participation might be.

In HTPK the sampling bias was arguably related to significant socio-economic and other inequalities amongst residents in the area encompassed by the case study project, some of which are highlighted in a report by a social housing provider for the area of Inner Nørrebro, which surrounds the case study site (FSB, 2013). These divisions and inequalities refer to issues such as language skills, housing tenure (whether in social or private housing) and ethnicity (whether 'Danish' or a recent migrant). These are interrelated as a large proportion of social housing tenants in this area are recent migrants (FSB, 2013) and they suffer other forms of socio-economic marginalisation, including lower educational attainment and participation in the labour market (FSB, 2013). At a national level, Nusche et al. (2015) find significantly lower English language skills among the children of migrants to Denmark. In Inner Nørrebro, there are poor Danish language skills among migrants as well as "social and cultural isolation" and a lack of knowledge required "to participate in local democratic processes" (FSB, 2013, 2).⁸

In the case study, such marginalised groups were not represented either in the formal consultation mechanisms for the project or in the interview sample. This is significant

⁸ "En stor del af områdets voksne er i en meget sårbar situation og mange er i praksis socialt og kulturelt isolerede i det danske samfund. De mangler ganske enkelt viden om egne muligheder og basale forudsætninger for at deltage i lokale demokratiske processer".

particularly given the emphasis on creating a new 'green' place identity in the HTPK project. As documented elsewhere, such efforts are likely to have varying levels of support and effects between different social groups (Roy, 2018; Andersson & James, 2018). Attempts were made to broaden the sample beyond those involved in the formal planning process. However, the level of success was limited, likely due to the lack of a means of introduction in combination with the above issues of marginalisation. This can be linked to the snowball sampling strategy; according to Atkinson and Flint (2001), snowballing can lead to sampling bias because the sample depends on the subjective choices and social network of the initial interviewees and that it will tend to exclude isolated groups or individuals who are not connected to this network. The unequal representation of residents in the formal planning processes for the HTPK project is discussed in detail in Chapter 9.

In the case of GtG, there were fewer apparent forms of sampling bias arising from the snowball sampling strategy. From the outset the intention was to interview professional and non-professional stakeholders, defined as those who had a direct involvement with the formal planning process. Due to the approach to consultation and the primarily non-residential character of the site, the category of non-professional stakeholders was comprised of a small set of representatives of local business interests. However, during the fieldwork it became apparent that the case study project is linked to broader processes of regeneration causing change to the use and character of the local area and this will potentially affect residents of areas not directly adjacent to the case study site. One such process is the controversial demolition of the former Castle Markets shopping centre and its planned redevelopment as a tourist attraction which the GtG project, it is intended, will facilitate by rendering the area more attractive for private investment. This redevelopment is described by authors such as Hatherley (2011) and Madanipour et al. (2018) as illustrating a major disconnect between the redevelopment visions of SCC and those of the city's residents. Hatherley (2011, 86), for example, describes the demolition of the Castle Markets as motivated by a desire to exclude working-class Sheffielders from the city centre: "the thing that unites Castle Market's visitors is that they are all working-class, which does not sit well with Sheffield's intent to make itself as yuppie-friendly as Leeds or central Manchester".

The linkage between GtG and wider processes of regeneration is discussed in detail in Chapter 10. However, in a similar manner to HTPK, those potentially affected by these

processes have not been included in the sample, primarily due to the difficulty of identifying who they might be. A wider range of interview participants could evidently have resulted in different views on the significance and value of the case study. In their absence, the empirical analysis discusses the approach to consultation in the case study as partly explaining the lack of alternative perspectives. It also uses documentary sources to support a discussion of the potentially uneven social impacts of the project.

5.8 Summary

Some of the key issues described in this section include the iterative progression of the research strategy through different phases. This entailed a transition from researching infrastructure design in abstract terms and via a sample of interviewees relatively disconnected from specific places or projects, to the specific context of design practice within urban stormwater management. The progression from scoping to case study research is not linear but there is a clear justification for their selection; the selection of case studies followed a set of definable criteria, both pragmatic and conceptual. Key among these was an aspiration to maximise the visibility and aesthetic value of new urban infrastructure, to facilitate new forms of interaction between people and infrastructure and involve different forms of expertise in infrastructure design. The extent and logics of such changes are examined in the empirical chapters.

While the method of selecting case studies can be justified, it introduces a conceptual challenge of defining what these projects represent, to what extent they are isolated, niche developments, whether they are paradigmatic examples of stormwater design or can inform a broader discussion of infrastructure design. The relationship between stormwater and infrastructure design is discussed in more detail in Chapter 7 and the empirical chapters further contribute to disentangling the complex range of influences on the design process in a manner which can usefully contribute to this discussion.

As discussed above, the case studies are the redevelopment of Hans Tavsens Park and Korsgade in Copenhagen and “Grey to Green” in Sheffield. Both of these projects are complex, produced at different scales of governance and at the intersection of different policy agendas. They both represent, for example, the coincidence of institutional frameworks for urban regeneration and for infrastructural development. This has required

an in-depth investigation using a mixed-methods research strategy and with a broad sample of interviewees. Within the empirical chapters on the case studies, the research objectives are to provide an in-depth description of the infrastructure design process, to explore parallels between the concept of a contemporary infrastructure design imaginary and design as practised in the case studies and to describe the emergence of Sheffield and Copenhagen as sites of innovation in design by investigating the context within which design operates.

The following chapters comprise the empirical material of the thesis. Chapter 6 presents the results of the scoping phase of the research. Chapter 7 briefly revisits the literature on stormwater management to discuss visions and practices of design in this sector, including to what degree they are particular to this field. Chapters 8 and 9 describe the HTPK case study with the material divided between analysis of influences on new approaches to design at the urban and project levels. The final empirical chapter, Chapter 10, presents the results of the GtG case study.

Chapter 6 Locating infrastructure design: results of scoping interviews

The following chapter presents the results and discussion of the first scoping phase of interviews undertaken with nine designers and other professionals involved in infrastructure projects as set out in Section 5.3 of the Methodology. The intention of the interviews was to provide a broad survey of meanings and practices of infrastructure design, including whether these might be subject to change and in what circumstances. In the research interviews and analysis, this intention was realised through investigating the significance attributed to design as a general concept by the interview participants, by exploring what approach to design was implied in their responses and, last, how the significance and/or model of design was related to the context such as the sector of infrastructure in which participants were working.

One finding of the chapter is of the diversity of meanings of infrastructure design which included practices bearing little relation to the core interest of the thesis in practices of spatial design such as “product” and “customer experience design” in the field of new transport infrastructures. In partial contrast, a further finding is the perception of new approaches to design amongst a specific subset of ‘infrastructure designers’ as a response to ecological, amongst other, pressures. Both of these findings incorporate discussion of the changing context for design, in the sense of who is involved and under what circumstances infrastructures become re-imagined as objects of design intervention. This highlights the importance of financial logics as a key variable. Further evidence was also generated by reflecting on the difficulties of accessing interviewees and substantive data. In fact, a recurrent theme and contribution of the chapter is a discussion of the difficulty of researching the relationship between infrastructure and design due to the challenges of defining the design dimension of infrastructure, of identifying ‘infrastructure designers’ and of delimiting the design aspect of a broader production process.

The chapter is structured as follows: Section 6.1 gives a broad outline of the significance and meanings of ‘infrastructure design’ for interview participants. Sections 6.2 and 6.3 describe two models of design which emerged from the interviews, those of “design thinking” and “product” or “service design”, which can both, to an extent, be linked to the significance of design within a market setting. Section 6.2 describes evidence of new

approaches to infrastructure design, including examples which parallel aspects of the contemporary design imaginary. It also discusses the context for these new approaches and the characteristics of the infrastructure designer. Section 6.5 discusses who is responsible for infrastructure design through a description of challenges encountered by the researcher of identifying and accessing relevant stakeholders and gathering substantive data.

6.1 Significance and meanings of infrastructure design

The context for the scoping phase of research is the apparent increasing emphasis on design within infrastructure projects as illustrated by design guidelines such as those produced by the Design Council (2012) in the UK or in the academic literature in fields such as landscape infrastructure (Hung and Aquino, 2013; Rosenberg, 2015). In response, the interviews sought to investigate to what extent this is reflected in the experience and perceptions of designers and practitioners. In terms of the significance of design within infrastructure projects, this was not disregarded as irrelevant or insignificant by any of the interview participants. Seven of the nine participants used the term to describe important aspects of their work although there was significant variability in terms of what it entailed. In fact, explaining its significance, including whether design was perceived as increasingly important, requires consideration of its meanings. These meanings were extremely variable and are discussed in detail below and throughout the rest of the chapter.

In terms of the meanings of 'infrastructure design', to some extent it functioned as a catch-all concept that was used to describe a wide range of practices from actual spatial design practices to the production of texts on the relationship between future transport technologies and urban design. Of those referring to spatial design disciplines of urban, landscape and architectural design, three participants were primarily concerned with urban design related to their involvement in transport planning. Four others were concerned with the architecture of infrastructural buildings referencing diverse examples of power stations, water treatment and waste processing facilities and railway stations. Four interviewees also referred to concepts which are not typically associated with infrastructure such as "customer-experience design" or used terminology such as "design thinking". While these concepts arguably illustrate the widespread legitimacy of design in the context of infrastructural projects, these did not necessarily relate to the interest of the thesis in design practices which have implications for urban public space and emerged in

specific circumstances. These terms and their significance are discussed in Sections 6.2 and 6.3 below. Last, one interview participant did not use the term 'design' to describe practices which are potentially identifiable as such which highlighted the methodological challenge of researching hidden practices. This is discussed in Section 6.5.2 below.

Negotiating the variable usages of 'design' in different domains of infrastructure and between research participants provided methodological challenges in terms of the consistency of interviews. However, it also allowed an analysis of the multiple ways the concept of infrastructure design is (or is not) used and how this, arguably, may be subject to change. Some of these issues are illustrated by the following quotation from an interview participant who had been a member of a design review panel for a major rail infrastructure project in the UK:

I wouldn't use the word design. I see you've got to use the word design but I'm not quite sure what you mean by it because everything is designed. Really you're not talking about design, what you're talking about is something like the non-engineering aspect of infrastructure. You're looking at the incidental or the externalities or the contextual. I don't know. There might be different words for it or it might be to do with intangibles, such as sense of place, or it might be to do with secondary aspects such as putting shops in and ensuring footfall. It's... Design is... Everything has to be designed down to the last rivet.

The response highlights some of the ambiguities of the term 'design' as applied to infrastructure. One of these is the existence of a continuum from the routine process of giving a material form to any object, even if it is not intended to provoke an 'aesthetic' experience, to another intuitive usage of 'design' as designating a concern with going beyond basic functional or technical performance criteria and considering how people might ultimately interact with an object. A related point is that the quote distinguishes between design and engineering, by situating design as "non-engineering aspects", and thus supports the common assumption (e.g. Bélanger, 2012) of a relationship between engineering expertise and a sole concern with strictly utilitarian considerations. The alternative model implied therefore evokes different types of expertise, whether architecture, landscape architecture, urban design or planning. In addition to the complexity of design, the quote indirectly highlights that 'infrastructure' is a catch-all

concept incorporating multiple domains of technology; what are suggested here as examples of design interventions (“putting in shops and ensuring footfall”) are relevant to the context of railway station architecture which was the primary field of infrastructure design discussed in this interview. Evidently in other fields, what constitutes design might manifest itself in other forms. Despite these ambiguities, a final and important feature of the quotation is a recognition of the inevitability of using this terminology, both directly and through the inadequacy of any of the alternatives to sum up what is at stake.

Similar issues arose in other interviews where participants were divided on whether it was useful to discuss infrastructure design in general terms. One participant considered the concept to be useful due to the existence of “general principles” relevant to different forms. This related to their work in a design practice which specialised in the landscaping and architecture of infrastructural buildings of different types but following apparently consistent principles. This participant also most closely approximated the concept of a specialist ‘infrastructure designer’ and his work is further discussed in Section 6.4.2. To another participant, use of the concept of ‘infrastructure design’ was strategic by linking their work to the perceived recognition accorded to concepts such as design thinking (see next section).

6.2 Design thinking

The interviews during the scoping phase aimed to understand the concepts and terminology used by interview participants and whether these had implications for design practice. As has been discussed, the context for this thesis is largely that of the current emphasis on the relationship between design and infrastructure in academic literature and design theory. One conceptual development which potentially exemplifies both this discursive significance and its ambiguities is the contemporary emphasis on design thinking as an approach to infrastructure, for example as recommended by business guru Tim Brown (2008; 2014), as described in Maia et al. (2015) or as referenced in the Design Council’s guidelines on infrastructure design (2012). Amongst interview participants, three discussed the concept of design thinking and all three referenced it as illustrating both the contemporary relevance of design and its ill-defined character. Of these, only one claimed to be implementing the principles of design thinking and this was for strategic reasons:

The fact that business has taken on design thinking... Now if you call things design thinking people are like that's the latest, that's really great which is really very frustrating as a designer and especially as an architect because this has been around since 1600 so it's not new but the fact that other disciplines are now moving into design thinking gives you a way of talking about it so you can say you are applying design thinking to infrastructure which is extremely annoying and degrading to the architect to talk in those terms but at least the public now understands that there is value in that.

Several relevant points are illustrated in this quotation. First, contrary to the position of Cowley et al. (2018) and Cowley (2018), that there has been a significant shift in design practice arising from new epistemologies associated with concepts such as design thinking, what is illustrated here is continuity rather than change in terms of the methods considered relevant to designing infrastructure. However, it simultaneously suggests that the popularisation of concepts such as design thinking can be leveraged to validate the conventional forms of expertise within spatial design disciplines, in this case architecture, and to communicate their value. That design might be regarded as more significant within infrastructure projects was attributed by this participant to external cultural and economic shifts leading to the validation of concepts such as design thinking due, for example, to a perceived connection to “innovation” (e.g. Brown, 2008) rather than the characteristics of infrastructure projects themselves as increasingly complex or subject to more rigorous demands in terms of design standards. Related to this, there is a clear indication that the perceived cause of the popularisation of design thinking arises from its adoption by the private-sector. Elsewhere the participant specified more clearly the connection between commercial imperatives and the adoption of new approaches to design by describing the example of a research project which they were involved in to design a new typology for electric vehicle charging stations. As described below, the public agency responsible for commissioning the research had ultimately not implemented its recommendations:

Design implies money. You are spending money and they didn't want to be seen as spending funds on frivolous things such as design... If it was a private enterprise they would engage all the business tools possible.

Ultimately, according to the interviewee, the public utility was unwilling to fully implement the design strategy proposed because it was not a commercial actor and was not motivated by a possible financial return. This implied context of design becoming reconceptualised as a potential investment with a financial return, and the sectors of infrastructure to which it applies, is further explored in the following section.

6.3 Product design, service design and customer experience

Among a subset of three interviewees, the terminology to describe design was in terms of its contribution to “customer experience” and referring to disciplines such as “product” and “service design”. This group was comprised of two design consultants and one transport planner who all were employees of UK-based engineering consultancies. They were originally contacted due to their involvement in the production of reports on future transport infrastructures such as automated vehicles and their implications for urban and landscape design. However, in these research interviews the sector which was part of participants’ everyday work and which was referenced as requiring design expertise was that of transport integration defined by the concept of “mobility-as-a-service”. This is defined as subscription-based access to a range of public and private modes of transport (Hensher, 2017; Kamargianni et al., 2015).

What emerged from the interviews was that design was a very relevant concern within their specific area of professional expertise of integrated transport. However, this was associated with particular models of “service design” and “product design” aimed at improving “customer experience” which did not correspond to the overall interest of the thesis in design practices with clear implications for public space. This was primarily because the types of infrastructure under consideration, and therefore the objects of design intervention, were not imagined as requiring any direct changes to public space or physical infrastructures. Rather, they were imagined as wholly constituted by online interfaces and digital integration of transport services and it was these interfaces that were prioritised as objects of design. In the understanding of these interviewees, design was identified as a means of distinguishing a commercial service or product in a marketised context.

If you have something how do you get people to want it particularly when it is a new product... I think you can look at examples of product design in terms of how people actually make decisions.

The use of similar terminology and interpretations of the role of design is well established in discussions of integrated transport in the academic literature (e.g. Sochor et al., 2015) and in the media (e.g. Pearce, 2010). Further, such dimensions of design practice are tangential to the research topic. What was more directly relevant was the suggestion, albeit based on very limited evidence from one participant, that some questions of spatial design were beginning to be considered in terms of their contribution to “customer experience”. According to this interviewee, customer experience offered a common framework to consider diverse issues ranging from pricing to the layout of transport interchanges which could all be measured through financial returns.

Customer focus, or passenger focus, twitter, sales. You start to look at all these things and you build up a picture of network effectiveness... Customer experience is often reflected through patronage, if you are not buying tickets... A great customer experience is a great carrot. It means lots of tickets. Everyone is using it.

Interviewer: How does customer experience relate to the design of physical infrastructure?

If you look into the station you have no need for barriers and gates even if there is modal shift. Interchanges can be as a shopping centre with a station in it. It can flip the balance. residential schemes, hot offices...

The response illustrates that, far from the abstract discussions of aesthetics as a fundamentally “ineffable” set of sensations (Salomon, 2016, 55), the model of design here is regarded as quantifiable through the metrics of consumers’ data and financial returns and that, at least in one case, this framework was also considered relevant to understanding the design of physical space. Further, this model is evidently very closely linked to the marketised context of this field of infrastructure. However, this model of infrastructure design as product or service design was ultimately not available to research in-depth because of the early stage of implementation of the types of infrastructure

referred to. Some further issues which arose during this subset of interviews are discussed below in Section 6.3.2 as examples of implicit design practices.

6.4 The new infrastructure design imaginary in practice?

The specific interpretation of infrastructure design which the thesis has set out to investigate has previously been discussed as a new infrastructure design imaginary. This section discusses interpretations of infrastructure design which emerged from three research interviews which arguably parallel aspects of this imaginary, in the sense that they raised questions of the visibility of infrastructure, the (ecological) politics of infrastructure design and the role of design expertise. This section further discusses the characteristics of the interviewees involved and the context for this interpretation of design. In the case of two interviewees, this was primarily an abstract discussion whereas in one further instance it had a practical application. The following two sections are divided on this basis.

6.4.1 Theorising the relationships between infrastructure, design and ecology

Two interview participants proposed distinctive understandings of infrastructure design that paralleled some aspects of the contemporary infrastructure design imaginary. This was linked, in both cases, to an understanding of the present moment as distinctive in terms of the relationship between design and infrastructure, including what the role of designers might be within infrastructure projects, and how this might relate to ecological sustainability. These interviewees were both architects but both also had a connection to academic research. In addition, both interviewees cited key authors in the landscape urbanism and infrastructure design literature, such as Waldheim (2006) and Bélanger (2016). One relevant point was the perceived importance of re-evaluating modernist approaches to infrastructure as illustrated in the following quote:

I think [infrastructure] is something that architects have in general shied away from in the last twenty or thirty years... My perception is that architects used to do far more in terms of intervening in infrastructural projects and had a broader remit of what they could do, what they were expected to do.

Within the context of the interviews, what is being referred to is the contrast between the present and modernist infrastructure, a period when, as described by Kaika and Swyngedouw (2000, 129), infrastructures were “prominently visible” in urban space and acted as reminders of the inevitability of technological and social progress. Within the context of the interview, what was taken to define modernism is, first, a sense of scale and ambition, or the idea that architects could contribute to resolving grand societal challenges. Second, it was the role of the architect or designer as integrating both functional and aesthetic forms of expertise with figures such as Berthold Lubetkin and Ludwig Hilberseimer being cited as examples of architects-planners-engineers who adapted their designs to take account of the latest technological and scientific advances. Further, both of these features were regarded as valuable models for contemporary design practice:

It's more the idea that you have to have big solutions to big questions. You have to define those questions as well... Technology inevitably shapes society anyway whether... someone is designing it, someone is doing it, someone is thinking about it.

Similar to the argument made by Easterling (2014), this quote acknowledges that there is little information about the infrastructure design process but that it is inevitably designed even if this is not conventionally recognised. There is an implication that the under-examination of contemporary design allows the political logics of design to go unexamined. What is critiqued here is defined by Rubio and Fogué (2015, 143; 146) as the “enfolding capacity of design” by which design is a “soft and tacit form of power” which is responsible for “hardwiring norms into the material world”. According to the same interviewee, this can be contrasted with a productive engagement between infrastructure and design following modernist principles whereby designers would tackle “big questions” and engage with infrastructural projects with a clearly stated political agenda. Further, climate change was highlighted as a paradigmatic example of the big questions with which designers might engage. Similar themes are illustrated in the following quote which identified the contemporary interest amongst design theorists in infrastructure as arising from the relevance of ecological sustainability:

I think that the big changes you want to make in the environment in terms of density of housing and being really green with your resources mean that you need

to tap into the network and not just the singular element of one house or one building so if you want to create an environment that is more sustainable you need to work with the whole system and not just one particular building or one particular house or one particular street so I think there's an environmental movement that contributes to it.

Further, and as illustrated in this quote, both of the relevant interviewees situated the contemporary interest in infrastructure design as reflecting an aspiration amongst designers to engage with “networks” and at a scale larger than that of individual buildings. This echoes the point made by Carlisle and Pevzner (2013) that by “embracing infrastructure, designers are extending their agency to look not just at the pieces and parts of the city, but at the design of entire systems and their operations”. It contrasts with the perspective of landscape infrastructure theorists such as Rosenberg (2015) who emphasise the need for site-specific, unique and small-scale solutions. It further represents a contrast with authors such as Cowley (2018, 1) who argues that the contemporary relevance of design illustrates a “cautious, inductive logic of change” and denies “our ability to solve pressing environmental and social problems through strong and direct human action”. Although, in contrast, De Block (2016), while noting the network rhetoric of authors in the field of ecological/landscape urbanism, observes that most completed projects are localised and small-scale.

As stated above, the relevant interviewees were both involved to some degree in academic debates on the topic of infrastructure design and their perspectives were clearly influenced by contemporary design theorists, in some cases authors whose work has been reviewed in Chapters 2 and 3 of the thesis, so it is unsurprisingly that there are common themes. Second, it is significant that the content of these interviews was generally abstract. They did not refer to examples of design practice and did not involve discussion of the circumstances under which new approaches to design might be realised. The relationship of infrastructure design theory and practice was summed up as follows:

Things still seem to operate at the level of discourse rather than as a method of action.

6.4.2 New approaches to infrastructure design in practice?

The following section discusses one interview which covered practical examples of design corresponding, to a certain extent, to the concept of contemporary infrastructure design imaginary. This example is interesting because this participant is identifiable as a paradigmatic 'infrastructure designer' in the sense that they perceived their work across different types of infrastructural developments as involving the application of "general principles" and had previously been involved in authoring a set of infrastructure design guidelines (ED & MS Studio, 2007). They were employed in a (North American) design practice which specialised in infrastructure projects and the characteristics of these projects, as discussed below, provide one example of the context in which infrastructures become consciously designed.

The type of infrastructure project on which this participant worked primarily involved conventional infrastructural buildings such as power stations, waste-to-energy facilities (incinerators), waste-water treatment and waste-processing facilities. Within the interview, these forms were described using terminology such as "large-scale", "concentrated" and as benefitting from "economies of scale" and they were specifically distinguished from a "distributed" infrastructure model. According to this participant, in such projects the role of design was described as to mitigate negative aesthetic and environmental impacts in order to overcome local opposition:

We have been invited on several projects as what I would call the last ditch effort it's when the power company for the municipality or whoever they have realised that there are fundamental flaws with what they have created, how they have sited it, what they have done and they want to know what they can do to make it better and get the project accepted by the public.

According to the interviewee, the practice is often recruited in cases of community opposition over siting, visual impact and other environmental concerns. From their perspective, investment in design can be justified financially through long-term cost savings to developers from, for example, reduced legal fees. Strategies referenced in the interview included increasing environmental performance in terms of technical measures such as emissions reductions, securing certificates of sustainable design and reducing consumption

of water and energy. Other measures related to architectural and landscape design and included features such as provision of public space, in some cases green space, visual mitigation through screening of facilities and adding green facades.

An important design principle advocated by the interviewee was to improve the “transparency” of infrastructural buildings, which relates to the thematic interest of the thesis in infrastructural ‘visibility’ and the forms of interaction between people and technology. The term ‘transparency’ is used by previously cited authors such as Lynch (1975) and Thayer (1994), for example in Lynch’s (1975) essay “Grounds for Utopia” which describes a “transparent” landscape where infrastructures are visually perceptible and understandable. The concept of transparency in this interview also closely parallels that of ‘visibility’ in the broader infrastructure design literature because it implies a relationship between design and how infrastructure is understood. Transparency was identified by the participant as an interrelated question of spatial design and other measures which could refer to improving the visual and literal accessibility of infrastructural buildings as well as adding facilities such as visitor centres, tours and other educational initiatives to increase public understanding of infrastructures. It was further related to questions of sustainability in two distinct ways: first, community opposition was constructed as resulting from a lack of understanding of the need for new infrastructures and their (supposed) sustainability benefits. Given the methodology at this stage of the research and an associated lack of detailed understanding of examples cited, it was difficult to investigate this idea further. Second, it was identified as a further method of improving the environmental performance of infrastructures where purely technical fixes were not available, as illustrated in the following quote:

We had 12 million dollars to spend on environmental educational and aesthetic enhancement to the building so one million dollars of that budget went to creating an interactive tour... The cost of [eliminating] that last half a percent [of pollutant emissions] is too high... The main way you handle that remaining micro percentage is through education, making sure that the lithium battery from a laptop or e-waste in general, batteries or phones, doesn't get in there in the first place. So the kids take these tours that also has this interactive design.

In infrastructure design theory there is much attention given to concepts such as visibility and interactivity, in which terms this example can arguably be interpreted, but there are fewer studies of why and how these concepts become realised in actual projects. In contrast, the quote above describes the rationale and approach to designing for 'transparency' in the case of an energy-generating incinerator or waste-to-energy facility; in this case the operator faced a problem of reducing hazardous emissions caused by inappropriate material entering the waste stream. A solution identified by the designers was a public education programme, in this case an interactive tour of the facility with expertise provided by a specialist interactive design consultancy which would, it was intended, lead to behaviour change and reductions in harmful emissions.

There are several significant aspects of the approach described here, most notably that it is conceived in quantifiable and instrumental terms; there is a direct financial rationale established for investment in design which was seen as a cheaper alternative to a technical fix. While no evidence of its effectiveness has been collected, it arguably constitutes a transfer of responsibility for ensuring adequate emissions standards are met from the operator to the public. Further, it constitutes a prescriptive relationship between design and sustainability with the intention to cause defined behavioural changes. This can be contrasted with the relationship between infrastructure, design and ecology in projects described by authors such as Evans (2008) or Rubio and Fogué (2015) who emphasise the positive characteristics of aesthetic interventions as open-ended and allowing multiple potential interpretations. As such, while the example above is interesting in representing the translation of aspects of the contemporary design imaginary into practice, ostensibly motivated by sustainability, it also mobilises a relatively narrow interpretation of the possible relationships between people, infrastructure and ecology.

6.5 Locating the infrastructure designer

From the outset of the thesis it has been acknowledged that specifying precisely who could be said to design infrastructure in a meaningful sense is a significant challenge and, although some examples of infrastructure design and their designers have been identified, it is not a question that this chapter claims to answer. Attempting to gather information about infrastructure design resulted in a difficult, extended and frustrating research process with frequently difficult social dynamics during interviews due to the failure of the

terminology or topic to resonate with interview participants. The difficulties included, first, gaining access to relevant interview participants; while more than 30 organisations were contacted during the scoping phase of research only a very small number of positive responses were received. Second, in the course of interviews it was difficult to gather substantive data that went beyond aspirations and abstract principles. Several specific challenges encountered, namely terminology, the existence of implicit design practices and accessing case studies, are discussed in the following sections because they illustrate some of the complexities of how agency to design is conventionally attributed, including how the design process is defined and who is regarded as a relevant actor.

6.5.1 Terminology

A methodological challenge which arguably explains some of the difficulties of recruiting and accessing interviewees and those encountered during interviews was the failure of the terminology to resonate with those contacted in the sense of being a definable set of concerns with a definite relationship to their everyday (professional) lives. According to qualitative methods texts, a basic requirement of interview questions is to render frequently abstract research questions into terms that resonate with participants' everyday experience (Longhurst, 2003). It is generally accepted that this may progress following an iterative process of learning and adapting to the language used by interview subjects. Following this approach, in the interviews reported on above (in Sections 6.2 & 6.3) there was a transition to the use of terminology such as "design thinking" and "customer experience". However, these did not necessarily mark a transition to understanding the language used by interviewees to describe relevant practices, rather it marked a use of seemingly related language to signify a different model of design; in this case the adaptation of terminology by the researcher resulted in a different set of phenomena being investigated which were not directly relevant to the research objectives.

6.5.2 Implicit design practices

Related to the above is a question of whether it was terminology used or the research topic itself that did not resonate with some participants. It has already been highlighted that processes of infrastructural change and development are always entangled in the shaping of urban space to some extent, but only some are intentionally designed with their

relationship to public space and aesthetic experience actively considered (Bruegmann, 1993) and where the infrastructure design process constitutes a discrete and identifiable aspect of the production of infrastructures (see Section 4.4 on the institutional setting of design). This introduces a conceptual distinction between designers of the former and latter categories, with one group involved in an implicit process of shaping space without recognising it as such. The methodological significance is that for such people, who see their work as having no bearing on urban space, an interview methodology will likely struggle to generate interesting findings irrespective of the terminology adopted. One example can be taken from the interviews with participants in the field of new transport infrastructures, specifically one participant who was a consultant responsible for coordinating projects on integrated transport. In disciplinary terms, their expertise was managerial rather than design. However, the interview demonstrated that the interviewee's work was underpinned by a distinct spatial imaginary:

Do we just remove car parks? So we don't have car parks in cities because cars don't need to park, just drop off and pick up and then when they need to recharge there's an out of city recharge centre.

Other issues clearly identifiable as questions of urban design that were raised in the same interview included changes to public transport interchanges, the allocation of road space between automated and conventional modes of transport, integration of public and private modes as well as broader changes to commuting and work patterns. Elsewhere, new transport infrastructures such as automated vehicles have been investigated in terms of their urban design implications, for example by the landscape architecture firm SWA (nd.); more specifically, how multi-storey car parks might be reused if no longer required following automation has also been explored (TIPSLab, 2014). While perhaps drawing on such spatial imaginaries, what was notable within this interview was the degree to which these were not identified as questions of design in the sense of requiring active intervention, rather as the direct, inevitable (and assumed positive) consequences of technological change. In the sense of the degree to which the topic resonated, it was not one which required in-depth consideration or constituted a feature of everyday work.

The claim here is not that design in this field is driven wholly by technological criteria; this participant and others were aware of a potential relationship between public space and

infrastructure as illustrated both through texts and interview material. Rather, it arguably illustrates how the design process is defined in a limited manner and highlights some associated challenges of researching this topic. The most obvious methodological point is that the infrastructures discussed have mostly not yet been implemented and specific decisions related to urban design have yet to be defined and tackled. However, it has also been argued throughout that design should not solely be identified as the product of a design professional which implies a broader understanding of the design process, for example, in terms of its extension in time. The work of this interview participant, concerned primarily with devising a regulatory and commercial model for automated vehicles, could potentially (retrospectively) be identified as an aspect of a design process if it influences the conditions within which design might ultimately operate. However, using an interview method and without specialist knowledge it is difficult to address any of these questions.

6.5.3 Access to case studies

As discussed in the Methodology (Section 5.3), one of the intended functions of the scoping interviews was to generate suggestions for case studies identified as examples of innovative design by participants. Two potential case study projects were identified at that point as, to an extent, paradigmatic examples of new approaches to infrastructure design; that of Amager Bakke in Copenhagen, a waste-to-energy facility designed by Bjarke Ingels Group (BIG) and BEI-Teesside, a biomass fuelled power station in the UK designed by Heatherwick Studio. Both are discussed in Poirier (2012, 118) as “signalling a shift in architecture’s longstanding hierarchies” and as new sites “for architectural invention” by engaging in the design of some of the “lowliest” urban functions of waste disposal and power generation. Both projects have also previously been introduced in Chapter 3 (Section 3.2.1) although that description was obviously based on secondary sources. Given their centrality, an effort was made to collect substantive data about both projects but this was ultimately unsuccessful.

In the case of Amager Bakke, this effort entailed contacting the developer (Amager Resource Centre) and local government (Københavns Kommune) with a request for information about the recruitment process for a design team and the design more generally. However, the responses from both parties indicated that, given the research

topic, the inquiry should be directed to the architects, Bjarke Ingels Group (who were ultimately also unwilling to participate in the research for reasons which were unclear). In the case of BEI-Teesside, contact was made with the design practice who responded stating that the staff members responsible for the proposal had since left its employment and therefore no suitable interview participant could be suggested. Deamer (2016) notes that it is common practice in the architecture industry to “hire up” on a project to project basis, of which this was potentially an example. It also arguably reflects the perspective that the design proposal was the product of a limited set of individuals who worked on it rather than reflecting a set of principles applied by the practice across different projects. Although neither of the projects above were ultimately followed up as case studies, what was arguably at stake (and presents an impediment to research) is an understanding of design as the responsibility of a limited set of institutions or people (design practices or “designers”) rather than seeing it as the outcome of a negotiated process involving various stakeholders, for example, those responsible for setting the criteria according to which a designer is recruited.

6.6 Summary

The overall contributions of the chapter include a review of the varied significance and meanings of design in the context of infrastructure projects and some limited evidence of the practical application of a new infrastructure design imaginary. “Design is in the zeitgeist”, as one interviewee put it. This is apparently the case but when applied to infrastructure it has a very variable set of meanings: what ‘infrastructure design’ was taken to mean, in terms of issues such as objectives, metrics of evaluating success, the types of design expertise involved and its relationship to sustainability, varied widely between interview participants. An overview of the connections between the evidence generated by the scoping phase and the analytical framework for the research is provided in Table 6.1 below.

In summary, one important finding which ‘emerged’ from the interviews (in the sense that the original intention was not to research such practices), was the idea of design as a key means of differentiating products in a market setting which was the dominant model in the field of new and integrated transport infrastructures. A second finding was the partial and limited relevance of interpretations of design approximating the concept of a new

infrastructure design imaginary. In the first instance described (Section 6.4.1), this referred to the idea that designers should engage with infrastructures because it provides opportunities to expand the scope of design practice in response to ecological pressures. However, this was articulated in abstract terms and remained at the level of theory rather than practice. A second iteration, discussed in Section 6.4.2, provided an interesting example of a self-identified infrastructure designer, including an explanation of one context, that of local opposition, in which infrastructures become the object of specialist design expertise and, therefore, are labelled as design objects. It also provided an example of one instance in which principles such as 'transparency' become manifest in projects as ostensibly linked to ecological sustainability as well as having an obvious financial logic.

The second contribution has been the discussion of challenges associated with delimiting the design process and identifying and accessing relevant stakeholders so that questions such as 'who is responsible for design?' could be meaningfully addressed. Ultimately, this has illustrated the limitations of equating design with a designer and has led to a transition to a case study method where the distribution of responsibilities could be investigated without the scope of investigation being immediately foreclosed by the use of a sampling strategy which relies on an identifiable designer as the key source of evidence. As outlined in the methodology (Sections 5.3 & 5.4), the following chapters involve an investigation of infrastructure design in the context of two stormwater management projects. This allows for an in-depth investigation of the infrastructure design process and encompasses a process of identifying the full range of actors, institutions and agendas which influence the approach to design in these cases.

	Influences on infrastructural development				
	Cultural, discursive, representational practices	Material	Who designs and what influences their thinking?		Economic development
Potential influences on design	Are there parallels with the 'contemporary infrastructure design imaginary'?	What forms of infrastructure are the objects of design intervention?	What does design or aesthetic expertise mean in a given context?	How is design expertise recruited and institutionally situated?	What is the significance of infrastructure design from an economic development perspective?
Relevance to the case study	There is limited and partial evidence of new design imaginaries similar to that defined in Chapter 3 becoming influential, primarily amongst interviewees with a connection to academic research rather than practice.	'Design' was regarded as a relevant concern in the field of integrated and low-carbon transport, which was linked to the existence of market pressures to increase consumer uptake. Another less frequently referenced function of design was to mitigate the negative aesthetic impact of conventional, centralised forms of infrastructure.	In the case of market-driven examples of design, the primary measure of the value of design and aesthetic expertise were financial. Overall, the evidence demonstrates the lack of a shared understanding of the 'infrastructure designer' including what forms of expertise they might apply.	<ul style="list-style-type: none"> • Infrastructure design as routine and anonymised (Easterling, 2014). <p>The evidence shows the difficulty of identifying and accessing a definite 'infrastructure designer' demonstrating that this is not widely used category. Design remains an anonymous and hidden dimension of the production process in infrastructural projects.</p>	<ul style="list-style-type: none"> • Design as an important component of the value of consumer goods (Lash & Urry, 1994). <p>There was a direct financial logic for 'design' in the case of low carbon and integrated transport systems. This was not a priority for other respondents which can be linked to the lack of realised projects.</p>

Table 6.1 Connections between the theoretical framework and the results of the scoping phase of the research

Chapter 7 “Climate Adaptation and Urban Nature”: Hans Tavsens Park and Korsgade in an urban context

This chapter is the first of two presenting the results of the case study on the redevelopment of Hans Tavsens Park and Korsgade (HTPK) in Copenhagen, Denmark. It focuses on the vision of design associated with stormwater management at the urban scale. Evidence here is drawn from 11 research interviews with interviewees identified as “strategic” stakeholders in stormwater management in Copenhagen (see Section 5.5 of the Methodology), from other informal conversations and a comprehensive analysis of relevant policy and planning documents. A more grounded analysis of the HTPK project is provided in Chapter 8.

The contribution of the chapter is the description and analysis of the “Copenhagen Model” of combining stormwater infrastructure with landscape and urban design. This is valuable, first, because it provides an important aspect of the background for the local case study. Second, it provides the basis for a discussion of the relationship between the particular visions and practices of stormwater design in Copenhagen and the concept of a contemporary infrastructure design imaginary. Last, it is also valuable because the analysis of the Copenhagen Model allows for discussion of the role of the structural context in influencing why and how new approaches to design are adopted.

In Section 7.1, the chapter first provides a basic introduction to the case study project. The rest of the chapter describes the intellectual and socio-economic context for stormwater design in Copenhagen. The recursive structure of the chapter, starting with the local case study and reverting to a discussion of the urban scale, reflects an important contribution of the research which is that the case study project needs to be understood in an urban context rather than seen as an isolated example of innovative design. As such, Section 7.2 discusses the emergence of Copenhagen as an internationally recognised site of innovation in ‘sustainable design’. Sections 7.3 and 7.4 document the principles and substance of the city’s aspirations to combine urban stormwater management and aesthetics, termed the “Copenhagen Model”. Section 7.5 extends the discussion of the Copenhagen Model to the design process and related questions of expertise and community engagement. Section 7.6 further extends the discussion to questions of control over investment in design.

7.1 Introduction to the case study

In July 2011, Copenhagen suffered severe flooding as a result of heavy rainfall which caused an estimated €700-800 million in damages. This led to the formulation in the following year of a Cloudburst Management Plan (Københavns Kommune [KK], 2012) which outlined a strategy to manage the increasing risks of flooding linked to climate change. Rather than upgrades to underground storm drains, the strategy recommended an alternative approach of surface level retention, infiltration and conveyance. This alternative approach was premised both on the basis of cost-effectiveness and as offering opportunities to enhance urban and landscape design by, as described in the Cloudburst Management Plan (KK, 2012, 2), creating “blue and green oases”. Overall, the strategy foresees the construction of approximately 300 projects following these principles between 2015-2035 at a cost of approximately 670 million euro (Jensen et al., 2016). The majority of the following chapter explores the substance of the city’s vision of design, what its implications might be and, more generally, why Copenhagen has emerged as a site of innovation in stormwater design.

The Hans Tavsens Park and Korsgade (HTPK) project is one early example of the approach advocated in the Cloudburst Management Plan (the rationale for selecting this project as a case study is given in Section 5.4 of the Methodology). It is located in Inner Nørrebro, a densely populated urban area close the centre of Copenhagen and is currently in the mid-stages of planning and design. In 2016 a consortium led by SLA landscape architects and Ramboll, an engineering consultancy, were appointed lead design consultants after winning a competition, the “Nordic Built Cities Challenge” with a proposal titled “The Soul of Nørrebro” (“Nørrebrosjælen”). In terms of its infrastructural functions, the intention of the project is to redirect stormwater from the surrounding sub-catchment which was previously entering underground storm drains or caused flooding in periods of heavy rain. Instead, the project proposes an above-ground system which will direct water into a series of surface-level retention, infiltration and water treatment areas and ultimately convey most of the water to a nearby lake. Major new retention and infiltration areas will be located in an existing park, Hans Tavsens Park, while the conveyance channels will follow Korsgade, a street which links the park to Peblinge Lake (see Figure 5). It is planned that the park will have the capacity to store approximately 20,000m² of water, which will be

redirected into the park from across the surrounding Assistens Cemetery (“Assistens Kirkegård”) sub-catchment, the extent of which is illustrated in Figure 8 below.

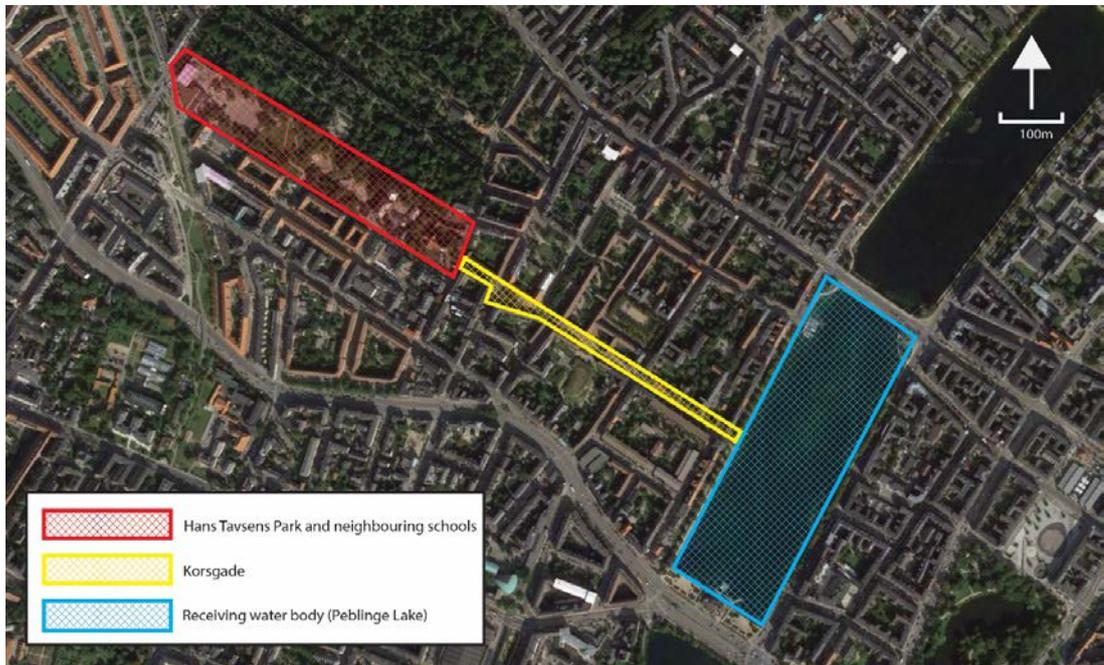


Figure 5 Case study area: Hans Tavsens Park, Korsgade and Peblinge Lake (Map data copyright Google 2018)

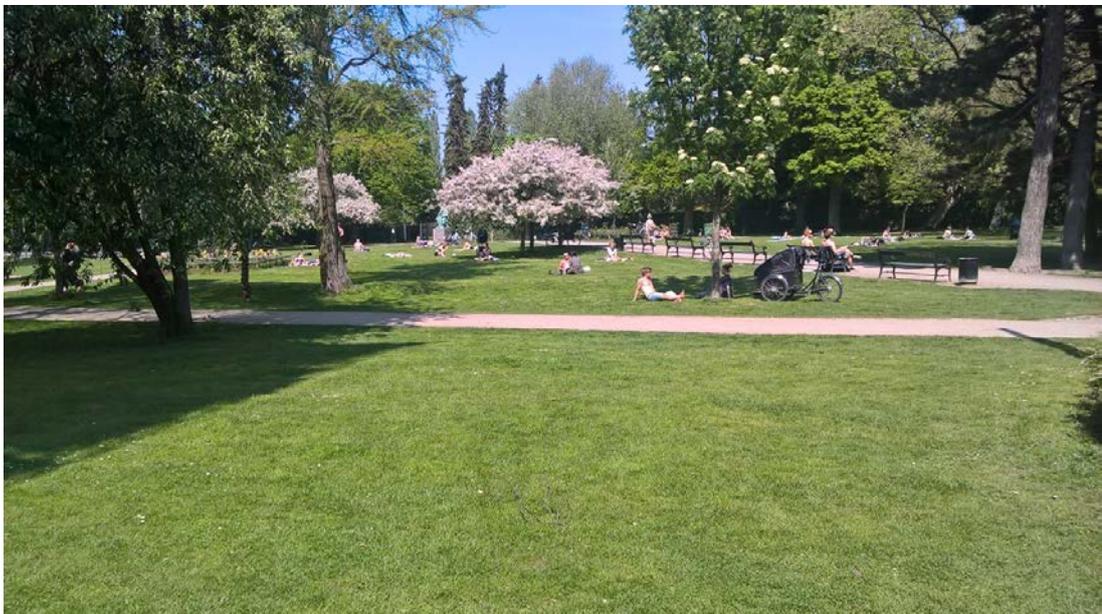


Figure 6 Present day landscape of Hans Tavsens Park: “Hans Tavsens Park is one of the city’s oldest parks with large trees and open areas” (ON, 2014, 60).⁹

⁹ “Hans Tavsens Park er en af byens ældste parker med store træer og åbne arealer”.

The complexity of the project arises from the scale and character of the proposed changes. At present, the park is the largest green space in Inner Nørrebro, an area which is otherwise densely developed. The neighbourhood plan (Områdefornyelsen Nørrebro [ON], 2014) notes that it is one of the city's oldest parks and is an important community space (see Figure 6). The plan (2014, 60) further recommends that it should be redeveloped "with respect for the park's history and present characteristics" but simultaneously recognises the challenge posed by the fact that "in the Cloudburst Plan the park is designated as a water retention area".¹⁰ The redefinition of the park's function and value has caused concern amongst some local residents. In contrast, by designers and others it has been conceptualised as an opportunity to reconfigure the park as a new green and aesthetically-enhanced infrastructural landscape.

Proposed changes to the park and surrounding areas are defined in "The Soul of Nørrebro", SLA and Ramboll's competition-winning design proposal. They include, most importantly, a water storage area to be located in Hans Tavsens Park which, it is intended, will be useable for recreation outside periods of heavy rain. There will also be new spaces for education linked to the neighbouring schools and a flexible use community space. It is also intended that the landscape aesthetic of the park will be wilder with, for example, longer grasses and less intensive maintenance. Several important features such as visible water, the water retention structures and the approach to planting are apparent in SLA's visualisation of the future park landscape (Figure 7). In the case of Korsgade, proposed changes include additional green space, improvements to traffic conditions and an open water channel carrying water to the lake. Water will also be recirculated in this channel outside periods of rain, a feature which is premised on the grounds of aesthetics and educational value.

One further important aspect of the proposal, which also provides a thematic link to the research topic, is that it presents an aspiration to maximise the aesthetic opportunities of new infrastructure such as by emphasising the educational and socio-cultural potential of visible water and of disordered forms of nature. The project is underpinned by a distinctive socio-natural vision with residents repositioned as active participants in the production and maintenance of infrastructure and "nature" with these activities seen as productive of new

¹⁰ "Problematik:... Parken er udpeget i skybrudsplanen som forsinkelsesbassin... Hans Tavsens Park renoveres med respekt for parkens kvaliteter og historie".

forms of community (SLA, nd.). Overall, the design envisages interlinked material and socio-cultural changes. In terms of influences on the design concept, this is directly linked to the urban context and the related “Copenhagen Model” which are discussed throughout the following chapter.



Figure 7 Designer’s visualisation of the future landscape of Hans Tavsens Park (credit: SLA/Beauty and the Bit).

7.1.1 Actors and institutions

The project is linked to a set of wider strategies and a broad range of stakeholders at different spatial scales have influenced the design. First, as previously discussed it, is one of the earliest examples of projects associated with the city’s Cloudburst Management Plan (2012). As an infrastructural project under this plan, the principal actors are the Technical and Environmental Administration (Teknik- og Miljøforvaltning [TMF]) of Copenhagen’s local government, which is also the owner of the park, and the city’s water utility, HOFOR, which is responsible for the drainage of stormwater and is also an important source of funding (Ziersen et al., 2017). However, responsibility is divided between the infrastructural aspect of the project and the development, both social and physical, of the surrounding area of Inner Nørrebro. This latter aspect of the project is the responsibility of a local urban regeneration agency, Områdefornyelse Nørrebro, which is also managed and partially

funded by the TMF (TMF, 2012). The extent of the urban regeneration area is mapped in Figure 7.

The urban regeneration programme has been, under different names, an established feature of urban development policy in Copenhagen since 1996 as a solution to perceived interlinked physical and social problems of (primarily) marginalised neighbourhoods in the city (Larsen, 2013; Savini, 2011). The programme involves the establishment of a temporary secretariat and local office which engages with the community to produce a neighbourhood plan (Larsen & Hansen, 2008). While the local secretariat is also tasked with realising the objectives of the neighbourhood plan, over the past decade funding allocations have been reduced meaning that further sources of investment will often need to be secured (Larsen, 2013).

The HTPK project is one initiative of a broader urban regeneration plan for the area, the objectives of which are defined in the Områdefornyelse Nørrebro Kvarterplan (ON, 2014) (the “neighbourhood plan”) which covers the period 2014-2019. The plan recognises a need to balance the strategic objectives of the city, including climate change adaptation and stormwater management, and local needs as defined in the neighbourhood plan which were informed by a consultation process (ON, 2014). In terms of how the project has developed, including the approach to community engagement, the institutionalisation of design within the existing urban regeneration framework emerged as an important influence which is discussed in more detail in Section 9.3 of the following chapter.

The urban regeneration agency was also responsible for co-ordinating the competition to recruit a consortium to plan and design the project. A further actor in this process was Nordic Innovation, a supra-national Scandinavian institution established by the Nordic Council of Ministers with a remit in the field of economic development. According to Nordic Innovation (NI, 2018), the background to the competition is “a global market for innovative solutions for our urban environment” in which Copenhagen and the wider Nordic region should aim to position themselves as leaders. As discussed in Section 9.1 of the next chapter, the competition provides a means to discuss the recruitment and validation of infrastructure design expertise.

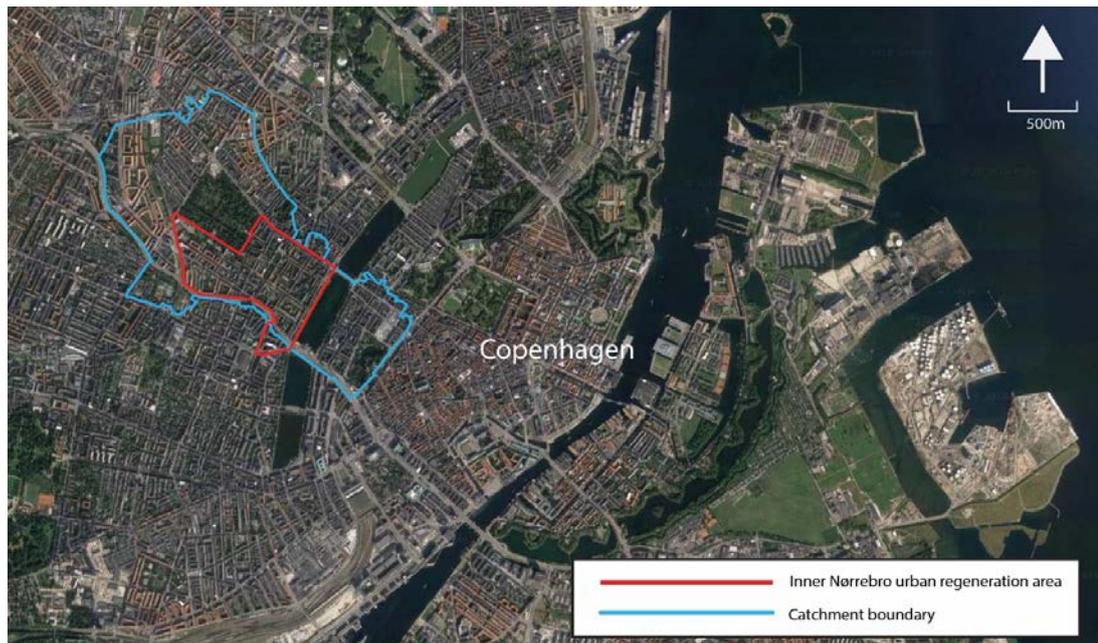


Figure 8 Extent of the Inner Nørrebro urban regeneration project and the Assistens Kirkegård sub-catchment (Map data copyright Google 2018).

7.2 Copenhagen: environmental policy and urban development

As previously discussed, the aim of the chapter is to provide an understanding of the background to the HTPK case study, including sources of ideas relevant to design and broader influences on the design process. To this end, it is relevant to note a range of cultural and socio-economic factors at the urban level including the significance of practices broadly definable as ‘sustainable design’ to Copenhagen’s model of economic development. Cucca (2017) notes Copenhagen’s perennial location at the top of indices ranking cities in terms of their sustainability, citing its receipt of the European Green Capital Award in 2014. Elsewhere, Anderberg and Clark (2013, 594) note the efforts of Copenhagen, and of the wider Øresund region, to brand itself as a ‘green’ and ‘sustainable’ as part of a key economic development strategy aimed at making it “more attractive to tourists, investors and the ‘creative class’”. Providing an example of the success of this marketing campaign, according to Styles (2011), Copenhagen is Europe’s “coolest green city” and “a hotspot for green travellers”. The drive to situate Copenhagen as an international leader in sustainable development has been manifest in various concrete urban development strategies such as the eco-suburb of Ørestad, part of “an urban landscape of great wonder” (Reimer, 2012, 120), and Nordhavn, a new ‘green’, carbon neutral, bicycle-friendly and renewable energy-based urban district described as “the sustainable city of the future” (Blok, 2013, 6).

As noted by Roy (2018), 'green' design strategies have also been adopted as part of the city's urban regeneration (Områdefornyelse) programme largely through greening public spaces and attempts to develop a sense of community cohesion through environmentally themed activities such as the maintenance of community gardens. According to Roy (2018, 296), this "intricately intersects with the rising entrepreneurial goal of the city to mobilise comparative advantage of being the 'green capital' and possibly trigger more capital flow into the city by attracting more tourists, green businesses, events and conventions". Equally, Cucca (2017) notes the emergence in Copenhagen of a model of "green urban renewal" and argues that, in combination with a reduction in the availability of social housing, this has led to the concentration of high-income residents in "eco-districts".

The logic of green development has also resulted in new approaches to stormwater infrastructures; Jensen et al. (2016, 235) describe the changing framing of stormwater management in Copenhagen from a purely technical matter to one which is recognised as having implications for "place-specific concerns associated with urban governance, such as the development of liveable, competitive and attractive places". This has been manifest in a series of changes to the stormwater network aimed at increasing the water quality in Copenhagen Harbour and thus allowing public swimming in the harbour waters. This has been identified as a pre-requisite for the transformation of the image of Copenhagen Harbour from a site of industrial activity into one of recreation and consumption (Jensen et al., 2015). In the case of the contemporary stormwater management as studied in this thesis, there is a distinctive emerging relationship between urban design and urban economic development which is discussed in Section 7.5.3 below. Prior to this, the following sections outline key features of the approach to design and stormwater infrastructure in Copenhagen.

7.3 Stormwater management, design and "urban nature"

As previously stated, there is a planned programme of infrastructural upgrades required to manage the risks of flooding from heavy rainfall or cloudbursts, the background and objectives of which are set out in the Cloudburst Management Plan (2012). However, this is accompanied by a distinct imagination of how stormwater management might contribute to urban and landscape design. The plan itself (2012, 2) describes the approach to

stormwater management as “blue-green infrastructure” involving the storage and conveyance of water at the surface level which will lead to the creation of “new blue and green oases and recreational areas” (2012, 2). A series of detailed implementation reports have also been produced by Ramboll, a Danish engineering consultancy, and Atelier Dreiseitl, the practice led by influential landscape architect, Herbert Dreiseitl (Ramboll, 2013a; 2013b). These suggest a “cloudburst toolkit” comprising four typologies of “cloudburst streets” for conveyance of water on the surface, “central retention areas” to store water in parks and plazas, “storage streets” which retain lesser volumes of water and “green streets” which allow some water infiltration (Ramboll, 2013b, 37).¹¹ The majority of these typologies involve greening of public space and opportunities for multifunctional uses are also identified. In the case of central retention areas (such as that planned for Hans Tavsens Park), Ramboll (2013b, 38) identifies potential “synergies... where the water helps to create liveability through improvements to places’ potential as social venues”.¹² Elsewhere *Community Copenhagen* (“Fællesskab København”) (TMF, 2015, 13), a report which sets out the “strategic vision” of the Technical and Environmental Division (Teknik- og Miljøforvaltning) of the local government, adopts the concept of “climate adaptation with added value” which repositions stormwater management as an opportunity to improve the urban environment: “the challenge [of climate change] will be an asset for Copenhagen because climate protection will create added value in the form of new green and living urban spaces”.¹³ Further design concepts, particularly that of “synergy”, are discussed in Section 9.1.1 of the following chapter.

In research interviews, seven of the participants referred to both the scale of changes to the city due to the stormwater management strategy and to questions of how these could be balanced with considerations related to design. The following quote from one of the local government planners involved in formulating the city’s Cloudburst Management Plan expresses an aspiration that the projects positively contribute to improving the urban environment.

¹¹ “Masterplanerne opererer med følgende overordnede elementer eller værktøjer: Skybrudsveje og –boulevarder, centrale forsinkelseselementer, Forsinkelsesboulevarder, Grønne veje”

¹² “De centrale forsinkelseselementer er samtidig de steder i byen, hvor der er bedst mulighed for at opnå synergier med andre funktioner, og hvor vandet medvirker til at skabe det ønskede byliv ved et løft af stedernes potentiale som sociale mødesteder i byen”.

¹³ “Klimasikker med mere værdi... Udfordringen skal blive et aktiv for København, fordi klimasikringen skal skabe merværdi i form af nye grønne og levende byrum.

The way that Copenhagen will be developing in the next 20 years will be through these projects. We want to make sure that the way we are doing it has a quality where we can still look back in 20 years' time and say this has really made an improvement and not just look back at 300 projects which basically all look the same because we have had very little true innovation.

Of note here is the aspiration for innovation in the design of stormwater projects. What this and the improvements referenced might mean in terms of material changes forms the substance of the following discussion. The most detailed discussion of the relationship between stormwater management and design is found in a joint publication by Copenhagen's local government and SLA landscape architects (the lead design consultants for HTPK) titled "Climate Adaptation and Urban Nature" (2016). This was formulated by a "think-tank" of actors from local government, private-sector consultancies and academic researchers. The report (KK & SLA, 2016, 22) describes what is termed the "Copenhagen Model" of climate adaptation, defined by combining infrastructural upgrades with aesthetics via simultaneous improvements to urban and landscape design:

"The Copenhagen Model brings climate adaptation and urban nature together in a new urban development practice. Nature's processes and the aesthetic nature feeling are used to develop the city's new quality of life, while the city adapts [to climate change] at the same time".

What is immediately apparent based on this definition (and that of "climate change adaptation with added value" above) is the centrality of "urban nature" to the vision of aesthetics; it is foreseen that the primary contribution of stormwater management to design is that it will facilitate the creation of new and redeveloped green space in the city. This is related to the model of stormwater management which is described as being "based on urban nature" (KK & SLA, 2016, 8) which itself is justified due to what are termed the "utility" and "amenity" values of nature in the city. The former refers to technical benefits such as absorption of water by plants. The latter are identified with five "cultural services" provided by nature, "belonging, coexistence, learning, sensing and community" (KK & SLA, 2016, 45). As illustrated by the idea and descriptions of these cultural services, the report can be understood as making a claim that the visible presence of nature in urban space is

related to cultural sustainability referring to people's understanding of their connection to both "nature" and to the surrounding social world.

This arguably also illustrates that stormwater design has been conceptualised as a socio-cultural project and this has emerged through the emphasis on "urban nature" and green design. One example of the perceived social role of green design is the suggestion that nature's cultural service of "learning" contributes to "integration" (KK & SLA, 2016, 50). In fact, the idea that integration of migrant communities might be promoted through stormwater design is an important influence on the HTPK case study as described in Section 9.3 of the following chapter. The social role of design was also emphasised by a local government planner who suggested that the realisation of this model will contribute to realising strategic infrastructural, ecological, aesthetic and social policy objectives:

We are also combining the solutions to a technical problem which is the stormwater management with the idea of saying we can use this as a way of also improving urban design, urban development. We can use it to improve our wish to have more urban nature to increase the social cohesion in the city and so on.

The idea that stormwater design, through its association with "urban nature", is underpinned by a distinct social vision, is applied to the analysis of further important features of the Copenhagen Model, namely visible water and naturalistic planting and, especially, the approach to community engagement.

7.4 The "Copenhagen Model"

The following sections discuss how the principles of the Copenhagen Model might be translated into material changes to urban space. Aspects of this model are highlighted both due to their relationship to the overall conceptual framework of a contemporary infrastructure design imaginary and because they emerged as points of contestation in the HTPK case study.

7.4.1 Visible water

One important aspect of the contemporary infrastructure design imaginary is the idea that infrastructures should be more visible and interactive. This is based on a normative position

that designers should problematise the un-reflexive relationships which are presumed to exist between people, infrastructures and the nonhuman world, for example through challenging design strategies and facilitating new forms of interaction. In addition, as described in the previous chapter, in the literature on stormwater design, theorists have promoted similar ideas of design strategies which visually emphasise the conventionally hidden functions of water infrastructure as a means to promote awareness of the interconnected-ness of social and natural systems, described by concepts such as “staging water” (Backhaus and Fryd, 2013, 52) or “eco-revelatory design” (Karvonen, 2011, 139). The discussion of the work of Atelier Dreiseitl (Section 7.6) also highlighted ambiguities in relation to defining the aesthetic dimension of stormwater management systems as emerging as an expression of function or alternatively defined by superficial greening. These issues provide a framework for the following discussion of stormwater design in Copenhagen.

As previously noted, the Copenhagen Model is defined by an aspiration to reconceptualise the programme of stormwater infrastructure upgrades as an opportunity to improve the quality of public space. Further, one of the key features highlighted by interview participants and in documentary sources was the idea of reconceptualising water as a design resource and one that can add aesthetic value to public space. In addition to cost-effectiveness, this is seen as an additional justification for the management of water at the surface level; according to the Cloudburst Management Plan (KK, 2012, 8), “mitigating pluvial flood risk in Copenhagen will contribute most to the blue and green infrastructure if the adaptive measures applied store or drain excess water at ground level”. A further example is the report on *Climate Adaptation and Urban Nature* (SLA & KK, 2016, 58) which states that water should be a “resource that is noticeable in our everyday life”. In addition, eight out of eleven interview participants described this as an important feature of the approach to stormwater management in Copenhagen, using terminology such as using “water as a resource” and “visible water”.

It was highlighted that conceptualising water as a design resource is not as an entirely new phenomenon. Three interview participants noted that this has been a feature of previous ‘sustainable design’ strategies with the example of harbour swimming cited in all cases. This follows Jensen et al.’s (2015; 2016) arguments that a “place-making” agenda has been a significant disruptive influence on the management of stormwater infrastructure in

Copenhagen. In terms of the sources of ideas, therefore, this illustrates a place-specific history of water in urban design and also a degree of continuity in expertise; for example, one interview participant who was a local government planner had previously coordinated efforts to improve water quality in the harbour before moving into the field of stormwater management. Similarly, one of the landscape architects interviewed described his current work in stormwater management as a continuation of previous projects where water was a decorative feature not specifically linked to ecological themes.

In terms of practical examples, the Tåsinge Plads stormwater management and urban regeneration project, completed in 2014, was cited as an important early exemplar of maximising the aesthetic value of water by seven of the interview participants. According to the *Climate Adaptation and Urban Nature* report (KK & SLA, 2016, 122), “rainwater is very visible in the project and staged through a number of distinctive urban space installations (park umbrellas and raindrop shaped water tanks), which in a very direct way inspire water games and *learning*” [emphasis in original]. Tåsinge Plads was one project in the “Klimakvarter” (“Climate Quarter”) described as “Denmark’s first climate resilient neighbourhood” (Klimakvarter.dk, nd.). Figure 9 is a visualisation of the design concept for the Klimakvarter by Third Nature landscape architects. The image can be interpreted as illustrating an aspiration to construct stormwater as a resource both for recreation and education, for example, as illustrated by the interaction between children and water features. Figure 10 shows features of the completed project.

In contrast to the positive assessments of projects such as Tåsinge Plads where water was an important design feature, the following quote from an urban regeneration agency staff member illustrates a critical perspective of public space redevelopment carried out as part of the urban regeneration programme prior to the emergence of the model of “green urban renewal” (Cucca, 2017):

[We] planted some trees but everything was paved and completely easy to clean and completely boring and nothing to do with the water or greenery or the trees totally like an architect would draw it on a piece of paper.

In the quote above, the perceived order, cleanliness and subjection to control by an architect, as well as the lack of any formal or functional connection to stormwater

management, are perceived as negative design features. This was identified by the same interviewee as contrasting with the disordered and naturalistic landscape aesthetics of Tåsinge Plads. However, opposition to design based on a perception of disorder was also reported. Three interviewees stated that visible water was frequently negatively perceived by non-professional stakeholders. The following quote is from a landscape architect who is discussing the acceptability of redesigning familiar urban landscapes, in this case parks, as infrastructural spaces with visible water:

Right from the start, people have been: "Oh if there's water standing there won't the benches get ruined. How safe is it? How often will there be water there? I want to be able to go out and play in my park the day after." These kind of things. Also if you have standing water for more than 48 hours you have risks of mosquitoes and other kinds of things that you don't want. So absolutely, loads of concerns and that's actually one of the biggest barriers, changing mind-sets and convincing people that we can do this and that they should accept it.

A notable feature of how such concerns were reported by such professional interview participants was their description of resistance to change as arising from a lack of understanding, such as illustrated by the identification of a problematic "mind-set" in the quote above. Similar language was used by two other landscape architects to describe opposition to both visible water and naturalistic planting (see Section 7.4.3). Related to this identification of opposition, the role of landscape architects in visually communicating what future redesigned spaces might look like was perceived as important in changing attitudes towards water in public space, particularly through visualisations produced as part of design competitions:

Every time there is a big competition and an architectural firm gets really nice visualisations done of people interacting with water we are moving in my opinion more and more forward and away from dealing with stormwater in underground pipes.

More detailed proposals and the perspectives of non-professionals are outlined in Chapter 9 and this provides a more nuanced understanding of how new infrastructural landscapes are perceived by different groups and why.



Figure 9 Stormwater as an aesthetic feature of urban space: the Klimakvarter concept (credit: Third Nature).



Figure 10 Tåsinge Plads: park umbrellas and planted swales

7.4.2 Visible water/invisible infrastructure

Although there was general acceptance of the aesthetic value of stormwater in urban space, there were obvious tensions between an aesthetic defined by expressing an infrastructural function and other equally aesthetic considerations such as a preference for greening of public space. One example involves an interview participant's assessment of the Tåsinge Plads project. While according to some participants this balanced stormwater management with other social and ecological functions, another argued that this was not wholly successful:

Tåsinge Plads is made with water as the centre of attention but it is a little bit odd and 95% of the time it is dry so the good project is one that looks beautiful and works well for people 95% of the time and easily handles rain the 5% of the time that you have heavy water going through.

What is stated here clearly parallels the position of Backhaus and Fryd (2013) that overreliance on water as a design theme creates “unsettled” designs which are potentially difficult to understand due to the absence of water. Further, similar to Backhaus and Fryd's (2013, 58) conclusion, it suggests that a good project is one that is “as unobtrusive and inconspicuous as possible”. A similar ambiguity over the extent to which an infrastructural function should be expressed is demonstrated by the following quote from a local government planner:

It doesn't look like something you would think about it as a stormwater management thing. The fact that we are focusing just as much about the use of the space in between the events where we need to use the stormwater management [function] as we are on the events themselves. Because maybe that is 1% of the time where you need to use it for those things whereas the rest of the time you can use it for other things and that is much more important.

This interviewee, first, described early attempts to construct surface stormwater retention structures without input from designers. In their opinion, the extra requirements in terms of design of a transition from underground to surface infrastructure were not sufficiently considered resulting in obviously visible structures but which they did not regard as examples of good design, describing them as “above-ground traditional infrastructure”.

This was contrasted with the alternative, preferable model described in the quote above where the infrastructural function is not formally expressed.

In addition, there was a further generalised, albeit implicit, idea expressed by interviewees that the visible water, rather than water infrastructure, was what constitutes good design. This point can be illustrated by a discussion of how stormwater is classified for the purposes of its use in urban space into 'good' and 'bad' categories. According to Jones and MacDonald (2007), a prerequisite for the transition to a SUDs model is the classification of water into good and bad categories of stormwater and foul sewage respectively, with the latter deemed appropriate for management in urban public space. This is apparent in Copenhagen. For example, Sørensen et al. (2006, 8) reflect on the changing meaning of visible water in the city between the 17th and 21st centuries: "the future townscape will include open drains. However, unlike the situation in the Copenhagen of Christian IV, they will only be filled with uncontaminated rainwater from roofs".

Also relevant is the greater emphasis in some cases on so-called "everyday rain" as a design resource as distinguished from excess rain occurring in cloudbursts, the infrastructural and design implications of which have arguably not been fully recognised. The point is illustrated by the *Climate Adaptation and Urban Nature* report's (2016) description of the concept of stormwater management "based on urban nature" which, it suggests, is a guiding principle for stormwater management in the city. This description emphasises the capacity of green space to delay, infiltrate and evaporate water from normal rainfall: "with everyday rain, rainwater management consists mainly of providing space for water in the ground" (KK & SLA, 2016, 58). However, the emphasis on nature-based solutions and everyday rain was regarded as misleading by one interviewee who noted their limited ability to reduce flooding in instances of intense rainfall:

When you have a 100-year rain, the soil saturates so quickly that it can't handle it so actually it's almost negligible... it won't help us with our flooding. We're only dealing with these big rain events where you have intense rain and the soil saturates.

The intention of the discussion here is not to dismiss the relevance of nature-based stormwater management, rather it is to highlight that this is not necessarily the most significant aspect of the stormwater management from an infrastructural perspective and

yet it has featured prominently in representations of the approach to design in the city. It also highlights the selectivity which characterises any aspiration to render infrastructures visible, but which is not necessarily recognised. Last, it highlights the mediation of the visibility of infrastructure by designers influenced by established aesthetic conventions. In practical terms, as discussed in Section 7.7, there are also costs associated with avoiding “unsettled design” while also creatively expressing a stormwater function. This draws attention to where and in what circumstances these costs are considered justified, a topic explored in more detail in Chapter 9.

A final point relates to the perceived significance of visible water and infrastructure from a cultural perspective, in other words to what extent it has been identified as an influence on ecological awareness in the manner hypothesised by infrastructure design theorists. However, in research interviews the visibility of water or infrastructure was notably not discussed as a question of ecological awareness or problematising contemporary relationships with ecological systems. In one instance, the following quotation highlights a relationship to the question of expression (and interpretation) of function as discussed above:

I think actually having your basement flooded is probably more awareness bringing than having a nice park outside.

Here the participant evidently assumed that many instances of stormwater projects will not be understood as having infrastructural functions or as being linked to issues such as climate change due to their presentation as attractive green spaces. The perceived cultural impact of visible water was addressed more directly by stakeholders directly involved in the HTPK project and therefore is discussed in the following chapter.

7.4.3 Wilderness landscape aesthetics

A second important feature of the Copenhagen Model is a “wilderness” landscape aesthetic. This was described using different terminology; the report on *Climate Adaptation and Urban Nature* (SLA & KK, 2016, 32;141) refers to the need for “a whole new type of urban nature and “wild urban nature”. It is elsewhere described by Caspersen (2016, 20) as “wilder, untamed and less-trimmed”. However, the term most consistently used by interview participants was that of a “wilderness aesthetic”. A range of perceived non-aesthetic benefits were highlighted in interviews including reduced maintenance costs and

improvements in biodiversity linked to the city's biodiversity strategy "Plads til Naturen" ("Space for Nature") (KK, 2010). However, it was emphasised by four interview participants that aesthetics was an important influence on changes in landscape design. A biodiversity consultant who has worked on stormwater management projects put it as follows:

Often we can improve the parks we are talking about and also from an aesthetic standpoint because there is not much that is more boring than a green lawn... A wilder aesthetic is coming. You see that in more and more projects. It is becoming more mainstream to use wild flowers, to have this more wild, lush look to your project rather than trimmed groomed rectangular lines or whatever.

In documentary sources the changing approach to design is most obviously apparent in visualisations produced for design competitions linked to stormwater management projects, such as Tåsinge Plads in Østerbro as well as HTPK. According to two interviewees, a wilderness aesthetic has emerged as a perceived "trademark" approach amongst several influential landscape architecture practices, especially SLA and Third Nature. The representation of an urban wilderness was perceived as problematic in some cases due to their being perceived as visually appealing but ultimately unrealistic, for example, due to the long periods of time required for trees to reach the degree of establishment represented.

Interview participants also reported opposition to a wilderness aesthetic among non-professionals which was often regarded as requiring cultural change. For example, the *Climate Adaptation and Urban Nature* report suggests that the city's residents must adopt a more "refined concept of nature" (KK & SLA, 2016, 141) that would be aligned with contemporary aesthetics and infrastructural requirements. In addition, similar to the question of visible water, opposition was described as originating from a problematic conservative "mind-set" which, implicitly, designers and other professionals might legitimately set out to challenge. According to one landscape architect:

There's a lot of people, older people from more conservative points of view who would say "are you hippies?". That's a sentence I have heard many times.

However, interview and documentary sources also recognised that an aspiration to create naturalistic landscapes should in some cases be balanced by other considerations, for

example, taking into account the value of existing parks; according to the Cloudburst Management Plan (2012, 8), “historical and aesthetic interests” should be taken into account when assessing whether existing parks should be used for stormwater management. Enghaveparken (Mølgaard Schmidt et al., 2016) and Sankt Annæ Plads, close to the residence of the Danish monarch, were referenced in interviews as examples of successfully combining stormwater management with classical park landscapes. This introduces the question of how historical and aesthetic values might be assessed and which parks judged worthy of preservation, a question which is relevant to the HTPK case study.

Finally, both participants and documentary sources emphasised the potential cultural impact of “urban nature” in the sense of urban green space. For example, two participants highlighted a perceived disconnection from nature as a problematic feature of the contemporary cities and suggested that stormwater management following the Copenhagen Model offered opportunities for change. The question of a wilderness aesthetic and its perceived relationship to culture is perhaps most clearly addressed in the identification of “coexistence” as one of the cultural services provided by proximity to green space in the *Urban Nature and Climate Adaptation* report. It (KK & SLA, 2016, 48) claims that “urban nature”, specifically “old trees, limestone rocks and buzzing wild bees,” promote a sense of “coexistence” which is “about how we as people, in the meeting with nature’s phenomena, achieve a realisation that we are part of a greater context. We realise that nature and its processes are our basis for existence and something which is crucial to safeguard”.

The meaning of “urban nature” within discussion of stormwater design in Copenhagen is a complex concept and could be understood in various ways. From one perspective, it represents an attempt to overcome the conventional separation between the city and nature which characterises much environmental thought. However, it could also be understood as offering an isolated experience of nature as a refuge from the city (Jensen et al., 2015) or as a narrow definition of nature as limited to its most obvious visible manifestations in the form of urban green space. This latter interpretation is arguably supported by the emphasis on urban greening as the key aesthetic contribution of the stormwater programme. For example, the emphasis on visibility of water rather than water infrastructure arguably edits out of our understanding the reliance of urban life on a complex networked system of infrastructures and, therefore, the complex socio-ecological links between cities and the rest of the world (Swyngedouw & Heynen, 2003). As

articulated in the previous paragraph, the understanding of urban nature also bears comparison with Usher's (2018) argument that new approaches to urban design related to water management are part of a project to create "feel for the environment" and an affective connection to nature and water which might be articulated in certain environmentally-responsible forms of behaviour. This is more clearly illustrated by the concept of "co-creation" which is discussed in more detail in Section 7.5.2 below.

7.5 Design expertise and "co-creation"

Fundamental to a discussion of change in the contemporary infrastructure design imaginaries and practices are questions of expertise. Authors such as Bélanger (2012) suggest that the realisation of aesthetic objectives within infrastructure projects depends upon the inclusion of a broader range of professional and non-professional stakeholders and on overcoming conventional definitions of success linked to financial and technical performance criteria. One of the research objectives draws on this argument by seeking to investigate whether the forms of expertise involved in infrastructure projects are subject to change.

In the context of Copenhagen, one starting point for this discussion is the work of Stig L. Andersson, the founder of SLA (lead design consultants for the HTPK case study) and a contributor to the report on *Climate Adaptation and Urban Nature* (KK & SLA, 2016). Andersson was also referenced as a key intellectual influence by three interviewees. Andersson's (2014) argues that environmental policy in the modern era is wholly monopolised by rationality as a framework for decision-making. Referencing Danish environmental policy and planning law, Andersson (2014, 23) states: "it is upon this framework of laws and revisions of laws that our politicians are expected to make their decisions on how to create a better world... They are made only with regard to the rational, the measurable and technocratic vocabulary. What we need is to find the complementary approach with which to make our decisions more sustainable". This complementary approach is identified as a decision-making framework informed by aesthetic criteria where "the belief that our senses and our feelings should play a complementary role to the rational in determining how we want our world to be in the future" (Andersson, 2014, 49). The following sections explore to what extent this vision has been reflected in practice. They discuss evidence of increasing professional interdisciplinarity, community

engagement and broader influences on the understanding of aesthetic expertise in Copenhagen.

7.5.1 Interdisciplinarity

The majority of strategic stakeholders discussed questions of expertise and changing disciplinary roles. There was broad agreement that skills identified with spatial design disciplines of architecture, landscape architecture and urban design were increasingly valued. In terms of explaining this transition, it was described in some cases as a straightforward consequence of the transition from underground to above-ground management of stormwater which meant that questions of urban and landscape design have become relevant. A further factor leading to changing disciplinary roles is the construction of stormwater management as a question of landscape design as, for example, highlighted by the concept of nature-based stormwater management. According to the report on *Climate Adaptation and Urban Nature* (KK & SLA, 2016, 32), “the methods used to manage grown environments are not the same as the ones used to create built environments” and rather require a “holistic” approach. This idea is, however, more closely linked to a re-evaluation of the role of non-professionals in stormwater projects and is therefore discussed in the following section. Related to both of the above, a further reason for including design expertise in stormwater management was the perception that the types of ‘green’, above-ground infrastructures foreseen are not an established typology and therefore require new ideas and innovation. According to a local government planner:

We are developing solutions and there are very few things in flat packs on the shelves which you can pick down and construct.

This idea was expressed in different forms through, for example, discussion of the need for experiments or pilot projects. Most relevant to the question of expertise was the identification of designers as a source of ‘innovative’ ideas. This was further related to a perceived ability, positioned as central to the role of the designer, to reconcile different and potentially competing demands and work within constraints, such as those imposed by infrastructural function. This is illustrated by the following quote from a designer employed in an engineering consultancy:

[These are] capabilities that landscape architects and landscape planners do have. They are very trained in combining the different strategies, [to] integrate them into these projects... Then of course you really have added value.

The interviews also provided evidence of changing practices, notably less clearly defined boundaries between disciplines and that design skills are increasingly valued in new settings. As an example of the former, the same interview participant as cited above described himself as a “civil engineer with architecture” and his role as involving mediation between technical and aesthetic priorities:

I'm on the design part of it so I'm working closely with civil engineers and biologists and different kinds of people. My role is to connect the different approaches and desires and try to get them all covered in one coherent design [...] This of course is a discipline that has changed in the last ten years with climate change and so there is ongoing change in approaches and the people that have worked in it for many years have been forced to change their approach [...] I think it is even more new in this field that I am in now to try to combine the technical with the aesthetic approach.

This quote highlights a perception that stormwater management is an evolving field in terms of the forms of expertise and “approaches” considered relevant. As background, the relevant interviewee described their university degree in “civil engineering with architecture” as a relatively new programme which provides interdisciplinary training with the intention of facilitating interaction between conventionally distinct disciplines. In the quote, the participant highlights that it is a yet more recent development to apply this perspective to his current field of practice, referring to stormwater management.

Further, changing employment practices among both engineering and design firms were highlighted by four interviewees. It was suggested that an increasing number of engineering consultancies now employ designers, primarily landscape architects, to work on stormwater management projects. These firms and the designers they employed were recognised as important actors in the design process and were suggested as important contacts when suggestions for further interviewees were sought by the researcher. Two landscape architects employed in engineering consultancies were interviewed and both described their roles as mediators or as an “interface” between actors described as having

distinct aesthetic and technical priorities, namely hydraulic engineers and the external landscape design consultants:

We look at the [landscape architecture practice's] designs and say okay they want this kind of streetscape. We will look at it as landscape architects and say it should look like that and take what our engineers have said and make a diagram that shows it very clearly. They [the landscape architecture practice] might say we don't want it to look quite like that and we're the main designers so please change it accordingly. Then we become the kind of interface between the two where we can help our engineers to communicate their ideas and integrate that into the landscape designs that we have received from the landscape architecture studio.

Described above is a process whereby landscape architects employed in an engineering consultancy mediated between engineers and an external design consultancy during a process of concretising an initial conceptual design. While an initial concept had been produced by the design consultancy, the hydraulic functions of water storage and conveyance then had to be worked out in detail. As described above, this required negotiation to ensure the original vision was retained. The existence of an alternative institutional model where technical and aesthetic aspects of design are both produced in-house by an engineering consultancy, was also highlighted. In such instances, landscape architects within the engineering consultancy were identified as the sole sources of aesthetic expertise. While this was associated with lower-profile projects, the vertical integration which it entailed was regarded as preferable in some instances because it facilitated less formal interactions between engineers and designers:

When you are working together and have it all in-house then you are able to contact your colleagues every day. It is very informal. You can go down and ask why are we doing this, what if we change this or what is the number that supports this decision. Could we do it in another way so it's more... The number of points of interaction between the disciplines involved is much higher when we have it all in-house and I think that creates more integrated solutions.

Last, in addition to the hiring of landscape architects in engineering firms, a converse phenomenon of hydraulic engineering skills being increasingly valued by landscape

architecture employers was also noted in one case by a director of a landscape architecture practice.

In terms of critical assessments provided by interview participants, these primarily concerned the reality or depth of changes in the range of expertise with significant influence on the design process; in other words, that it is easy to overemphasise the degree of change. Four interview participants referred to difficulties of overcoming resistance to change in established “engineering” paradigms focused on technical and cost-efficiency criteria. In addition, Section 7.6.3 describes the continued relevance of financial logics in assessments of the value of stormwater design.

7.5.2 Co-creation

In addition to greater professional interdisciplinarity, the vision of design in Copenhagen also emphasises the active participation of citizens in the design process and their ongoing engagement in the maintenance of new green infrastructural spaces. This was most frequently described in interviews using the term “co-creation”. Co-creation was identified by six interview participants as an important feature of the approach to stormwater design in Copenhagen. It has also been discussed in Palomino (2017) and Caspersen (2016). According to the report on *Climate Adaptation and Urban Nature* (KK & SLA, 2016, 28), the idea that citizens should be able to participate in design is justified by the “new awareness of the amenity value” of “urban nature”. In other words, it is linked to a recognition of the potential aesthetic value of stormwater infrastructures and this, in turn, relates to the adoption of a “nature-based” model. The definition and discussion of co-creation both in interviews and in documentary sources highlights that a significant feature of this model is a change in the balance of responsibilities for urban development between professionals, local government and citizens:

“If co-creation is to succeed, it requires that all parties give up their usual roles. Politicians and administrators must dare to relinquish some control and deviate from familiar routines... Citizens must get used to not just being demanding customers at the welfare shop, but must also step in and take co-responsibility” (KK & SLA, 2016, 28).

This was interpreted by interview participants as involving flexibility on the part of local government to facilitate (and support) initiatives by citizens, for example, through

accommodation of temporary uses of public space as occurred in the Tåsinge Plads project. The converse change on the part of citizens has focussed on the question of maintenance for new and redesigned green space required for stormwater management where it is suggested that citizens should play a more active role. According to the report on *Climate Adaptation and Urban Nature* (KK & SLA, 2016, 30), “Copenhageners will be involved before, during and after the realisation of the projects, where they especially should assume the role of central stakeholders in maintenance activities”. Again, the case of Tåsinge Plads, where residents have formed associations to maintain and improve the new space, was referenced as an exemplary example of co-creation.

The description of co-creation here clearly illustrates a set of parallels with previous literature. One is the role of fiscal considerations as a driver of change as co-creation is clearly underpinned by an attempt to ‘responsibilise’ (Usher, 2018) citizens for maintenance activities which would previously have been carried out by the state. Elsewhere, community engagement conducted as part of the Tåsinge Plads project has been discussed by Caspersen (2016) who argues that the process of community engagement involves the discursive construction of an idealised urban citizen who is active, engaged with their local community and environmentally aware. For example, Caspersen (2016, 23) notes that there is an attempt to establish a connection between active engagement in maintenance of green space and the development of a sense of community: “it is not only gardening but working collectively with the neighbourhood that is important”. This is criticised by the author as potentially stigmatising anyone, such as migrants or working-class people, who cannot conform to this ideal type. A further feature of the approach to community engagement within the Tåsinge Plads project observed by Caspersen is that it took place within a limited framing where the desirability of green lifestyles was not open for debate. More broadly, the description of co-creation here highlights that stormwater management projects in Copenhagen are underpinned by certain assumptions about the value of self-consciously ‘green’ lifestyles and that interactions between people and infrastructural spaces are an important site for their articulation.

However, the assessments of co-creation provided by interview participants were markedly distinct from those in the literature and did not involve critical perspectives on its underlying logic. Similar to the case of interdisciplinarity, they concerned the degree to which it had been realised outside a limited number of exceptional projects such as Tåsinge

Plads. Several participants cited obstacles presented by the established practices within utility companies responsible for stormwater management projects which were regarded as unused to working with the public. This complements the findings of Palomino (2017) of dissatisfaction among residents involved in processes of co-creation in similar projects regarding the degree to which their ideas had been taken into account by professionals.

It also emerged from interviews that it is potentially simplistic to attribute changing approaches to community engagement such as the emphasis on co-creation as driven wholly by a new emphasis on aesthetics and stormwater management. Rather, there has been continuity as well as change in the way that community engagement is approached as illustrated in the following quote from a local government planner:

It is not just for these projects. We have a high degree of community engagement wherever we do projects in the city. One of the reasons we are doing this is because it also has an educational purpose because we need to explain that these new areas, apart from having a sort of social function, they also have different functions and sometimes the square will fill up with water for a short period of time and the rest of the time it is used for something else.

The first sentence of this quote highlights that the model of co-creation is not an entirely new development but rather builds on established institutional practices of community engagement in Copenhagen's planning system, specifically within urban regeneration initiatives. This was reiterated by three further interview participants. The institutional context of urban regeneration is particularly important because several important stormwater projects have been coordinated by this programme using its existing organisational model and approach to community engagement. This is one important influence on the HTPK case study which is discussed in the following chapter. Elsewhere, Larsen and Hansen (2008) have traced the development of an "inclusive planning approach" associated with Copenhagen's urban regeneration programme. This is identified by the authors as a response to community opposition and resistance (particularly in Inner Nørrebro where the HTPK case study is located) to a previous model of "wholesale, top-down urban renewal" (Larsen & Hansen, 2008, 2437). This new model involved, amongst other measures, the establishment of local urban regeneration offices to facilitate community engagement. However, according to the authors, this has not significantly

mitigated the socially unequal effects of urban regeneration initiatives and their tendency to facilitate gentrification. Rather, it has marked the beginning of a “gentle” or “stealthy” (Hansen & Karpantschhof, 2016, 185) model of gentrification in the sense that it has become masked by a limited degree of responsiveness to local residents’ concerns.

However, a further important feature of the quote cited above is that it identifies a further impetus towards community engagement as linked to the context of stormwater management, specifically the requirement to explain the infrastructural functions of new spaces and why they are necessary. It is notable that this implies a unidirectional and instrumental understanding of community engagement as facilitating the dissemination of information by an expert group. Arguably, it also assumes that acceptance of new infrastructural spaces follows from their functions being sufficiently understood. There are obvious parallels with Dreiseitl’s (2013, 74) injunction that designers must “tell the story of water” in order to gain acceptance for new infrastructural uses of space. It simultaneously highlights that processes of community engagement (as well as physical design strategies) can be seen as an extension of the effort to render infrastructures visible and publicly understandable. This parallels Usher’s (2018) description, drawing on a case study of Singapore, of the wide range of public relations, advertising and ecological education programmes as well as urban and landscape design which all formed part of a combined effort to reconfigure public attitudes to water and water infrastructure and engage citizens in their management. As such, it also illustrates Gandy’s (2006, 62) argument that “the production of urban nature” is the outcome of “a combined process of social and bio-physical change”, in the sense that public awareness and attitudes as influenced by educational efforts as well as material change in the form of new approaches to urban and landscape design are all part of the reconfiguration of the overall infrastructural system.

7.5.3 Entrepreneurial urbanism and expertise

As discussed in Chapter 4, the outline of the infrastructure design process suggests a relationship between economic development and new approaches to infrastructure design. In the case of Copenhagen, the research investigated the relationship between the city’s model of economic development and the approach to stormwater design. It emerged that this was closely linked to questions of expertise; the following section argues that an “entrepreneurial” urban agenda has resulted in a “context-free” (Moore & Karvonen, 2008, 34) vision of design which promotes the quantification of the value of design in financial

terms and constructs projects in the city as sites of experimentation to test transferable stormwater systems.

Section 7.2 above previously described the significance in Copenhagen of various 'sustainable design' practices from an urban economic development perspective, which has often involved entrepreneurial strategies linked to place-branding. A somewhat different model of economic development is arguably apparent in the eco-city of Nordhavn, described by Blok (2013, 12) as an example of "context-free" design in which "architects and engineers position Nordhavn as an urban laboratory for testing various 'cutting-edge' green technologies, implying that experiences gained from this locality will be readily transferable to other contexts". Elsewhere, the model of context-free design is described by Moore and Karvonen (2008) as underpinned by the idea that new sustainable technologies do not need to be adapted to fit a particular context.

As evidenced in interviews and documentary sources, the vision of stormwater design in Copenhagen illustrates a combination of aspects of entrepreneurialism and a context-free design imagination. The idea that the Copenhagen Model was simultaneously an economic development strategy was recognised by the majority of interview participants. In fact, the current professional roles of three (public- and private-sector) strategic stakeholders was linked to promoting Danish expertise in "sustainable urbanisation" and stormwater design. As an urban economic development strategy, this has aimed to promote the work of companies in Copenhagen so that they might ultimately compete more effectively outside Denmark. This can be understood as one of the manifestations of urban entrepreneurialism described by Harvey (1989) which involves seeking to advantageously position the city in terms of the global division of labour, in this case by focusing on high-value consultancy services in the field of sustainable urban development. That stormwater design is simultaneously an important industrial development tool is recognised by the local government which notes that, currently, approximately 10% of Danish exports are in the fields of "water and environmental technology... but the sector is growing very rapidly" (KK, 2015, 14). According to the environmental division of the local government, the model of combining stormwater management and design in the city provides "a showcase to the

outside world that can promote the export of Copenhagen's solutions and create a green economy" (TMF, 2015, 13).¹⁴ One interview participant summarised the strategy as follows:

[There are] a variety of companies with a very green agenda and of course overall the government no matter red or blue realises that if we have to position this tiny tiny country in any way on a global scene it has to be within the green agenda. So we're talking water, wind, solar energy, etc. That is very much in the forefront on a very high strategic note.

According to several interviewees, this has acted as an impetus towards higher standards of design in Copenhagen with associated local benefits. One participant observed that the engineering consultancy in which they are employed aspires to winning further contracts both in Denmark and abroad and has therefore sought to build up a portfolio of projects which would be perceived as innovative. This has meant that the consultancy has become one of the key actors in the design process encouraging the adoption of new and more ambitious approaches to design:

[We] ourselves have an agenda that we try to put in the projects so if we have a client that wants the square hole in the ground with a fence around to put water in then we try to challenge that and to open up the task so you could also add us to the channels of input because we also try to push it. In our experience it creates better projects and when we are trying to sell our knowledge this is the project we would like to show because we believe this is the road ahead... If we have this fence and water bowl in the outskirts of an urban area, it harms us actually if we put our name on that.

However, the necessity to promote Danish companies abroad was simultaneously related to a model of design whose value can be easily quantified and communicated. It was proposed by four interviewees that the value of design should be more systematically assessed using tools such as cost-benefit analysis or increases in property prices and this was directly linked to "marketing" requirements in several cases:

¹⁴ "Et udstillingsvindue over for omverdenen, som kan fremme eksport af københavnske løsninger og skabe en grøn økonomi".

As an engineering company they want to quantify everything but the clients also want these numbers too. That's a challenge definitely. It's also really important for marketing to have these results, saying that you're the greenest city in the world.

A further example is a promotional video featuring spokespeople for Ramboll and SLA landscape architects (which are both major actors in the HTPK case study), in which representatives argue that the local government should emphasise the “profitable business case” associated with the approach to design in Copenhagen and focus on developing “iconic” projects which could be showcased to potential clients (Realdania, 2017). Elsewhere, the local government (KK, 2015, 14) suggests that state support should be directed towards developing systems “that can be repeated/copied... The aim here is to reduce costs by standardising the solution methodologies and creating a basis for reproducible solutions that businesses can refer to and, if appropriate, sell on”. Similarly, a local government planner suggested stormwater management projects in Copenhagen should be understood as sites of experimentation, providing a testing site for a model which could later be sold wholesale to clients:

We can establish a small system on its own and that is something which is quite easy to take and move whether it is to Queens or DC or any other city. You can make a model here and then you can see how much you can actually get out of it. You can test it on the ground.

This represents a model of context-free design similar to that identified by Moore and Karvonen (2008) in the sense that it assumes that new stormwater infrastructures can function equally well irrespective of context. This obviously contradicts previously noted features of the vision of stormwater design in Copenhagen which is simultaneously a social policy agenda as demonstrated through the description of co-creation. Whether it is assumed that the social vision of ‘green’ urban lifestyles might equally apply irrespective of geographical context was not discussed in research interviews. However, how communities in Copenhagen who have arguably been converted into subjects of experimentation have experienced this process is discussed in the following chapter which explores tensions related to competing models of design which are imagined as more or less context-free.

7.6 Financing design

Hitherto, this chapter has focused on what is identified as the design dimension of stormwater management in Copenhagen and an associated understanding of expertise. In contrast, this section describes the institutional arrangements to realise design focusing on the allocation of funding, in other words, how and why urban and landscape design improvements are financed. This section also serves to highlight some of the challenges of stormwater design because it illustrates that, rather than new surface-level infrastructures translating un-problematically into good design, there are competing financial, infrastructural and other logics within projects which must be negotiated.

As previously described in Section 7.1, responsibility for the HTPK project is broadly divided between the infrastructural functions of water management and considerations related to design which, in that case, are the responsibility of the local urban regeneration agency. This is equally true of the division of responsibility for funding any stormwater infrastructures in Denmark; water companies finance infrastructural upgrades whereas other sources of funding, such as that allocated for urban regeneration, must be secured for improvements to public space. This has been the case since 2013 when a system of “co-financing” (“medfinansiering”) was introduced to allow water companies to part fund ‘sustainable’ surface-level stormwater systems, something which had not previously been permitted due to strict state regulation of capital investment by water companies designed to reduce water tariffs for consumers (Jensen et al., 2016). While water companies can now provide some of the funding for surface-level stormwater systems, this is subject to various conditions, compliance with which is assessed by the Supply Secretariat (Forsyningssekretariatet), a division of the national Competition and Consumer Agency (Konkurrence og Forbrugertyrelsen [KFST]). The most relevant condition is that funding can only be provided for structures which are strictly necessary from a hydraulic perspective and not for improvements in urban or landscape design. According to the regulations, “you cannot get extra costs that do not relate to the hydraulic function of the project. This means that you cannot add, for example, benches, basketball courts, or other actions that beautify the area” (KFST, 2017, 4).¹⁵ This raises a set of questions, related to the impact of

¹⁵ “I kan derfor ikke få tillæg til udgifter, der ikke vedrører projektets hydrauliske funktion. Det betyder, at I ikke kan få tillæg til eksempelvis bænke, basketballbaner, tiltag der forskønner området eller lignende”.

these cost-efficiency criteria and the challenges of defining what is necessary from a hydraulic perspective, which were discussed in research interviews.

In research interviews, it was first highlighted that co-financing is regarded as a new system and a common interpretation of the legislation has not yet been established. Second, there were significant differences of opinion regarding its value. Of the interview participants, three considered that it provided a viable institutional framework to realise the combination of infrastructural and design benefits desired in Copenhagen. In contrast, six emphasised the system's complexity and, especially, the challenge of defining expenses necessary from a hydraulic perspective versus those for design. This is illustrated in the following quote from a planner employed in a water company:

We have to go through the budget to determine which costs do have a hydraulic purpose and which do not [...] I've been dealing with, for example, the cost of removing a flagpole to dig a depression and then put the flagpole back. Is that a park purpose or is that my hydraulic purpose? We ended up splitting the flagpole in two.

As implied in these quotes, the principal criticisms from these and other participants related to, first, the time which must be invested in negotiating over the eligibility of expenses and, second, the lack of consistency between different projects. Related to this latter point, it emerged that there were a range of creative practices adopted, such as re-using materials left over from construction of stormwater structures which allow design benefits to be realised with minimal extra investment. According to one engineering consultant:

I think some of our clients on the budgets they call it something different than it really is so you work around these limits... It is probably going to cost you less money later in the process to deal with these demands.

What is more generally apparent is that, in many cases, whether additional design benefits are realised in a given project will depend on the outcome of negotiations between the project's promoters and the regulator which, it was repeatedly highlighted in interviews, continues to operate on the basis of strict cost-efficiency criteria. Therefore, improvements in landscape and urban design will often not be possible unless other sources of funding

can be identified; for example, several completed projects have relied on private philanthropic foundations (Jensen et al., 2016). Further, the above discussion serves to situate projects, such as Tåsinge Plads and HTPK, in relation to the broader programme of 300 stormwater projects in Copenhagen foreseen over the next 20 years. While being represented as exemplifying the Copenhagen Model, these are in fact outliers due to their coordination with urban regeneration efforts which meant some resources were available for improvements to public space. At the same time, uncertainties regarding sources of funding have directly impacted the design process for HTPK as described in the following chapter.

7.7 Summary: the “Copenhagen Model” and the contemporary infrastructure design imaginary

The contribution of the chapter has been the description and analysis of visions and practices of stormwater design in Copenhagen. This is a valuable contribution for several reasons: first, it provides an understanding of the background to the HTPK local case study; second, it has provided the basis for an analysis of the relationship between the model of stormwater design in Copenhagen and the concept of a contemporary infrastructure design imaginary; last, it has described the relationship between stormwater design in Copenhagen, including problematic aspects, and the structural context for design, referring primarily to its institutional and economic context. An overview of the connections between the evidence in this chapter and the theoretical framework for the research presented in Chapter 4 (Section 4.3) is provided in Table 7.1 below.

There are clear parallels between the approach to design in Copenhagen and trends in infrastructure design theory which have been described as constituting a contemporary infrastructure design imaginary. These include, most obviously, the recognition that the development of new infrastructures requires consideration of aesthetics and, for this reason, the involvement of a broad range of professional and non-professional expertise. Second, the vision foresees the production of new infrastructural spaces where it is intended that aesthetic and infrastructural objectives will create synergies (Rosenberg, 2015) such as through the emphasis on visible water and a wilderness landscape aesthetic, both of which are premised on functional and aesthetic grounds. Finally, there is an attempt to rethink the interactions between society, nature and infrastructures. Co-

creation envisages local people taking an active role in the maintenance of infrastructural landscapes and this interactive process is simultaneously identified as a site for the development of new cultural values, such as that of “coexistence” or a sense of connectedness to nature and to the local social environment. A number of problematic aspects and tensions within this model have also been highlighted. These include the selective application of concepts of ‘visibility’ which are clearly refracted through a set of aesthetic conventions in which urban greening is regarded as of paramount importance. In fact, this reflects a broader ambiguity in the SUDs literature as previously discussed in Chapter 4 (Section 4.2.5). Further critical interpretations have also been provided of the concept of co-creation and the role of economic and financial logics in the design process which are discussed below.

The chapter has also discussed the context for stormwater design in Copenhagen, referring to the actors, institutions and agendas which combine to influence where and how new approaches to stormwater design become realised. This has encompassed questions of the relationship between community engagement and the institutional context for stormwater design projects coordinated through the existing urban regeneration framework. The approach to community engagement has evidently been influenced by the “inclusive planning approach” (Larsen & Hansen, 2008, 2437) which characterised previous examples of urban regeneration in Copenhagen. However, co-creation arguably also responds to the new context of stormwater design, for example, by seeking to responsabilise citizens for the management of urban green space. The underlying social vision of co-creation which idealises self-consciously green and socially-engaged urban lifestyles is further explored in the following chapter. This chapter has further investigated the relationship between new approaches to design and economic development. This has demonstrated conflicted interpretations of the forms of expertise relevant to stormwater design. One model of context-free design and design expertise is clearly influenced by an entrepreneurial urban agenda of boosting exports of stormwater technologies and consultancy services which creates a contradictory drive towards standardised solutions and the precise quantification of the aesthetic and social benefits of new approaches to design.

	Influences on infrastructural development				
	Cultural practices	Material	Who designs and what influences their thinking?		Economic development
Potential influences on design	Are there parallels with the 'contemporary infrastructure design imaginary'?	What forms of infrastructure are the objects of design intervention?	What does design or aesthetic expertise mean in a given context?	How is design expertise recruited and institutionally situated?	What is the significance of infrastructure design from an economic development perspective?
Relevance to the case study	There are parallels with what has been the contemporary infrastructure design imaginary, notably it has been recognised that new infrastructures have implications for aesthetics and require design expertise. There has been an attempt to maximise the aesthetic and cultural value of visible water infrastructures arising partly through the influences of theorists such as H. Dreiseitl.	Urban stormwater management is a key sector for the adoption of new approaches to design. This is because it has been recognised that above-ground stormwater systems will have a significant impact on public space and that implementation could be aligned with other urban objectives including greening.	<ul style="list-style-type: none"> Context-free design (Moore & Karvonen, 2008). <p>The model of 'context free design' is oriented towards the production of standard solutions and the (financial) quantification of outcomes. There is also increasing professional interdisciplinarity linked to the emphasis on aesthetics and greening. The cocreation model suggests that communities should also be involved in the design process but its impact has been limited.</p>	Two important features of the institutional context are, first, the emergence of the stormwater designer as a recognised professional role key to which is the integration of different forms of expertise. Second, the coordination of some stormwater design projects through Copenhagen's existing urban regeneration programme has created opportunities for community engagement.	<ul style="list-style-type: none"> Urban entrepreneurialism: situating Copenhagen favourably in the international division of labour (Harvey, 1989). Conflicting place-making and cost-efficiency agendas (Jensen et al., 2016) <p>There is an entrepreneurial logic underpinning stormwater design in Copenhagen. The stated objective is to boost exports of 'transferable' green climate adaptation solution as well as indirectly contributing to other urban economic development goals. There is a countervailing fiscal pressure to reduce expenditure on design.</p>

Table 7.1 Connections between the theoretical framework and the evidence presented in Chapter 7

Chapter 8 “Cloudburst and Culture”: the infrastructure design process in the Hans Tavsens Park and Korsgade case study

This chapter describes the processes and visions of urban and landscape design in the Hans Tavsens Park and Korsgade (HTPK) stormwater management and urban regeneration project in Copenhagen. This chapter is the second of two on stormwater design in Copenhagen. It develops on the discussion of the Copenhagen Model in Chapter 8 by describing one instance where implementation of this model is underway. The major contribution of the chapter is to provide an in-depth description and analysis of the infrastructure design process. This enables discussion of concepts and tensions mapped out in the literature and previous chapters, such as different models of aesthetic expertise, new approaches to infrastructure design and the idea that design is a situated process, to be grounded in specific features of the design vision for HTPK. As discussed in the methodology, the chapter is based on interviews with ten professional and non-professional project stakeholders, informal conversations and documentary analysis.

Each of the three sections of the chapter responds to aspects of the research objectives on, respectively, expertise, the relationship between a contemporary design imaginary and design practice and the relationship between design and its institutional and economic context. First, Section 8.1 describes the evolution of the design vision and how it has been contested by exploring the process of selecting a lead designer through the Nordic Built Cities Challenge competition. It describes tensions between different models of aesthetic expertise which can be related to the discussion of context-free and entrepreneurial design in the previous chapter. Section 8.2 describes features of the design vision which have been identified as most significant from an aesthetic perspective such as visible water, a wilderness landscape aesthetic and interaction between people and nature. It analyses how these features correspond to the concept of a contemporary infrastructure design imaginary described in Chapter 2 and describes to what extent/why they have been contested. Section 8.3 discusses implicit influences on the design vision which can be linked to the institutionalisation of design through the existing urban regeneration programme. This explains key features of the design vision, especially why infrastructure design in this instance has been reconceptualised as a socio-cultural project. This can further be linked to an entrepreneurial urban design agenda to rebrand Inner Nørrebro as having a strong community oriented around ‘green’ lifestyles and, thereby, to create opportunities for property speculation.

8.1 The Nordic Built Cities Challenge: recruiting and validating design expertise

A general introduction to the case study project is given at the beginning of the previous chapter. More specifically, how the project should contribute to local and urban planning objectives is described in the Inner Nørrebro neighbourhood plan (ON, 2014). This plan was produced by the area's urban regeneration office and sets out the full range of regeneration objectives for Inner Nørrebro with an emphasis on sustainability and social cohesion. HTPK is one sub-project in the overall urban regeneration strategy.

Relevant strategic urban objectives referenced in the neighbourhood plan include implementation of the Cloudburst Management Plan (2012) by reconfiguring the existing park to collect and retain stormwater from the surrounding sub-catchment. It also states that the project should facilitate experimentation in transferable stormwater "solutions": "Solutions that are being developed and tested should demonstrate the neighbourhood is a pioneer and spread to the rest of the city ... Unique solutions should not be developed. They must be scalable" (ON, 2014, 49).¹⁶ This is evidently an affirmation of the entrepreneurial "context-free" model of design described in Section 8.5.3 of the previous chapter and its influence in this project is discussed below.

In contrast, local objectives include leveraging the stormwater management strategy (and associated funding) to improve the availability of public green space. This was perceived as an acute necessity both in interviews and other sources. It was referenced both in the local area plan (Nørrebro Lokaludvalg, 2017) and the regeneration agency's neighbourhood plan (ON, 2014). The latter states that "Inner Nørrebro is the neighbourhood with the fewest m² of green space per resident in the city and, therefore, one objective is to use the Cloudburst Plan as a means to create more m² of green space per resident" (ON, 2014, 38).¹⁷ The neighbourhood plan identifies the current landscape of Hans Tavsens Park as an important social resource but also suggests that its redevelopment is an opportunity for

¹⁶ "Løsninger, der udvikles og afprøves, skal vise kvarteret som et foregangskvarter og udbredes til resten af byen som en københavnermodel for regnvandshåndtering... Der skal ikke udvikles unikke løsninger – det skal være løsninger, der er skalerbare".

¹⁷ "Indre Nørrebro er det kvarter med færrest grønne kvadratmeter i byrummet pr. beboer, og derfor er det målet at bruge Skybrudsplanen som anledning til at skabe flere grønne m² pr. Beboer".

“social and cultural development of the area” (ON, 2014, 10).¹⁸ In research interviews, the objective of improving the quality and quantity of local green space was supported by all of the project stakeholders. Equally, the majority recognised the social significance of the existing urban spaces, especially Hans Tavsens Park. However, as discussed below, there were different visions of its future. As identified by several interview participants, from the outset of the project there was a potential conflict between local and urban strategies as described by one of the project planners:

Nobody in this district asked for a climate adaptation solution in their local environment. Rather they have visions regarding making local community space, developing the school areas, make better use of certain areas in the park and then transforming this street from what it is like today which is empty, unsafe regarding traffic and grey, into a living area, green and safe for schoolchildren with places to meet and reasons to meet in the street [...] They never asked for their local park to be able to delay almost 20000 cubic metres of rain water which will of course transform the landscape immensely.

What is indicated here is the conflict between local priorities and the reconfiguration of the park as an infrastructural space or landscape which emphasises its material implications in terms of the appropriation of space required for surface-level water storage. As discussed below, the Nordic Built Cities Challenge illustrates one perspective on how the conflict might be resolved; by identifying “synergies” between the park’s new infrastructural function and landscape and urban design objectives.

8.1.1 Competition brief: “Cloudburst and Culture”

The neighbourhood plan was followed in 2015 by an opportunity to coordinate the project with an international design competition, the “Nordic Built Cities Challenge” (NBCC), which was funded and organised by Nordic Innovation (NI). NI is a division of the Nordic Council of Ministers, an organisation to promote cooperation between Nordic governments, and is tasked with promoting trade and innovation among the Nordic countries. In practical

¹⁸ “Områdefornyelsen vil blandt andet arbejde tæt sammen med Blågård Skole, der kan åbnes mod Hans Tavsens gade og -Park og bruges aktivt i den sociale og kulturelle udvikling af området”.

terms, the NBCC involved local competitions in each of the Nordic countries followed by the selection of an overall winner. The background to the competition is described as the challenge of developing “liveable, smart and sustainable cities”, which is suggested to relate to the trade and innovation remit of NI because “it creates a global market for innovative solutions” (KK & NI, 2015, 3). The commercial potential of the NBCC is described as its “showcas[ing] Nordic design, architecture and engineering... thereby contributing to making the rest of the world aware of the competencies of Nordic companies within urban development... [and helping to] position Nordic countries in the world market” (Teknik- og Miljøforvaltning [TMF], 2016b).¹⁹ According to one of the competition organisers:

We have this political mandate to come up with different ways of making the Nordic region co-operate around promoting these issues and developing solutions and also selling them to the world... We have to be able to explain how it benefits Nordic businesses so we come at it very much from the business side not from the city's side.

The same interviewee also explained that this had affected how projects were selected to participate in the local-level competitions in Denmark and the other Nordic countries, because “scalability” of the solutions developed was one important criterion. This contrasts with the perspective of local stakeholders for whom the primary advantage of coordinating the urban regeneration and stormwater projects with the NBCC was that NI would provide funding (approx. €200,000) both to run the competition and for a financial award for the winner.

A combination of these influences subsequently became fixed in a competition brief titled “Cloudburst and Culture” which established a set of principles for competition entries. This introduced the key idea of reconciling competing demands on urban space by combining stormwater infrastructure with “social and cultural renewal” and to “ensure cultural and climate synergy by developing multifunctional facilities” (KK & NI, 2015, 4). This entails a complex vision of the role of the relationship between infrastructure and other uses of

¹⁹ “Vi er sikre på, at de seks projekter vil blive vel modtaget i de respektive byer, og at de vil fremvise nordisk design, arkitektur og ingeniørkunst fra sin fineste side og dermed bidrage til at gøre resten af verden opmærksom på de kompetencer, nordiske virksomheder har inden for byudvikling... Alle deltagerne inviteres med på et eksportprojekt, der skal positionere Norden som en stærk aktør på verdensmarkedet ved hjælp af gode, bæredygtige byløsninger”.

space which can perhaps best be explored through the concept of “synergy”. This term was used frequently in the competition brief, other documentary sources and in research interviews to suggest a potential complementary relationship between infrastructural and design objectives and as a means to overcome the basic material conflict between a requirement to appropriate space for infrastructural use and its established social value.

One of the most frequent usages of this concept was to suggest that surface-level stormwater management could simultaneously have functional and aesthetic value. For example, according to the brief, the overall challenge is to “ensure cultural and climate synergy by developing multifunctional facilities for a liveable urban space” while, more specifically, competitors should “develop rainwater solutions that are visible and ‘above the ground’ so they support the green and recreational values and identity of the park” (KK & NI, 2015, 4; 6). The concept was also a feature of the winning proposal by SLA who suggest that there are hydraulic, natural and social “cycles” which together provide the framework for their design vision, described as “a product of the synergy” between these cycles (SLA, nd., 9). They argue that the hydrological and natural cycles, encompassing both infrastructure and new green space, are part of an integrated whole with improvements to the social environment rather than an unwelcome element which must be mitigated: “We will use the enhancement provided by urban nature to strengthen various communities in order to give life in the city an entirely new meaning” (SLA, nd., 7). Synergy was also referenced in research interviews, where it was used by four of the professional interviewees to refer to the idea that in the future the park would facilitate a range of complementary uses thematically linked to water management and ‘sustainability’, such as urban gardening and ecological education.

The emphasis on synergy establishes a relationship between the case study project and current literature on infrastructure design because it echoes the definition of “multifunctionality” suggested by Selman (2009, 49) as the interaction of different functions “to create synergistic effects”. This is regarded as a core principle of new approaches to infrastructure design by authors such as Rosenberg (2015). Further, within the HTPK project, the concept of synergy positions infrastructure design as a socio-cultural project because it involves making normative claims about how people might or should interact with infrastructural spaces. This is further explored later in the chapter, including

both how it relates to key features of the design vision as described in Section 8.2 and what its underlying logic might be, a topic explored in Section 8.3.

8.1.2 Contesting the design process

In addition to providing funding, NI retained a degree of oversight over the formulation of the competition brief, providing “a template for the competition programme to be used” and the assessment of entries by imposing the condition that the decision-making body would include representatives of NI to “add expertise and a bird’s eye perspective to each of the local juries” (NI, nd., 2). According to one of the competition organisers:

We [NI] set some guidelines and we also had some restrictions on the juries to decide the winner. We had a requirement that we should be on the jury and that they should also have members from the other Nordic countries so that it was not too much of a national project and that you got perspectives from outside as well.

As illustrated here, the decision-making framework was intended to ensure that entries corresponded to a standard of global relevance and transferability. However, this framework was contested by local stakeholders who had an alternative vision of design as more responsive to local priorities. As described by one of the project planners:

The core of Nordic Built Cities Challenge was to make solutions that would be possible to export. [But] what we would like to be able to upscale or export is how to fit the uniqueness of the neighbourhood, the identity or the place specific-ness of the neighbourhood in the climate adaptation solution.

This illustrates an alternative view of the design process oriented towards the production of design proposals which match local priorities (albeit still framed in the language of transferability). Second, the idea that a new decision-making framework was required was linked to the context of new approaches to surface-level stormwater management, as illustrated in the following quote from the same interviewee:

We like to follow contemporary research which sees this not like we try to include local networks or local stakeholders. No, this is a whole socio-technical network

which is distributed around the rainwater and before the rainwater was invisible and it was handled below ground level by the utility company and the citizens would be passive yet satisfied consumers of the service provided by the utility companies. Then the cloudbursts started coming in 2011 and suddenly the rainwater was no longer invisible. It was above ground level and it was very visible and it was all over so everybody changed positions in this network of citizens, water, technical solutions, utility companies, municipalities, NGOs and experts. There was an established network and everything has been twisted now and citizens are no longer just consumers. They are victims of rainwater, they are learners about rainwater and they are co-creators with the utility companies and city municipalities to find new ways to design urban spaces

There are various interesting aspects to this perspective. First, it suggests that previous academic research on stormwater management in Copenhagen has been an important influence on the interviewee's approach to managing community engagement. Elsewhere in this interview, the value of academic research was identified as providing actionable knowledge in a complex and emerging field. In fact, the interviewee's perspective outlined here is similar to that of authors writing on the topic of sustainable design in Copenhagen such as Hoffmann (2016). More specifically, it parallels Munthe-Kass and Hoffmann's (2017, 288) concept of "democratic design experiments" as design processes oriented towards reconfiguring socio-technical networks to establish new relationships between actors rather than solely focusing on the production of new material design objects.

A further related feature of the quote is the reference to the concept of "co-creation" which links the approach described here to the overall "Copenhagen Model". In addition, the idea of a new socio-technical network, and the repositioning of citizens within it, suggests a radical re-organisation of the design process including, perhaps, a re-allocation of power to influence design; it suggests change in the division of responsibilities between citizens and professionals which is also linked to the perceived complexity of new stormwater management challenges, the lack of standardised solutions and an associated requirement for learning through experimentation. The final important feature is the recognition that the changing model of stormwater infrastructure provision has implications for the design of urban spaces which is regarded as a key justification for the repositioning of citizens in the network of actors constituting the design process. The

extent of change is discussed below in the description of decision-making structures for the NBCC and is also addressed again directly in Section 8.3.2.

Although not fully explored in research interviews, and despite the guidelines provided by NI, this conflict between the export-oriented vision put forward by NI and the alternative described above was resolved by the formulation of a new decision-making framework defined and implemented by the urban regeneration agency (which had ultimately remained the competition “promoter” (KK & NI, 2015, 4). Following this new framework, local residents contributed to the project through formal and informal consultation mechanisms which were implemented during the competition and which continued as a key feature of the design process thereafter. The informal mechanisms were a series of open workshops where people were able to interact with the competition architects and engineers. The formal mechanism involved the constitution of a “project group”²⁰ of local residents who consistently participated in consultation meetings throughout the formulation of the “Cloudburst and Culture” competition brief, the subsequent development of competition entries and after the competition’s end. At the time of research, the project group had approximately ten members though this had varied over time. The role of the group as a whole was to inform the discussion and provide feedback as well as having a defined, albeit limited decision-making role in the competition jury where two of its members represented local residents. According to one of the project group members, the consultation process had significantly influenced the competition brief and the evolution of the competition entries:

The local community had a huge say in what was put in the programme. The programme defined very closely the desired changes to the urban spaces. Then also during the whole process since there has been all these citizen meetings and hearings. I think we have had a lot of input. Have they taken it in? Some of it, some of it they haven't.

However, there were also critical assessments of the co-creation concept and its degree of influence. First, the project group was not regarded as representative of all residents in

²⁰ “Hurtigruppe” (lit. “fast group”). Various translations of this term were suggested by interview participants including “focus group” and “project group”.

Inner Nørrebro. This is discussed in detail in Section 8.3.1 below because it first requires analysis of the context for and the role of the local urban regeneration programme. Second, according to two of the designers involved in the NBCC, the process of co-creation had a limited impact on the development of their proposals. This was because site-visits and workshops involving residents as well as competitors were judged to be complicated by competitive pressures:

It was a competition so we didn't have the chance, we didn't have the time... The spirit was not completely about sharing because it was very much a competition so you want to keep a bit for yourself... [It is] such a huge project. I mean it's about 20 or 15 million euros so it's a big project. It's a big, big assignment in a very central location in Copenhagen.

As indicated here, the scale and high-profile character of the project meant it was regarded as a desirable commission and important in gaining future work in what was identified as an increasingly important field. Last, there was also criticism of the degree of influence accorded to local residents at the point of choosing a winning proposal. This is discussed in the following section.

8.1.3 Competition entries and decision-making

Following a process of pre-selection, the three finalists in the NBCC were: *Grow Nørrebro*, *The Earth Calls* and the ultimate winner *The Soul of Nørrebro*. Each entry was submitted by a consortium composed of an architecture or landscape architecture practice and an engineering consultancy, respectively Effekt Architects and De Urbanisten, Third Nature and Orbicon and SLA and Ramboll. The ultimate decision to choose a winner was made by a jury with nine members, including representatives from the water company (HOFOR), the Technical and Environmental Administration (TMF) of the local government as well as two residents representing the views of the project group. The entries were marked according to a defined set of criteria, of which the two most important and equally weighted were “architecture” and “functionality”, followed by cost (ON, 2016).

The Earth Calls by Orbicon and Third Nature was ranked third on both architectural and functional grounds. However, one of its designers argued that in functional terms this was

the most innovative project because, unlike the other two, it aimed to manage water wholly above-ground as well as in the least technologically intensive and most ‘sustainable’ manner judged in terms of energy consumption. However, the solution was considered by the jury to counteract the aesthetic value of the proposal. What this reveals about the understanding of infrastructural aesthetics in the project is discussed in Section 8.3.2 below on the ambiguous visibility of water infrastructure.

In the case of *Grow Nørrebro*, the jury’s critique was of an insufficiently “green” presentation and an inadequate reflection of the stormwater management and “urban nature” themes; the jury’s decision states that “[t]his is a very urban project, with a lot of hard surfacing and non-green solutions” and notes that the park retained an emphasis on conventional landscape aesthetics, meaning lawns, and conventional social activities such as football (see Figure 11) (ON, 2016, 9).²¹ A related criticism was that the designers proposed un-programmed community spaces but these were not thematically linked to water management and did not fully explore potential “synergies”. According to the jury, “the innovative dimension of the project relates to the social” (ON, 2016, 10).²² In contrast, all of these points were described as strengths of the proposal by two of the designers responsible because they perceived their role as adapting rather than reinventing the existing park landscape:

I think something particular to this proposal is that the people love the park the way it is now. They didn't want to have a brand new park with many new things and we tried to stick to that... We tried to change it to adapt it to the climate issues but still try to keep the park the way it is.

Equally, the *Grow Nørrebro* proposal was preferred by one of the project group members who supported the retention of existing sports facilities and the principle of creating un-programmed spaces which could be appropriated by community groups and “grow organically” (Effekt, 2017). Both of these issues were sources of conflict and are discussed in Section 8.2 below.

²¹ “Der er tale om et meget urbant projekt, med megen belægning og ikke-grønne løsninger”.

²² “Projektets innovationsdel knytter sig til det sociale”.



Figure 11 Grow Nørrebro: a conventional park landscape (credit: Effekt Architects).

SLA and Ramboll's entry, *The Soul of Nørrebro*, was judged best on both architectural and functional grounds. This section describes the jury's assessment of what constitutes 'innovative' design in this context. This was primarily defined by the identification of synergies between infrastructural stormwater management functions and other objectives: "The competition proposal should be praised for its functional co-location and often fine synthesis of urban life, urban nature, water management and climate solutions" (ON, 2016, 6).²³ In another version of the jury's decision, the project is described as having achieved "a delicate balance in the synthesis between form and function" (TMF, 2016a, 3).

Several design features were highlighted as both aesthetically and culturally significant, including an open water channel with added planting to be sited in Korsgade where, according to the jury, "water is made present, useful and aesthetically attractive" (ON, 2016, 5).²⁴ SLA's proposal was also regarded as innovative in terms of its use of green space, specifically the proposal for "rough" nature or the wilderness aesthetic described as a feature of the Copenhagen Model in Section 7.4 of the previous chapter. In this context, the perceived value of a wilderness aesthetic included reduced costs for maintenance and its educational potential (ON, 2016). This idea that specific configurations of space

²³ "Konkurrenceforslaget skal generelt fremhæves for sin funktionelle samlokalisering og ofte fine syntese af byliv, bynatur, vandhåndtering og klimaløsninger".

²⁴ "Vandets tilstedeværelse gøres nærværende, brugbar og æstetisk attraktivt".

involving visible water, such as the open water channel and wilder forms of green space have a potential cultural or symbolic value is further discussed in Section 8.2.1 and 8.2.3 below. A final perceived strength highlighted by the jury related to the design process, specifically the integration of local residents' perspectives and requirements. Further, it was claimed that this co-existed un-problematically with the realisation of a transferable model. In fact, according to a local government press release, the global commercial potential of the model is actively enhanced by the local residents' involvement: "local power has, at the same time, global potential" (TMF, 2016b).²⁵

This assessment of the successful integration of local residents' perspectives was not universally shared. One critical, though sympathetic, interpretation provided by the majority of the professional interviewees was that there were obstacles to effective participation of non-professionals due to the scale and complexity of the project but that overall the consultation structures had resulted in changes to the plans. A more critical assessment was evident in the case of one of the project group members who argued that the decision-making process was not 'democratic' for several reasons as illustrated in the following quote:

We were divided into two groups, and [on the jury] there were the city council people, there were a lot of people from the water department. They have their professional interest and they said yeah but because of this and that, it has to be this project... the other one it was better, they were more integrated in the way people are thinking here. The way they wanted to make the project or sort of the process was really much better than the other one, but they chose for some professional reasons [...] you know HOFOR, they pay so maybe they have a lot to say so it is also about influence and democracy. You are sort of taking the citizens into the project but it doesn't say that you are deciding anything. It's not like voting where the citizens will say "we vote for this proposition".

The quote refers to the separation for the purposes of decision-making between the project group of local residents and the jury for the competition which was composed

²⁵ "Det er en opgave, der har krævet stort lokalt kendskab, og hvor det lokale greb samtidig har et globalt potentiale".

primarily of professionals (ON, 2016). Second, the quote references the fact that the water company HOFOR was represented on the jury and that they are the primary source of funding for the project. They were assumed for this reason to have a disproportionate degree of influence on decision-making. In fact, no detailed data was available to the researcher about how this decision was made but the broader point is that it was not perceived as wholly democratic or transparent because the process of community engagement was distinct from that of actual decision-making. Finally, it is relevant that a key distinction is made in the quote between different competitors on the basis of the degree to which they were perceived to understand the local context. This was linked by the same participant to a perception that the winning team was more “professional” and commercially-oriented:

[The winning team] were more like a big company and it was a prestige thing. They were more professional and they had won other projects.

The discussion in this section has explored some of the competing logics which influenced the competition process and the tensions between different models of aesthetic expertise. What is highlighted in the above discussion is that the transition towards surface-level management of stormwater and recognition of its design implications has led to new forms of decision-making with a degree of influence awarded to local residents. However, despite a new decision-making structure being adopted, there were still obvious obstacles to transparent or democratic decision-making linked, primarily, to the competitive nature of the recruitment process and the drive to create an iconic project. This latter issue is explored in more detail in the following section which describes key features of the competition-winning proposal which were suggested as innovative by the competition jury but have been contested by other stakeholders.

8.2 Hans Tavsens Park and Korsgade: the contemporary infrastructure design imaginary in practice

This section identifies parallels between theory and practice by discussing to what extent aspects of the design proposal can be taken as examples of the contemporary infrastructure design imaginary. By identifying parallels and thus grounding discussion of this imaginary in specific features of the project, there is an opportunity to explore its

implications, including to what extent/why it might be contested. In fact, a notice posted by the urban regeneration agency in public spaces surrounding Hans Tavsens Park in August 2017 stated that SLA's "draft proposal will be reworked many times before any parts of it can be implemented".²⁶ This could be interpreted as seeking to emphasise the possibility of change to SLA's proposals in response to opposition. Opposition to the proposals has centred on some of its most significant features such as the wilderness landscape aesthetic and the visibility of water due to their perceived negative implications for the social value of the park. Therefore, Sections 8.2.1- 8.2.3 describe to what extent, why and by whom these features of the design have been contested.

8.2.1 Landscape aesthetics

The vision of landscape design outlined in SLA's competition-winning proposal, *The Soul of Nørrebro*, is characterised by an aspiration to change both the quantity and form of green public spaces within the project area. As previously discussed, the idea that more public green space is required was widely supported by a variety of sources. However, beyond this basic assertion the vision of urban nature in SLA's proposal goes beyond conventional park design both in terms of its physical composition and the underlying social vision of new forms of interaction between people and nature.

A notable feature of the proposal is the emphasis on what was described in Section 7.4.3 of the previous chapter as a 'wilderness aesthetic' or what was termed in the jury's assessment of the project as "rough" nature (ON, 2016, 6).²⁷ Its most obvious manifestation is the presence of long grasses rather than conventional park lawns (see Figures 7 and 12). Similar to the Copenhagen Model, the benefits in this case will be, it is claimed, both functional and aesthetic: "Urban nature will handle and retain rain water... [and improve] the quality of life for residents" (SLA, nd., 10). The description of the proposal further evokes the future landscape's aesthetic qualities: "When you go for a walk in Inner Nørrebro in two years, you will be surprised by the small saplings, beautiful old exotic plants, dead trees and rotting compost" (SLA, nd., 18). Of relevance to the research topic is the identification of a cultural dimension to landscape aesthetics through a conceptual

²⁶ "Skitseforslaget vil blive ombearbejdet mange gange inden der evt. anlægges dele af det".

²⁷ "Grovt vegetation".

linkage to ecological education; according to the jury's statement, the "rough vegetation will... provide for ambitious activities related to nature education for children in an urban context, a task that the schools will largely support" (ON, 2016, 6).²⁸ The combined ecological, cultural and symbolic role of "urban nature" is elsewhere emphasised by Peters (2017, 25) who describes SLA's vision as "architecture that is not merely sustainable, but offers positive benefits for both human wellbeing and the environment [through] a deep connection with nature".



Figure 12 Disordered landscape aesthetics in Hans Tavsens Park: long grass and visible stormwater (credit: SLA/Beauty and the Bit).

Changing landscape aesthetics was identified as a key feature of the proposal by all of the project stakeholders interviewed but there were varying interpretations of its value. It was regarded positively by two of the professionals as potentially creating opportunities for yet to be defined activities and experiences, for example, as illustrated by the following quotation from one of the professional interviewees:

²⁸ "De cirkulære formationer med grov vegetation i parken giver god biodiversitet og begrænset vedligehold (da det ikke skal klippes)... De kalder derimod på andre og i en bynaturesammenhæng ambitiøse aktiviteter, som knytter sig til naturlæring med børnene; en opgave, som skolerne i vid udstrækning skal stå for"

There is a fairly large part of the population that want to be able to play football and use the park as they use it today and that's probably the biggest challenge but I think if you make something new with more rough nature, with more landscape, it will give you new opportunities that you maybe don't see today for other activities that are not just playing football.

This quote recognises a conflict between established practices and the “opportunities” which a new landscape aesthetic might provide but it is suggested that the public should accept that existing uses might be foreclosed. This conflict underpinned divided views on the competition entries; several local residents and other stakeholders emphasised the social value of the existing park landscape as linked to uses such as playing football. In fact, this was identified by three participants as a significant advantage of the *Grow Nørrebro* competition entry and as illustrative of a better understanding of local needs on the part of its designers. This emphasis on the park’s present social value is also in stark contrast with SLA’s description of it as “run down” and “hard coated” and requiring a total transformation to become a “modern city park of the future” (SLA & Ramboll, nd., 7). Further, the idea that the established use of park for sport was valuable for all socio-economic groups was raised by three interview participants and this was contrasted with the vision of ‘green’ social activities proposed by SLA which was perceived to have a distinctly middle-class character (see 8.3.1 below). This evidence also provides a counterargument to the explanation of opposition to changing landscape aesthetics as culturally motivated or due to a lack of understanding of ecology provided by strategic stakeholders in the previous chapter (see Section 7.4.3). In contrast, the evidence from the case study was that opposition stemmed from (well-founded) concerns that the new park landscape might preclude existing socially significant activities.

8.2.2 The “fablab”: nature and culture

In the case of HTPK, the idea that infrastructure design should seek to promote ‘cultural sustainability’ has affected the programming and uses of the park, a claim which can be illustrated by a discussion of what has been termed the “fablab for urban nature” (SLA, nd. 10). This concept originates in the neighbourhood plan (ON, 2014, 59) which proposed a “green culture centre” described as a flexible use space to be used both by neighbouring schools and by other community groups. The fablab is described in SLA’s (nd.) design

proposal as a collaboratively managed building which could be used for activities thematically linked to water management and sustainability such as urban gardening. At the time of research, the precise function and value of the fablab was perceived as lacking in definition by several interviewees, a point which was described as an advantage by one of the landscape architects responsible:

It's not 100% designed. Actually we just make the frames and then people they can put their small mark in this frame.

Discussion of the fablab has focused on a normative vision of the relationship between nature and social life rather than on precise activities. It simultaneously exemplifies the centrality to the overall design of an idea that “urban nature” is a unifying cultural project which provides a framework for the development of a sense of community in Inner Nørrebro. According to SLA (nd., 18), it “will be the focal point for a wide range of ‘green’ and social activities. The building will be programmed in such a way that more and more of the inhabitants of the district will have a relationship with it... It will become an arena for coexistence and dialogue which will create new social interaction and shared understanding”. Section 8.3 below discusses the origins of the emphasis on social cohesion and integration which is apparent here. In more practical terms, according to four interview participants, the fablab was inadequately adapted to local conditions. For example, two emphasised that it is a globally-recognised typology but that what its value and function might be in the local context has not been established. This is illustrated in the following quotation from one of the project group members who also represented the interests of the local schools:

I don't know what a fablab is. I've looked up a fablab but it doesn't resemble the thing that I can see in the proposal at all. I think it's open for interpretation that building. No one really knows what it is... The architects thought of it as a citizen's project where you could use it for composting or things like that. That's not enough for us. We have to have some facilities built in more like a classroom if we are going to be able to use it.

More generally, this interviewee argued that, contrary to principles of un-programmed space or self-organisation, in order for the building to be useful from an educational

perspective, there would need to be both material alterations and an institutional framework to regulate its use. A more general critique made in several interviews and other informal conversations was that this and other initiatives of the project assume that providing a physical “frame”, such as that described in the quote from one of the designers above, will translate into new community activities within an overall theme of local sustainability. This was problematised as both unrealistic and as privileging a middle-class vision of community oriented around self-consciously ‘green’ activities. This is illustrated in the following quote from the same interviewee:

All three architects talked about the initiatives growing up, just popping up, you even had pop up farms and “it has to come from the citizens.” Their plan is just to make the framework for the initiatives. “It has to happen because people want to.” And then it is not going to happen or it will just spring up but it will be on the premises of the wealthy families and not the other low-income families.

A related point highlighted by several interview participants, which parallels that made in the discussion of naturalistic landscape aesthetics, is that engagement with urban nature in the form of local sustainability initiatives, is not a universally relevant social or cultural vision.

More generally, the topic of the fablab is important because it provides the basis for a more grounded discussion of new approaches to infrastructure design; the discussion has demonstrated the existence of a distinctive vision of changing infrastructures as a combined technological, natural, social and cultural process. More specifically, SLA’s proposal attempts to create points of interaction between typically disconnected infrastructural, ecological and social systems, in this case through residents’ active engagement in production and management of urban green space. In this sense, there is a clearly identifiable parallel between the design vision articulated here and the broader concept of a contemporary infrastructure design imaginary. However, this vision of active participation and spontaneous, “pop up” initiatives can also be critiqued both as inadequately adapted to local cultural and socio-economic realities and as a relatively superficial form of interaction between social, infrastructure and natural systems, a topic which is explored in the following discussion of the ambiguous visibility of water infrastructure in SLA’s vision.

8.2.3 Visibility/invisibility of water infrastructure

A significant feature of SLA's design proposal is that stormwater should be a visible and aesthetic feature of urban space. According to SLA (nd., 12), "[w]ater will become a visible part of everyday life in Inner Nørrebro, and will significantly increase the perceived value of the district". As described below, this principle is closely linked to an aspiration to promote changing attitudes towards water and "nature" more generally. As such, it parallels concepts in the stormwater design literature such as staging water (Backhaus and Fryd, 2013) or eco-revelatory design (Karvonen, 2011) as well as arguably representing a practical example of the contemporary infrastructure design imaginary.

The principle of rendering water visible has been realised in several aspects of the proposal, most obviously the water retention structure to be located in Hans Tavsens Park (see Figure 13) but also in proposals for an open water conveyance channel in Korsgade and a surface-level treatment 'biotope'. In research interviews, there was broad agreement about the potential aesthetic value of surface-level water storage with only one participant suggesting that a conventional underground system would be preferable. Rather than visible water being undesirable, one project group member, referencing the visualisation produced by SLA of a water-filled future park landscape which has been included as Figure 13, stated that that images produced by SLA had created unrealistic expectations about what the park would look like in the future. In their opinion, the images would be interpreted as meaning that water would be a permanent feature of the park whereas in reality the water storage structures would only occasionally be water-filled.

The picture that is associated with the winning project the morning after a one-hundred-year event. How likely is it that we will see the park like that? [...] It has created an expectation that we will have lakes in the city and we won't.

This design challenge, of the intermittent presence of water in surface-level systems, has been discussed in the literature by Backhaus and Fryd (2013, 58) who recommend "unobtrusive" structures which do not look out of place when dry. However, an alternative solution has been suggested in the case of the stormwater channel proposed for Korsgade which will be permanently filled with recirculated lake water (see below).



Figure 13 Aestheticising stormwater: designer's visualisation of Hans Tavsens Park (credit: SLA/Beauty and the Bit).

Similar to the case of a wilderness landscape aesthetic, the visibility and aesthetic qualities of stormwater were viewed as culturally and symbolically significant. The competition jury, for example, describes surface-level water management as “helping to visualise climate change adaptation in everyday life” (ON, 2016, 11).²⁹ This was also raised by three interview participants. In one case, it was assumed that a “visible, connected system” would lead to understanding, feelings of ownership and a willingness to engage in maintenance activities. In another case, the visibility of water was connected by one of the project planners to opportunities for education and increased ecological awareness both for children and others:

What we see is the possibility of making a series of visible water steps from the schools all the way down to the city lake. There are great possibilities for children to learn about the water and we hope that some of the cleansing biotopes can be designed to create a learning environment. It is not developed yet but my hope is that it could serve as a teaching facility somehow. I hope that this is a way to raise awareness of water as a resource which is extremely important to care of and

²⁹ “Vådområdet i HTP giver også merværdi og synliggør klimatilpasning i hverdagen uden at optage for meget volumen i en skybrudssituation”.

nourish [...] [The system] will be one physical story about how water works and it will be possible to follow visually for everybody.

A further important finding was the key role of designers in the HTPK project in mediating the visibility or invisibility of stormwater and stormwater infrastructure in urban space. This relates to a recurrent theme of the argument throughout the thesis which has been that rendering infrastructures visible and aesthetic features of urban space is not a question of literal visibility, but rather a selective process of editing and mediation which is informed by broader cultural narratives, assumptions about aesthetics and interpretations of the relationship between city and “nature”. This selectivity can be illustrated through a discussion of SLA’s proposal for a water channel to be located in Korsgade, represented in Figure 14 below.



Figure 14 “Natural” water in an urban space: the Korsgade stormwater channel (credit: SLA/Beauty and the Bit).

As apparent in Figure 14, the channel has a relatively green and natural appearance with irregular shapes, small areas of planting and permanent circulation of water. Several interviewees even hoped that it would provide a valuable habitat for animals. As envisaged by SLA, the channel will contribute functionally to water conveyance and purification. In terms of its aesthetic and cultural value, the competition jury interpreted it as contributing “to making the water’s route from park to lake understandable” (ON, 2016, 11).³⁰ A similar

³⁰ “Principielt set bidrager den åbne vandrende til at gøre os vandets vej fra park til sø begribelig”.

open water channel included in Effekt Architect's competition entry was described in the jury's decision as "clarify[ing] aesthetically, symbolically and in theoretical terms that this is a new kind of urban planning" (ON, 2016, 10).³¹

In fact, as illustrated in Figure 15, SLA's overall plan includes a mixture of "nature-based" and conventional infrastructures such as underground water retention tanks and an outflow pipe. This means that, in reality, the water channel on Korsgade is incidental for the purposes of water conveyance and rather has been included due to its perceived symbolic and aesthetic value. As described by SLA (nd., 12), "when it is not raining, the water gutter will remain full and lush" ... because lake water is pumped via pipes from the Peblinge Lake to the Hellig Kors Church, and from there, the water will become a "spring" and flow back to the lakes via the gutter in Korsgade. The circulation removes large quantities of nutrients and phosphorus from the lake water". As apparent from this description and as highlighted in several research interviews, the desire to ensure that the channel is permanently water-filled significantly increases the technical complexity of the project. While it is justified on the basis of water quality, there is no policy or planning requirement for its addition (ON, 2016) and the pumping system also adds to the overall energy consumption of the project.

A range of further issues were raised in research interviews which illustrated the technical and financial costs of engineering a superficially "natural" water channel into an urban setting. For example, referring to SLA's visualisation of the water channel, included as Figure 14 above, one of the project's landscape architects highlighted the legal and technological complexity of adding the small planted spaces which the image presents:

We have these stones and this little narrow water channel with some plants in it that have to go into soil but it looks like it is going into stone so you have to then have a cut out of soil in it and then the water will infiltrate into there and you're not allowed to infiltrate water in Copenhagen because we drink the groundwater so you actually have to seal the entire soil substructure in a geotextile membrane and

³¹ "Den sammenbindende vandrende tydeliggør æstetisk, symbolsk og læringsmæssigt at der er tale om en ny slags byplanlægning".

have a drain in the bottom. That's usually how we do it. Then it is not really a blue-green infrastructure any more, it is two separate...

In practical terms, what is highlighted here is that for the planted areas to be added to the water channel, an impermeable membrane (representing a significant financial cost) would need to be installed in order to prevent contaminated surface water infiltrating into the soil. What is further significant is the uncertainty evident in the final sentence where the interviewee recognises the superficiality of the planted areas and that they do not conform to the ideal of a “blue-green infrastructure” which, in theory, would have both aesthetic and functional benefits. In other words, although the appearance here is of natural watercourse, the addition of impermeable lining illustrates that, similar to Jones and MacDonald’s (2007) analysis of urban SUDs, the behaviour of water in urban space continues to be subject to strict regulation.

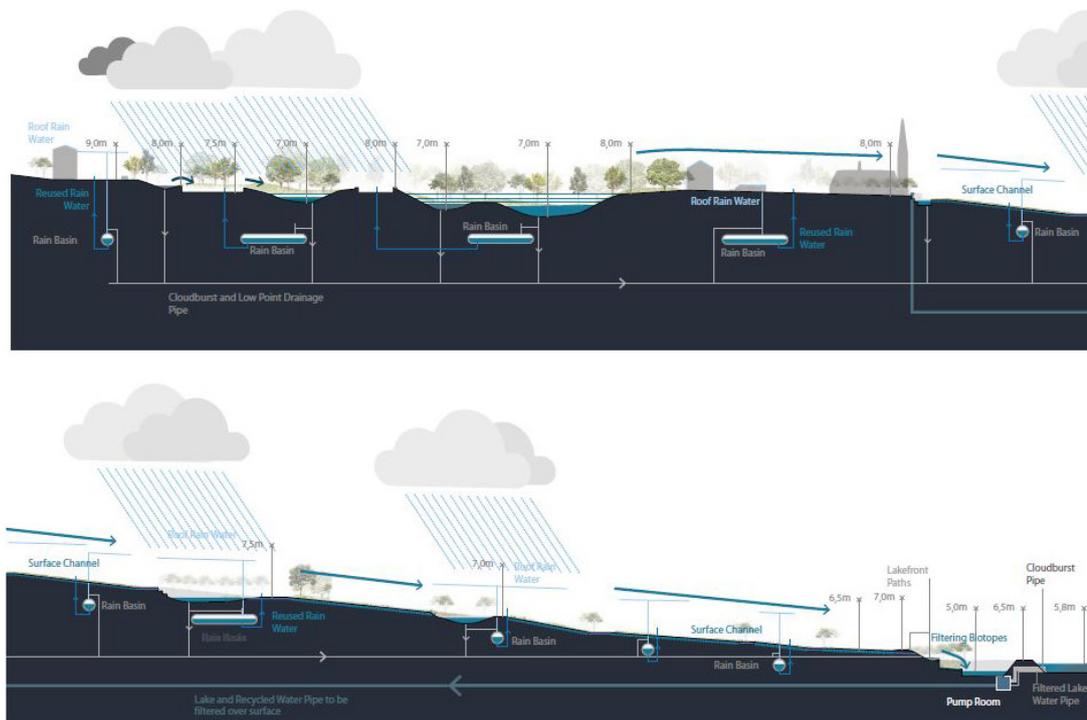


Figure 15 “The Soul of Nørrebro”: a combination of nature-based and conventional stormwater structures (credit: SLA).

It is also relevant to note that during the NBCC competition an alternative system to carry water from Hans Tavsens Park to Peblinge Lake was proposed in the competition entry titled *The Earth Calls*. This entailed a wholly over-ground system without pumps, meaning

improvements in energy consumption. According to one of the landscape architects responsible:

It was not possible to lead the stormwater on the surface all the way down to the recipient. You needed to install some pumps somewhere but we tried to do something else, to lead it in elevated channels that put a very clear limit in the urban spaces and the jury did not like this. They wanted the water to follow the terrain but then it would end in a low point on the urban surface before they reach the lakes.

As described in the quote, the solution was perceived by the jury as an aesthetically undesirable feature due to what could be described as its overtly infrastructural character; the jury stated that it was “out of scale” with its surroundings (ON, 2016, 14)³² and that it created a barrier in the streetscape which “work[ed] against the goal of coherently integrating Korsgade into the urban context” (TMF, 2016a, 4). Unfortunately, no images of the relevant proposal are available.

Other examples of conflict between infrastructural or ecological logics and aesthetics (depending on what interpretation of aesthetics is applied) were identified within the project. One of these was the proposal for surface-level water purification in a ‘biotope’, or filtration pond, in Askovgården, a public square with hard-landscaping between Hans Tavsens Park and Korsgade (see Figure 16). Three interviewees were concerned that the space required for the biotopes was too great and therefore other methods of water purification should be explored. Another stated that, with appropriate design for public access, surface-level water purification could be reconciled with local priorities, specifically the desire to use stormwater infrastructure as an educational resource:

If we get the money, we will be able to put a walkway over it and make it into socially useful space. If we don't then it will just be very big and wet.

This arguably provides a more nuanced perspective on the discussion of water as a visible feature in urban space as not arising directly from the function of surface-level or nature-

³² “Dommerkomiteen finder denne løsning ude af skala med byrummet”.

based stormwater management systems but, instead, as requiring design intervention to reconcile it with aesthetics (insofar as what constitutes aesthetics is defined by local residents). However, an alternative perspective is also possible, for example, if aesthetics was understood, following infrastructure design theorists (e.g. Brown, 2014), as more closely related to ecological sustainability or as arising from the expression of a socially-useful function. According to such interpretations, attempts to recreate a natural landscape, such as the Korsgade water channel, could be described as superficial and resulting from the continued strict regulation of water in urban space with both ecological and financial costs (energy consumption and impermeable liners) and the use of conventional hidden infrastructures (an underground pumping system). In one sense, the water channel reduces the complex and unpredictable temporal fluctuations of rainfall, and of climate change, to a decorative visual enhancement to the streetscape. Further, the degree to which this could be considered to promote an understanding of the relationship between social and natural systems, such as is stated as a normative objective by infrastructure design theorists, is obviously limited.



Figure 16 Askovgård: site of a proposed stormwater filtration biotope and learning space.

Overall, the argument has demonstrated that the design vision within the project consistently emphasises ‘greening’ or the visibility of certain “natural” forms in urban space as key to improved landscape and urban design. It has also been argued that this does not arise un-problematically in “synergy” with the project’s infrastructural functions, as demonstrated by the case of the Korsgade water channel. However, the argument is not

that this represents 'bad' design. Rather, what is suggested is further exploration of the role or function of this design vision in the specific context of Inner Nørrebro. This simultaneously relates to the research objective to provide a 'situated account of design' and understand its structural context. This topic is discussed in the following section.

8.3 Institutionalisation of design: influences on the design process and vision

The analytical framework for the research was described in Chapter 4 as an investigation of how infrastructure design is situated, or the context for new approaches to infrastructure design. Possible influences highlighted in previous literature and which were explored in the outline of the infrastructure design process in Chapter 4 included the cultural, material, institutional and economic context for design. Following this analytical framework, the objective of the rest of the chapter is to highlight a set of institutional and economic influences on the design process related to the coordination of the HTPK project through the existing urban regeneration ("Områdefornyelse") programme in Copenhagen. This section is concerned with how the design process and vision have been structured, if not wholly determined, by this setting.

As previously discussed, the local urban regeneration agency was the coordinator of the NBCC competition and one of the primary authors of the competition brief. Subsequently, the agency, as client to the design consultants, continued to coordinate the process of developing SLA's outline design proposal. This role entailed activities such as organising project group meetings to consult with residents and securing funding to proceed to construction. However, rather than the urban regeneration agency simply implementing an externally defined stormwater management agenda and design vision, what emerged from the research was that this agenda and vision was itself transformed through the process of implementation. Overall, the conjunction of infrastructure planning and urban regeneration was highlighted in several research interviews as an important and distinctive element of the case study project with potential implications for both infrastructural and regeneration agendas. This is highlighted in the following quote from one of the project planners:

The macro thing here, that's climate change adaptation. So [what] you will see in this case is how an urban renewal or regeneration project is transformed in that macro movement and also transforming it or implementing it.

In practical terms, from an urban regeneration perspective one positive implication which was identified was the increased funding available due to the co-financing system (see Section 7.6 of the previous chapter). In terms of how stormwater management might be transformed, it was highlighted that the urban regeneration agency had established mechanisms of community engagement which could be adapted to this new field. Regarding the latter point, the adoption of a co-creation model was previously described by project participants as an outcome of managing stormwater above-ground and a recognition of its design implications (see Section 8.1.3). However, it can equally be described as an alignment of the design process in this project with the “inclusive planning approach” which is an established feature of urban regeneration projects in Copenhagen (Larsen & Hansen, 2008, 2437). In practical terms, prior to the establishment of a new consultation framework for the NBCC (as previously described in Section 8.1.2.), the neighbourhood plan had already established a framework for community engagement to be followed involving the constitution of ‘project groups’ composed of citizens and professionals which would “develop” the plan’s sub-projects (ON, 2014, 84).³³ Therefore, the establishment of a project group of local residents can be seen as an extension of this existing model to a new field of designing stormwater infrastructure.

The following sections discuss further issues of the relationship between stormwater design in the case study and its framing within the urban regeneration programme. These include the emergence of a vision of combined infrastructural and social change and, related to this, the composition of the project group of local residents. They also include the impact of financial logics through the operation of the co-financing system.

8.3.1 Infrastructure as a social and cultural project

A feature of the contemporary infrastructure design imaginary as described in Chapter 3 is the idea that infrastructure design practices might become a catalyst for social and cultural

³³ “De konkrete projekter udvikles i projektgrupperne”.

change. This has also been documented as an important aspect of SLA's vision for HTPK. This vision of design, however, also aligns with that of previous urban regeneration initiatives in Copenhagen which have emphasised the relationship between physical regeneration of public spaces and cultural change, including through social cohesion strategies which emphasise 'green' social practices. The following section explores the co-evolution of the vision of design in HTPK, describing it as influenced by the established urban regeneration model but adapted to a new context and set of opportunities provided by stormwater management. This also leads to a more grounded understanding of some of the problematic social implications of design in the case study.

The objectives of the overall Områdefornyelse programme are "to promote development in local areas encompassing physical, social, cultural and environmental aspects" (TMF, 2012, 4). More specifically, its social objectives include promoting social cohesion through establishing connections between disadvantaged and "resourceful" social groups (Larsen, 2013) and by promoting the social integration of migrant communities (Cole & Etherington, 2005). In previous examples, these objectives have been combined with the programme's physical environment remit in the form of changes to public space intended to improve social cohesion (Savini, 2011).

However, this model has been deemed ineffective because, according to Larsen (2013, 403), there is an overemphasis on "highly visible but relatively insignificant physical issues while underlying critical social problems are left unresolved". A related criticism is that regeneration programmes are, in reality, more concerned with "place-branding" than with finding real solutions to residents' problems. This is illustrated in stark terms by a review of the urban regeneration programme published by the Danish Ministry of Integration in which Tverskov (2007, 35) describes its objectives as using "image and branding" to counter negative perceptions of areas that arise due to a "social and ethnic imbalance in composition" and ultimately "to ensure the area can live up to the demands of the "consumers" (potential residents) in terms of housing and a local community". As apparent here, there is an explicit aspiration to use place-branding to increase the desirability of areas using measures such as physical improvements and through creating the perception of a functioning "community". This obviously has the potential (or intention) to facilitate gentrification which, in fact, has been an observed consequence of the urban regeneration programme (Larsen & Hansen, 2008). In addition, since 2001, gentrification has been

facilitated through a series of housing market reforms which have increased speculation and housing costs particularly in the private-cooperative sector which was previously an affordable form of tenure (Larsen & Hansen, 2015).

A further important trend in the overall trajectory of urban regeneration in the city is the emergence of a model of “green urban renewal” (Cucca, 2017). This transition has been identified by some authors as a further iteration of place-branding and entrepreneurial strategies as well as having socially and environmentally progressive objectives (Roy, 2018). Roy (2018) notes the partial conjunction of social cohesion or integration with practices of sustainable design through the encouragement of activities such as an urban gardening which “was seen as a means to orchestrate positive meetings between “groups of citizens with different cultural and ethnic background and different abilities” (Roy, 2018, 297). The author’s conclusion, drawing on a case study of urban regeneration in Sundholm, Copenhagen, is that the active engagement of residents in the management of public space has increased feelings of community and safety but led to the exclusion of the homeless population through surveillance and altered behavioural norms in public space. This outcome is taken to illustrate the potential complementarity of “discourses of greening, social integration/cohesion” and objectives of “greater attractiveness for existing and potential middle-income residents” (Roy, 2018, 298).

This discussion, on the surface, does not appear immediately relevant to understanding practices of designing stormwater infrastructure. However, the argument here is that this history and context at least partially explains the complex socio-cultural vision of design in the case study project or the concept of combining infrastructural change and “social and cultural renewal” (KK & NI, 2015, 4). In terms of the socio-economic context of the case study project, according to Hansen and Karpantschof (2016, 177), Nørrebro “has undergone profound changes, beginning with the evacuation of worn-out buildings in the 1970s, followed by urban renewal ('sanitation') during the 1980s, neoliberal gentrification in the 1990s, all the way to what we describe as 'hipsterfication' in the 2000s". However, the process of gentrification is not complete; the authors (2016) cite property market forecasts that urban regeneration in Nørrebro will provide further opportunities for speculation. Further, there are continuing significant disparities between Inner Nørrebro’s residents on the basis of access to employment, language skills and housing tenure (FSB, 2013).

Following the conventional emphasis on visible physical changes observed by Savini (2011), these issues have been addressed in the overall urban regeneration plan for Inner Nørrebro through changes to public space intended to improve social cohesion and attempts to increase feelings of safety from crime (ON, 2014). In fact, during the period of data collection, Nørrebro became the centre of an episode of ‘gang violence’ (“Nørrebro residents ‘living in fear’”, 2017) and this issue became a focal point for interviewees’ expressions of concern regarding both the social context and public spaces of Inner Nørrebro. Further, this context has clearly influenced the understanding of the HTPK project; for example, one of the competition teams described their interpretation of the project as simultaneously securing the area against climate change and crime using “crime prevention through urban planning” (Third Nature, 2016).³⁴ Generally, how the above context of concern about social polarisation has interacted with the case study project is difficult to disentangle but provides a crucial influence on the design vision.

In evidence from interviews, there were different interpretations of how the design project might interact with Nørrebro’s social context. One notable interpretation evidenced in three interviews with designers involved the representation of these socio-economic complexities as evidence of “diversity”, “creativity” and “innovation”. SLA’s (nd.) description of the case study project makes frequent use of terms such as “experimentation” and “pioneer projects” to refer to activities such as urban gardening. Equally, the character of Nørrebro as socially diverse was described by one of the project’s landscape architects as evidence of its openness to change and as rendering it appropriate for experimentation:

Nørrebro has always been the laboratory for new solutions. Sometimes it works out really well. Other times it fails a bit but it has always been the area for tests historically in Copenhagen. I think that's where the politicians dare to try out things because in other areas, [the residents] are more conservative.

A more nuanced perspective was provided by most interviewees where the socio-economic realities of Nørrebro were frequently raised as providing the context within which the case

³⁴ “Der er et stort behov for kriminalitetsforebyggelse gennem byplanlægning”.

study project was situated and to which it emerged as a response. Two interview participants highlighted the increasing polarisation of the district between on the one hand, extremely gentrified streets such as Jægersborggade (described by one participant as “Little Kreuzberg”) and the converse reality of social housing complexes described as “ghettos” by another. Increasing house prices and changing demographic composition were also frequently referenced. The following quote highlights the impact of changing regulation of private housing cooperatives, described in detail in Larsen and Hansen (2015), as an impetus towards gentrification:

Now you can borrow money against your flat so it's getting more and more expensive. it's like what is it called, gentrification, so the people living here are changing. There are more and more rich people living here and the other people I don't know where they go.

It is also this polarisation and perception of socio-cultural differences which provides the context for proposals for ‘green’ social activities apparent in the design vision, for example, as apparent in the case of the fablab (see Section 8.2.2 above). The above discussion is intended as a means to recontextualise that evidence and provide a framework to understand aspects of the project which are represented as solutions to infrastructural as well as perceived social and cultural problems. More specifically, it provides the context for the identification of “urban nature” as a unifying cultural project which might have benefits in terms of social cohesion, an idea that was supported by most of the professional project stakeholders, as illustrated in the following quote from one of the project planners:

[These are] easy physical structures that support social structures. And of course that urban farming thing, we work with that all the time all over the city because we know it has a lot of potential in terms of supporting the social relations and the social structures.

However, this was moderated by a simultaneous recognition that the social content of the design vision was not universally relevant or democratically defined, including by some of the professionals who were broadly supportive. In the following quote from one of the project group members, it was identified as a vision of the city which corresponded to the needs of middle-class, property-owning residents:

It's not only the students and the poor living in the area now. Many more families are staying in the city. It is much more attractive to be in the city so is the project meeting the needs? For my segment it is indeed meeting the needs. I think it is very nice that we will have a redesign of the urban space. I think it is very interesting that the municipality is having a climate focus but you will find people in this area which are excluded in general from society and where it is probably not meeting their needs.

A key related point is the composition of the project group; four interviewees, both residents and professionals, stated that socio-economic inequalities among residents in Inner Nørrebro were reflected in participation in the group and, therefore, that it should not be considered a representative sample of residents. This was attributed to difficulties of including marginalised groups, primarily referring to migrants and residents of social housing (categories which frequently overlap [FSB, 2013]). According to one of the project's planners:

The project group are primarily what we would call resourceful people, middle-class people but not only. Generally, we have difficulties in getting relations to very underprivileged people in this district.

More details on the difficulties of accessing residents not included in the project's formal consultation mechanisms are provided in the Methodology (Section 5.7.3). As above, the project group was described as composed of middle-class residents with a pre-existing interest in urban sustainability as it has been understood within the project. For example, one member specifically highlighted the overrepresentation of property-owning residents of a private-housing cooperative adjacent to the park. This simultaneously illustrates the difficulty of identifying a monolithic "community" perspective which could be juxtaposed against a context-free or entrepreneurial interpretation of aesthetics represented by other stakeholders, given the internal divisions between local residents.

There was also some limited evidence of more progressive visions of the relationship between social problems and sustainable design. For example, two interviewees suggested that the urban regeneration programme could make a positive contribution if there was

sufficient emphasis on structural determinants of exclusion, emphasising access to employment, in conjunction with redevelopment of public space. In the following quote, one of the project group members referenced the example of a social enterprise in New York which combined urban gardening with the provision of employment:

It's a garden where they grow green groceries and sell them in markets. so all these young kids they get in... I think what we miss here it's like, it's some projects that just goes for ever where you can integrate and you have some social contact.

This is explicitly identified as contrary to the urban regeneration programme's conventional model of temporary social programmes which, where provided, are only financially supported for the period of the regeneration programme's work in a given neighbourhood (approximately five years).

8.3.2 Infrastructure as a site of environmental education

A further distinctive feature of the HTPK design vision is the identification of the future infrastructural landscape as a site of environmental education or increased ecological awareness. As described in previous sections, this is an explicit objective of the wilderness landscape aesthetic, the fablab and of the visibility of stormwater. This topic is also of thematic interest because it links to the perceived relationship between the visibility of infrastructure and ecological awareness which has been described as a key feature of the contemporary infrastructure design imaginary. Within the HTPK, a further iteration of this idea was the suggestion that above-ground stormwater management might also provide opportunities for ecological education for schoolchildren by incorporating it into the formal education system. The following section explores the origins of this idea as a means of investigating the circumstances in which aspects of the contemporary design imaginary are adopted. This can be at least partially explained by two features of the institutional context which are, first, the financial structures of the project and, second, the agenda of social integration as applied to schoolchildren in Nørrebro.

The first influence, that of financial structure, was referenced by three interviewees and relates to the operation of the system of 'co-financing' above-ground stormwater systems which was discussed in Section 7.6 of the previous chapter. The implication of this system

for the HTPK case study was that the project's realisation depended on the availability of funding from different sources, the first being investment from HOFOR for hydraulic infrastructure while the second source of investment for 'design' needed to come from elsewhere. During the period of research, the allocation of funding for design was regarded as uncertain because, since a restructuring of the urban regeneration programme in 2007 (Larsen, 2013), funding for initiatives to proceed to construction is not guaranteed from the outset. This uncertainty resulted in the development of a partnership between the urban regeneration agency and the Children and Young People's Administration (Børne- og Ungdomsforvaltningen [BUF]) of the local government which is responsible for capital investment in schools. The agreement was that the BUF would provide funding for aspects of the park to be redesigned as outdoor learning spaces for use by neighbouring schools. It was suggested that this was a solution to existing school capacity problems, that it would facilitate outdoor education and would provide funding to mitigate the impact of 'infrastructural' changes to the park, namely terrain changes to create water retention areas. Once the provision of outdoor classrooms was proposed, it was perceived as intuitive that they should be linked to the overall climate adaptation and stormwater management theme of the project as indicated in the following quote from one of the project planners:

The schools will experiment with teaching outdoors now as part of the project and this wasn't in the project from the beginning. In terms of learning and pedagogics, new forms of teaching and new forms of sociality will be possible by moving classes outdoors.

Another important influence, indicated in the second sentence of the quote above, towards conceptualisation of the redeveloped park as an educational space is linked to the social cohesion focus of the urban regeneration programme as it applied to children. More specifically, three interviewees suggested that children of low-income and migrant families, although they attended the local schools, did not take part in the social life of the neighbourhood, for example, by using the supervised playgrounds in the park. In terms of physical changes, this translated into a proposal in the neighbourhood plan (ON, 2014) and competition brief (KK & NI, 2015) to remove barriers between one of the schools and the park. Subsequently, SLA's proposal (SLA & Ramboll, nd., 8) suggested including the schools in activities such as those associated with the fablab with assumed benefits of integration

into the local community: “by including the local school children in the maintenance and development of the city nature they will learn new things about their world, their city and themselves”. A further visualisation by SLA (Figure 17) shows children participating in ‘green’ and community-oriented practices of urban gardening. The linkage to social cohesion is also apparent in the quote below from one of the project planners:

There is also the aspect that by moving the pupils outside and make them meet the local community it will also make them gain knowledge of what kind of social space is this that I am growing up in.

Finally, besides local factors, interviewees also highlighted an existing outdoor education “udeskole” movement (Bentsen et al., 2009) and national school reforms (“folkeskolereform”) implemented in 2016 (European Commission, 2017; KK & NI, 2015) as influences on changing relationships between the schools and the wider community although these were not discussed in detail in research interviews.



Figure 17 Infrastructure as a site of environmental education and social cohesion: designer’s visualisation of schoolchildren engaged in sustainable social activities (credit: SLA/Beauty and the Bit).

There were also critical interpretations of the complementarity of the infrastructural agenda and educational needs. For example, one representative of the local schools stated that proposals for outdoor classrooms, ecological education and social integration were of marginal value from an educational perspective:

We are thinking learning in a much broader sense that just nature or environment [...] There is a desire to open up the schools and make them a part of the nearby society, but it's not my objective, that's learning.

The participant's broader perspective was that the current proposals, both for outdoor classrooms and for the fablab, emerged from opportunistic attempts to combine educational objectives with opportunities arising from the stormwater plan, but that these were constrained by the financial context such that the proposals superficially responded to but would not meaningfully address the actual need for more classrooms. In fact, this links to a broader discussion of the relationship between infrastructural and other priorities within the project and the central role of the urban regeneration agency as seeking to maximise possible "synergies". This role was described as follows by one of the project planners:

We always try to make the local agendas match the city level agendas but also the local ideas that pop up wherever they come from, just gently switch them to match or to fit into some structure because local ideas are great but what makes them sustainable is if they can match the city level so that would create a long term sustainability for some local idea.

There are several important features to this perspective, including that it describes design outcomes as the product of a process of negotiation involving competing (and hierarchical) local and urban objectives. It raises the possibility that local priorities will be reflected in the final outcome to the extent that they can be reoriented or adapted to fit trajectories defined at a higher level of governance. This belies the notion of a radical reorientation of power in the design process such as implied in the concept of co-creation. In one sense, these findings on the role of planners implementing the urban regeneration programme are similar to Munthe-Kaas and Hoffmann's (2017) description of the changing role of planners in Copenhagen in a similar set of projects with both infrastructural and design objectives. The authors (2017, 287) suggest that design in this context should be understood as a "reconfiguration of the existing rather than radical invention of the new". However, the findings here are distinct from those of Munthe-Kaas and Hoffman's (2017) generally positive interpretation insofar as they have found evidence that the resulting

outcomes are distorted through the process of negotiation and intermediation to the point that, in some cases, they do not fulfil the needs they are originally intended to serve.

8.4 Summary

The key contribution of this chapter has been to ground discussion of key aspects of the conceptual and analytical framework for the research in specific features of the case study project. This extends to questions of design imaginaries, expertise and the material, institutional and economic context for design. It has provided a detailed understanding of the circumstances in which new approaches to design, incorporating aspects of what has been defined as a contemporary infrastructure design imaginary, might be realised and what function these ideas might perform in a given context. The chapter has simultaneously responded to the research objective of providing an in-depth understanding of the infrastructure design process. This has uncovered the messiness of the design process as a negotiation of diverse and conflicting interests. On this basis, the findings can arguably be contrasted with concepts such as “synergy” or “multifunctionality” (Selman, 2009; Rosenberg, 2015) which are key tenets of new approaches to infrastructure design and suggest the possibility of an unproblematic reconciliation of infrastructural development, and the appropriation of urban space which this entails, with other established uses of urban space. The connections between the analytical framework established in Chapter 4 (Section 4.3) and the evidence from the HTPK case study are summarised in Table 8.1.

An important topic throughout the thesis has been that of design expertise, including the interplay between design and other forms of expertise within infrastructure projects as well as the consequences of adopting design or aesthetics as a framework for decision-making. In this project, there were competing models of design expertise which were alternatively context-free or more responsive to the concerns of local residents. The description of the changing decision-making structures of the NBCC illustrates that recognition of the aesthetic implications of surface-level stormwater infrastructure is one of the key influences towards more democratic project structures and initiating a process of co-creation. Nonetheless, it has also demonstrated the internal socio-economic and cultural divisions within a “community” perspective which was reflected in unequal representation of residents in the consultation structures. A further important finding has

been the strategic mediating role of urban regeneration planners within the process of co-creation which, rather than involving a radical re-allocation of power to influence the design process, continues to be constrained by its institutional, economic and fiscal context.

The case study has also allowed discussion of the translation of a contemporary infrastructure design imaginary into practice, through its description of key features of the project such as unconventional landscape aesthetics, the visibility of water, attempts to facilitate new forms of interaction between social, infrastructural and natural systems and its reconceptualisation of visible infrastructure as an educational resource. One important finding has been the ambiguity of discourses of rendering water visible, such as was illustrated by the discussion of the Korsgade water channel. From one perspective, the role of design in this instance can be interpreted as managing an inherently conflicted relationship between the social value of urban space and the material demands on its use imposed by new infrastructural systems. Alternatively, similar to the arguments of Gandy (2011) or Repishti (2008), it can be interpreted as obscuring the reality of the relationships between social and natural systems, or between city and nature, which are mediated by infrastructures. Overall, the analysis supports the argument, made by authors such as Larkin (2013) and Schwenkel (2015) that practices of aestheticising and rendering infrastructures visible are inevitably selective and informed by broader ideologies and narratives of the relationship between city and nature.

However, arguably a more important finding been the description of the function of SLA's design vision in the specific socio-economic and material context of the case study site. This has provided an account of the co-evolution and complex entanglement of the design vision with a broader range of influences on the design process, the exploration of which provides a fuller explanation of the reconceptualisation of infrastructure design as a social and cultural project. One productive point of both agreement and contrast with previous literature is with the work of Usher (2018) who suggests that the material efficacy of water for government is that it provides a response to property market pressures and that it contributes to a politically and financially motivated strategy to promote environmentally-responsible behaviour, both of which are certainly relevant in this case. What is distinctive is the vision of new forms of "urban nature" in the HTPK case study as a process of establishing affective relationships amongst different social groups, thus contributing to

social cohesion. Generally, the evidence suggests that a complex range of institutional, economic and fiscal influences underpin the design vision. These include the institutional context of the urban regeneration programme, the entrepreneurial drive to brand Inner Nørrebro as having a strong community oriented around 'green' social activities, thereby facilitating property development, and, finally, financial pressures which created a need to attract additional funding and led to the reconceptualisation of the park as an educational space.

	Influences on infrastructural development				
	Cultural practices	Material	Who designs and what influences their thinking?		Economic development
Potential influences on design	Are there parallels with the 'contemporary infrastructure design imaginary'?	What forms of infrastructure are the objects of design intervention?	What does design or aesthetic expertise mean in a given context?	How is design expertise recruited and institutionally situated?	What is the significance of infrastructure design from an economic development perspective?
Relevance to the case study	There are many parallels between what has been defined as the contemporary design imaginary and the design vision in HTPK including an emphasis on visibility, environmental education. The analysis shows that this is the outcome of pragmatism and funding constraints as well as changing aesthetic ideals or imaginaries.	Urban stormwater management is a key sector for the adoption of new approaches to design. This has several pragmatic drivers including the availability of funding for climate adaptation and because 'nature-based' stormwater design is valuable from place-branding perspective. Last, as suggested in Sections 4.1.1 & 4.2.4, the need to appropriate space for infrastructural use has been a key driver of the design agenda. This pragmatism is reflected in an emphasis on the aesthetic value of visible infrastructure but, at the same time, this is refracted through a model of aesthetics which prioritises (superficial) urban greening.	The evidence shows an unresolved conflict between different models of aesthetic expertise, namely <ul style="list-style-type: none"> • context free design (Blok, 2013) and • "co-creation" or democratic design (Hoffman and Munthe-Kaas, 2018). These models have different perspectives on the role of communities in decision making.	The institutional context for design in HTPK was a key influence. First, the NBCC competition included an aim to produce and internationally iconic proposals and was generally exclusive of community perspectives. In this context, the role of SLA in the HTPK case study parallels Hatherley's (2011) description of the specialist designer of iconic infrastructure projects. In contrast, the setting of the project within the local regeneration programme provided a framework for community engagement, even though it retained an entrepreneurial focus.	<ul style="list-style-type: none"> • Green gentrification, place-branding and property values (Harvey, 1989; Gandy, 2011; Cucca, 2017) There are alternatively coincident and conflicting economic logics which have significantly affected the approach to design in HTPK. These include place-branding at the urban level to position Copenhagen as a leader in green climate adaptation and, on the other hand, local economic priorities to improve property values (amongst other objectives) through creating a sense of community oriented about a new green identity.

Table 8.1 Connections between the analytical framework and the results of the HTPK case study

Chapter 9 “Grey to Green”, Sheffield: case study results

The following chapter describes the second case study investigated in the thesis, that of “Grey to Green” (GtG), a combined urban regeneration and stormwater management project in Sheffield, UK. This has been described by Sheffield City Council (SCC, 2014, 4-5) as “an attractive new linear public space incorporating perennial meadows, sustainable drainage, rain gardens and walking and cycling routes... high-profile and innovative but low maintenance... [It is] Sheffield’s own take on Manhattan’s High Line Park”. Though this description may be somewhat hyperbolic, it is true that the project is an anomaly both within the city and nationally, representing the largest linear urban SUDs “retrofit” in the UK. Further, the project is characterised by an aspiration to explore how climate change adaptation in the form of stormwater infrastructure might contribute to the aesthetic value of public space, notably through the implementation of what was termed a “green SUDs” model where new and visible, above-ground stormwater infrastructures were combined with the creation of public green space using a distinctive “naturalistic” (Hitchmough & Dunnett, 2004) wildflower meadow planting scheme rather than a more conventional urban landscape aesthetic.

This raises the question of why this example of seemingly “innovative” design has occurred in Sheffield. The contribution of the chapter is to explore its origins and disentangle influences on the design process ranging from local histories of stormwater design to the current context of economic regeneration and the pressures of competing in the “knowledge economy”. The key finding of the chapter is that GtG is characterised by a distinctive relationship between stormwater infrastructure and design; infrastructure has been selectively aestheticised and rendered visible insofar as this corresponds to a narrow set of design objectives related to increasing the attractiveness of the case study site for property development. As such, its visibility is not related to rethinking how people interact with infrastructure. The findings are based on interviews with thirteen project professionals and other stakeholders as well as documentary sources. A feature of the evidence collected was the limited participation of non-professionals in research interviews (due to the lack of community engagement in the planning process) and the consistent interpretation of the project’s objectives amongst the different professionals and institutions involved (as discussed in Sections 9.3.1-2 below).

In terms of structure, Section 9.1 introduces the case study and describes the policy and planning context. It also analyses previous examples of urban and landscape design related to water management in Sheffield which were referenced as influences. This provides the basis for a nuanced account of both continuity and change in stormwater design practice in Sheffield. Section 9.2 describes and analyses the terminology and concepts used to describe the case study, notably the concept of “green SUDs” referring to the model of visible, above-ground SUDs with associated new green space. This links to a discussion of the economic context for design because this model, including its emphasis on the visibility of infrastructure, can be situated as a response to a set of specific financial and economic pressures. Section 9.3 discusses who has been involved in the infrastructure design process. It describes the lack of community engagement in the design process for GtG, the reliance on in-house expertise within Sheffield City Council and also describes and analyses the key role of academic expertise. The chapter suggests that academic expertise is a symbolic asset which is integral to the representation of GtG as “innovative”. Last, Section 9.4 analyses the conflict between infrastructural and design logics where the latter is institutionalised through a spatially limited urban regeneration programme.

9.1 Case study description

“Grey to Green” is a combined sustainable urban drainage (SUDs) and urban regeneration project located close to Sheffield city centre in the Bridge St./West Bar area (see Figure 21 below). It was completed in 2016 and is described as the first phase of an overall extended three-part scheme called the “Grey to Green Corridor” (SCC, 2018a) which has not yet been completed. It was built on a roadway which became underused following the completion of an outer ring road in 2007. In terms of its basic features, the project involved the construction of a series of “swales”, or water retention structures (see Figure 18), which capture stormwater from nearby streets and allow it to infiltrate into the soil or alternatively to travel downhill through the system into an outflow pipe and the River Don, at which point it should have been decontaminated by natural filtration. This means that surface water is disconnected from the underground combined sewers and that it contributes to reducing the likelihood of combined sewer overflows during periods of heavy rainfall. Beyond its hydrological function, GtG has been designed following what is described as a “layered approach”. This refers to the combination of new stormwater infrastructure with other changes to urban and landscape design such as the provision of a

small hard-landscaped square and seating area, planting within the swales following a distinctive wildflower meadow landscape aesthetic (see Figures 18 & 19) and alterations to cycling and walking infrastructure intended to create new links between the city centre and nearby commercial and residential centres. More detail on the concept of ‘layers’ is given in Section 9.2.1 below.



Figure 18 A planted swale on Bridge St., Sheffield, part of the Grey to Green project.

Since its completion, GtG has been widely claimed as a success following the receipt of several awards for landscape design, water management and sustainable construction. According to Sheffield City Council (2018a, 51), the project has transformed “previously hostile spaces into places where people choose to linger and which become attractive to new investments”. This has led to plans for an eastward expansion of the scheme, justified by the first phase’s success in “enhancing the image of the area and attracting new investment and footfall” (SCC, 2018b). A public consultation on the proposed expansion was launched in March 2018. Elsewhere in the city, the “green SUDs” approach trialled in GtG is being applied in another high-profile city centre SUDs scheme designed by the SCC landscape designers. Last, although it does not reference GtG directly, the National Flood Resilience Review (2014) proposed that Sheffield’s model of combining new water management infrastructures with urban and landscape design should be replicated in other

UK cities due to its contribution to social and economic regeneration and because it opens new avenues to secure funding for water management infrastructures.



Figure 19 Wildflower meadow planting and new public seating on Snig Hill/Bridge St.

A small number of individuals and institutions were directly involved in the design process, the most important of which was Sheffield City Council (SCC). The project was planned and coordinated and funding was secured by SCC's City Regeneration Division. The relationship between the objectives of the project as related to urban (economic) regeneration and the specific model of design adopted is a recurrent topic in the following chapter but is discussed most directly in Section 9.2. Also within SCC, detailed design was by in-house landscape designers and hydraulic expertise was added by the SUDs Advisory Body in conjunction with an external consultant. The reliance on in-house expertise is discussed in 9.4.2. Further consultancy services on planting were provided by staff from the University of Sheffield's Department of Landscape and the role of academic expertise and its relationship to landscape aesthetics is discussed in Section 9.4. Finally, a further significant actor was the Sheffield City Region (SCR) Local Enterprise Partnership, composed of major regional private commercial interests and employers, which was responsible for formulating the policy context for capital investment in infrastructure and public space in the city through its Strategic Economic Plan (SCR, 2014) and was also one of the primary

sources of funding for the project. The relationship between the financial context and model of design is also discussed in Section 9.2.

9.1.1 Planning and policy context

SCC's (2014, 5) description of GtG situates the project in relation to the overall trajectory of urban regeneration and design in Sheffield, stating that "[f]or the past 15 years, Sheffield City Centre has experienced a significant transformation, spreading out from the 'Heart of the City' and the other key projects that originated from the 2000 Sheffield One Masterplan, which were in part funded by Objective 1...The 'Grey to Green' project uses a similar approach, albeit adapted to an era of scarce resources and greater sustainability. It has grown out of proposals in the City Centre Masterplan 2013 (Draft) and is a key step towards the vision of where the City wants to be over the next 10-15 years". As described here, GtG is perceived as representing both continuation and change in the approach to urban regeneration in the city in response to financial and ecological pressures compared to the previous period when the city and surrounding region qualified for additional European Objective 1 investment due to their high unemployment rates (Dabinett, 2005).

Relevant to explaining what this "vision of where the City wants to be" might entail, various authors have noted the centrality of urban regeneration and design to the city's economic policy; according to Madanipour et al. (2018, 469; 471), since the publication of the Sheffield City Centre Strategy (1994), "a successful city centre" with high-value retail and an "experience economy", has been considered the key to the city's economic development. A further important influence is SCC's wider strategy to restructure the economy and transform the city from a site of post-industrial decline into one of high-value employment in legal, financial and "creative" industries (Dabinett, 2004; 2005). This has been conceptualised by SCC as a question of urban and landscape design; the City Centre Masterplan (CCMP) (SCC, 2013a, 12) argues that "Sheffield's economy has significantly transformed over the last two decades... The changes in the city centre over the last 15 years have played a substantial part in that transformation becoming the main focus of the key growth sectors of knowledge, higher education, business services and creative-digital sectors offering an attractive place to work, play and live". Similarly, the Sheffield City Region's Strategic Economic Plan (SEP) identifies the city centre as a "key engine for growth in the wider city region" and as a hub for "knowledge, creative and digital industries,

leisure, higher education, culture and financial and professional services” (SCR, 2014, 31). This corresponds to an overall objective to restructure the economy of the city region towards more private-sector employment in “innovative and knowledge intensive” sectors (SCR, 2014, 29). Correspondence with the objectives of the SEP was important in securing funding for GtG and the relationship between the policy and financial context and design is discussed in more detail in Section 9.2.1.

The origins of the GtG project, more specifically, can be partially traced to the City Centre Masterplan (CCMP) (SCC, 2013a) which outlined a set of proposals for what would later become the site of the GtG scheme (see Figure 20). In the plan, this area is described as part of the “Riverside Business District”, one of the city’s key business districts, which is envisaged as a site of high-value employment in legal and professional services. However, the CCMP (2013a, 24) stated that the attractiveness of the area for high-value employers depended on “public realm improvements” such as reclaiming underused road space, improving pedestrian links as well as requiring “active frontage” on adjacent streets in future private developments. Attracting these employers was further regarded as subject to development of new office space. Potential sites of office development identified by SCC are illustrated in Figure 21 of which the most significant are West Bar Square and the Castle Markets site.

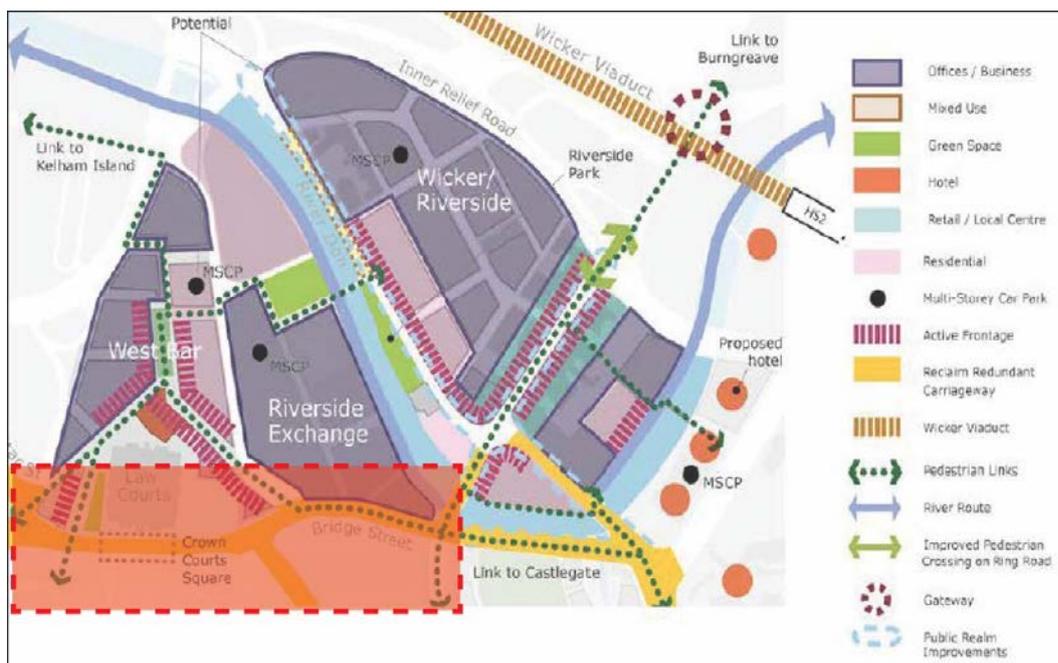


Figure 20 Proposals for the area later encompassed by GtG (in red) in the CCMP (2013a).



Figure 21 Grey to Green and nearby development sites identified by SCC (Map data copyright Google 2018)

The Castle Markets site is described in a new CCMP (SCC, 2018a) as representing “an exciting opportunity... to become a distinctive new focus for tech and creative start-up businesses” while West Bar Square was repeatedly highlighted in both documentary sources and interviews as one of the opportunities to which GtG was a response and central to attracting high value employers due to the scale of development possible:

In terms of opportunities we also have West Bar which is the largest office site, the only one of a certain size left in Sheffield.

However, one notable feature of the CCMP (2013a) is that it did not propose SUDs as part of the regeneration of the Riverside Business District or in any other city centre sites. Neither is the SUDs concept directly traceable to environmental policy or flood management strategies in Sheffield; while there is considerable emphasis on SUDs in Sheffield’s Core (2009) and Flood Management (SCC, 2013b) strategies and SUDs design guidelines are provided (SCC, 2011), these refer to new private developments rather than retrofit projects led by SCC such as GtG. In addition, the Sheffield Flood Risk Management Strategy (2013b) notes that surface water is not one of the primary sources of flood risk in the city. For example, while the area surrounding GtG was affected by serious flooding in

2007 and is therefore identified as an area of flood risk, this was caused by the River Don overflowing its banks rather than localised stormwater runoff (SCC, 2013b). Starting from this observation of the uncertain origin of the SUDs concept in GtG, the following sections further explore the project's background. In addition, the idea that the origins of the SUDs aspect of the scheme is not, in reality, linked to managing flooding provides a starting point for the discussion in Section 9.2 of more significant influences on the design process.

9.1.2 Water as a regeneration "asset"

The previous section has demonstrated that aspects of the case study, notably the inclusion of SUDs, are not directly traceable to the planning or policy context. In contrast, evidence from research interviews and documentary sources highlighted the significance of previous regeneration projects in Sheffield which involve reconfiguring the relationship between water and urban space as key influences on the approach to design in GtG; SCC's (2016) description of GtG situates the project in the overall context of the city's identity: "Sheffield is a green city. It's home to 2 million trees, beautiful ancient woodlands, and stunning expanses of parks and gardens". Similarly, according to three of the project's key stakeholders, the previous history of urban and landscape design in the city, especially projects where water was a central design theme, were an important influence on the origins of SUDs in the project. According to one of the project designers:

The water was part of the mix if you like and I think the origin of the water is... There is a bit of a history of water being a part of regeneration in the fountains but also in the rivers, access to rivers, the Five Weirs Walk, water being an asset in new development, so there is a bit of a SUDs history in the city anyway.

In this and other interviews, participants referenced previous urban and landscape design projects where water was a central theme as explaining the approach in GtG. All of the projects which were referenced in research interviews are mapped in Figure 22. These included decorative fountains in the city centre Peace Gardens, projects which provide opportunities for riverside access and recreation, such as the "Five Weirs Walk" or the "Blue Loop" alongside the River Don and the Sheffield-Tinsley Canal as well as others which combine 'infrastructural' water management functions with urban and landscape design,

such as the Nursery Street pocket park and the Manor Fields SUDs project. The Nursery Street project involved the creation of a new park adjacent to the River Don with access to the water for fishing and canoeing as well as removal of part of the riverside wall to provide additional water retention capacity and reduce flood risk (see Figure 23). The Manor Fields SUDs project is discussed in more detail below.



Figure 22 Water as a design “asset” in Sheffield: previous projects referenced in research interviews (Map data copyright Google 2018).

As perhaps implied in the reference to water as an “asset” in the quote above, some of these projects prefigure GtG in terms of the reconceptualisation of water as a design feature but also by establishing a connection between improvements in local environmental quality, urban regeneration and economic development. Authors such as Ramsden (1993), Wild et al. (2008) and Rotherham (2012) have noted that the evolving relationship between the city and its waterways is related to socio-economic change; while in the past the rivers were sites of industrial production and waste disposal, following the decline of industrial production they have “re-emerged as a central feature in the region’s urban ecology and even in the new lifestyles of city dwellers” (Rotherham, 2012, 131). The restoration of the rivers has occurred in conjunction with change in the urban economy from manufacturing to one based on “leisure, sport and retail” where “the [River Don] has

become a catalyst rather than a hindrance and waterfront dwellings and offices are now premium locations” (Rotherham, 2012, 136).



Figure 23 Nursery St. riverside park and flood management scheme.

According to Wild et al. (2008, 3), a changing relationship between the city and its rivers, manifest in new forms of urban and landscape design, has been an important aspect of the restructuring of the city’s economy to compete in the “knowledge economy”:

“Enhancements to public spaces and the restoration of riverside environments have been put at the heart of a broader strategy for stimulating economic growth and social cohesion, driven by the need to both provide a high quality of life for skilled and mobile employees in the global knowledge economy... an important developing regeneration theme was therefore to invest in environmental assets and the cultural ‘offer’ to investors”. This approach has been formalised in policies such as the Sheffield Waterways Strategy (Sheffield Waterways Strategy Group [SWSG], 2014) targets for actions such as deculverting which is based on a combination of ecological, social and economic development objectives. According to the strategy (2014, 5), “Sheffield’s rivers can play a major part in making Sheffield a thriving place and competitive city, helping us adapt to climate change [and] improving quality of life”.

One specific previous urban stormwater management project, Manor Fields Park, was referenced by four of the key project stakeholders as a relevant and successful example of combining stormwater infrastructure and landscape design in Sheffield which partially explained the addition of SUDs to GtG. According to one of the project designers:

Over the years we have really tried to embrace SUDs in a lot of the schemes we have done in the past, going back quite a long way into housing area schemes in big park spaces, Manor Fields and that sort of stuff, that one has been established for years.

Manor Fields was developed between 2003-2005 and was planned and designed by the SCC Landscape and Parks Divisions. The project provided stormwater infrastructure for a new housing estate in conjunction with the planning and design of a new park adjacent to the site. Within the park, stormwater was used to create a recreational and visual amenity in the form of a series of ponds and a watercourse while undergoing filtration. Innovative features of the project include the re-imagining of utilitarian stormwater infrastructures as visible and aesthetic features in urban space; according to Nowell and Bray (2005), “[t]he need for drainage of the Park in order to provide better access and recreation opportunities has been carried out with the proviso that water should remain visible... Water was therefore seen as an asset in creating character in the site”. For this reason, the project is regarded as an early practical illustration of the ‘non-drainage benefits’ of SUDs (Sheffield Wildlife Trust & Ponds Conservation Trust, 2002; Kennedy et al., 2007).

The project is also notable because (in a similar manner to GtG) the site is characterised by a landscape aesthetic that “employs few of the traditional forms associated with park design” (Dunnett & Tylecote, 2012, 150). This refers to the retention after its redevelopment of “spontaneous” and non-native vegetation which creates dense and relatively inaccessible enclaves. The potentially ‘challenging’ character of this type of planting has been recognised by the designers. However, Dunnett and Tylecote (2012, 145) argue that it has nonetheless been supported and embraced by most park users and residents because it reflects previous uses of the site and has followed “an incremental approach” which means that “changes in the landscape have developed alongside changes in culture”.

Last, Manor Fields also involved a significant attempt to maximise the social value of SUDs. Prior to implementation, a study by the Sheffield Wildlife Trust / Ponds Conservation Trust (2002) recommended community engagement in design to understand how SUDs could contribute to the aesthetic and amenity value of the park and, further, that the project should deliver broader social benefits through provision of training and employment opportunities. This was translated into the finished project through the establishment of a social enterprise to manage the new park which, according to Nowell and Bray (2005), “means local employment and ownership and the spreading of an understanding of the scheme”.

There have also been attempts to maximise the social and cultural value of other water-related projects in the city. The social value of some projects has been related to their spatial configuration; Wild et al. (2008) highlight the environmental justice case for investment in improving riverside environments in sites of former industrial production, such as the Lower Don Valley, which are some of the most socio-economically deprived areas in Sheffield. In addition, in one research interview, it was highlighted that the Blue Loop and Five Weirs Walk (which are located in these deprived areas) provide valuable recreational amenities but also, as riverside walking and cycling routes, perform the important function of providing safe walking and cycling routes to sites of employment which would otherwise be difficult or expensive to access. The social value of other projects, similar to Manor Fields, relates to the availability of opportunities for formal training and access to employment such as those provided by the River Stewardship Company, a social enterprise established to manage Sheffield’s waterways. Last, in one case, the value of new forms of design and associated community engagement activities were described, similar to Rosenberg (2015), as facilitating the development of a sense of connection to both the surrounding social and ecological environments and an understanding of the degree to which they are interconnected. According to one stakeholder involved in coordinating maintenance activities:

They realise there's more to just looking at a river and appreciating it. It doesn't just look nice because... It's because there's a group looking after it.

The degree to which GtG represents a continuation of the attempt to maximise the social and cultural value of SUDs in a similar manner to Manor Fields and other previous projects in Sheffield is discussed below in Sections 9.2.2 and 9.3.1.

9.2 The design dimension of “Grey to Green”

This section describes some of the terminology, notably the concepts of “layers” and “green SUDs”, used to describe design in the case study project. It also notes the importance of the concept of “innovative design” as well as its potential complexity which is a theme of discussion throughout the chapter. This leads to a finding that the origins of the design agenda are urban regeneration and economic development objectives. More generally, it leads to a diagnosis of a distinctive relationship between design and infrastructure in the case study and, related to this, a discussion of the extent to which the case study relates to the concept of a contemporary infrastructure design imaginary.

9.2.1 “Layers”

Three of the key project stakeholders used the concept of “layers” or “layering” to describe the co-location of different functions in the limited space available. According to one of the project’s landscape designers:

We've tried to maximise it as much as we can and that's the layering approach and thinking about the street and the character of the street, thinking about the biodiversity, thinking about the water management, thinking about the place-making, trying to layer all those different things in a relatively narrow corridor... I think we have managed to really max out the benefits in what is really just a street

As such, layering refers to the combination of different design features such as new public seating, SUDs with added planting and changes to transport infrastructure which are perceived as performing complementary functions. It thereby accords with Selman’s (2009, 49) definition of multifunctionality as the identification of “synergistic effects”. Elsewhere, the terminology of ‘layers’ was explicitly used to describe the relationship between design features and what was identified as the origin or key objective of the project by all of the

project stakeholders, that of urban regeneration (in the sense of facilitating investment in commercial property). According to one of the project's planners:

The origin of the project was regeneration I suppose and then water came in as another layer

[...] We wanted to create a setting for encouraging this investment into the city, to remove these blockages, turn this environment into parts of the access network in the city. What else can we do with it? We can bring some green in to the city, take out the tarmac, and the water question came in as well which was can we make this environment actually a bit more innovative, just be a bit more innovative so kind of layering up, cycle routes, pedestrian routes, gathering spaces.

There are several important features of this quote, one of which is the reference to “innovation”. The identification of GtG as an example of innovative design was common in both interviews and in documentary sources, creating a challenge of understanding what is meant by innovation in this context and why it is perceived as important. One relatively straightforward sense in which the term was used within the project refers to its status as a site of experimentation with SUDs and planting techniques which were regarded as new and untested in an urban setting. One example of experimentation within GtG was the decision to seal a series of swales with an impermeable liner to create a wetland environment. This was perceived as largely unnecessary to the overall project objectives and, instead, as driven by an aspiration to trial different SUDs and planting techniques thereby producing transferable knowledge which could be applied elsewhere in Sheffield. However, beyond this, the concept of innovation referred to complex and overlapping dimensions of the project such as the opportunism of maximising available resources as well as its aesthetic and symbolic significance. In what sense the project might be described as innovative is discussed throughout the rest of the chapter.

A further key feature of the quote above is the reference to “creating a setting for investment”. This concept is derived from a report commissioned by South Yorkshire Forest and SCC (CSI, 2008) which sought to investigate the impact of availability and quality of green space on commercial property investment decisions. The report was referenced by SCC in funding applications for GtG to support an argument that investment in the project would facilitate private developments in the surrounding area and therefore contribute to

achieving the objectives of the City Centre Masterplan (2013a). According to SCC (2015, 6), the project will “address key issues of access and environment which will support and stimulate further investment ... [and] restart a number of strategic stalled development sites along the route”. The description of the origin of the project as regeneration (in the form of commercial property development) was directly juxtaposed in several research interviews with that of flood management; in other words, it was clarified that the scheme’s contribution to reducing flood risk was insignificant as stormwater was not a significant source of flooding or water quality issues (through combined sewer overflows) in the area encompassed by the scheme (see Section 9.1.1).

The description of the project’s origin as regeneration rather than stormwater management requires explanation of the sources of funding for the project and the supporting policy context. The majority of the funding (approximately 60%) was provided by the Sheffield City Region Local Enterprise Partnership (SCR LEP) via the Sheffield City Region Investment Fund with the remainder from SCC and the European Regional Development Fund (ERDF). As described above, the policy context for SCR’s investment in the project is provided by its Strategic Economic Plan (SCR LEP, 2014) and the plan sets out the economic development objectives of the SCR which focus on private-sector job growth in knowledge intensive and high-value industries. The following quote from an SCR planner describes the project’s significance from the SCR’s perspective:

The GtG phase one project was really just a public realm scheme that made an area more attractive. In terms of the sustainable side, whilst that's nice to have we don't have any scoring criteria that looks at that... It's irrelevant what we're funding if you like. We've got some schemes in the programme that deliver roads, we've got some that do public realm works. We're not so bothered about that. It's the outcome of it and it's the jobs that it creates because the whole ethos of the City Region is about job growth, economic growth.

As described here, applications for capital funding from the SCR for infrastructure or regeneration projects such as GtG are assessed entirely on their correspondence with the objectives of the Strategic Economic Plan (2014) which do not include environmental improvements. As such, funding for GtG was provided because it was assumed it would increase the attractiveness of the site for commercial office development, regarded as a

prerequisite for the type of high-value employers targeted by both SCC and the SCR. This arguably provides an alternative perspective on the concept of 'layering'; in other words, it represents an opportunistic strategy of maximising available financial resources through design strategies that performed the basic functions required by this policy framework but also, as described in the quote above, were "a bit more innovative", corresponding to a more ambitious spatial vision on the part of SCC than that presented in the SCR planning framework.

9.2.2 "Green SUDs"

As discussed above, a primary objective of the project was that of regeneration through providing opportunities for commercial property development. This leaves unresolved a question of why this project emerged as a site of innovative design in the sense of incorporating unconventional planting techniques and additional complex stormwater management functions. One entry point to this discussion is the concept of "green SUDs" which was used by several project stakeholders to describe the model of design in GtG, more specifically the combination of wildflower meadow planting with stormwater infrastructure. This was not clearly defined but what is meant by the concept of green SUDs is implied in the following quote from one of the project's landscape architects:

This has been the first phase of really introducing a green SUDs approach to the city... You can't do this on every street so you are limited in some degree [...] [You can do] SUDs on a narrow street because you can use infiltration paving, you know porous pavement, and storage beneath the pavement. You can still achieve SUDs outcomes. You just can't always achieve it in the green manner that we are trying to push.

This quote demonstrates a recognition on the part of the interviewee that SUDs is a flexible or toolbox approach to stormwater management. The approach to design in GtG, featuring above-ground visible structures with associated planting, is compared in the quote with alternative SUDs techniques such as permeable paving which would achieve the same results ("SUDs outcomes"). The interviewee recognises that these techniques are potentially more suitable in urban settings with space constraints but notes that the results would not be "green" in the sense that new areas of planting would not be created. More

specifically, in the case of GtG, such an approach would not have resulted in visible changes to public space and new green spaces which were a prerequisite from the perspective of regeneration. The following quote from one of the project's landscape architects identifies the relationship between the green SUDs model and regeneration objectives:

If we can get SUDs to work in these environments and do it in a way which is green and ground level or surface level, I think it is a massive win for the city centre. I can't think of anywhere in Britain which has done anything to that extent.

This is linked to that fact that the specific type of green spaces created in the case study were identified as the most valuable element of the project from an aesthetic perspective due to the wildflower meadow planting scheme. According to the same interviewee:

[This type of planting is] very floriferous, full of colour throughout the seasons... It has been very successful. It's obviously the big visual thing that everyone sees. You don't want to see the tarmac or [pause] that's the big element.

The degree of importance accorded to the visibility of SUDs can be further illustrated by a conflict between improvements to transport infrastructures and the appropriation of space required for the green SUDs model. As previously discussed, one of the design features, or 'layers,' of the project consists of improvements to cycling and pedestrian infrastructure. However, the value of the finished scheme has been criticised by a local cycling campaign group for its provision of spaces shared by both cyclists and pedestrians rather than fully segregated cycle lanes (see Figure 24) (Cycle Sheffield, 2017). According to one of the project planners, while the need for improved cycling and walking infrastructures was recognised, the realisation of the SUDs in the visible and above-ground manner intended was considered more important:

There was a debate about segregated cycling lanes and SUDs. In order to get the segregated cycle lanes, it would have meant the loss of up to half of the SUDs so... That is one of the critical points...

This highlights the existence of a conflict between infrastructural (in the sense of cycling and walking facilities) and regeneration (referring to SUDs and urban greening) priorities

which was resolved in favour of the latter. This arguably provides the basis to diagnose a distinctive relationship between design and infrastructure in the case study in the sense that design was not understood as a means to mitigate the visual or other negative aesthetic impacts of stormwater infrastructures premised on their functional value. Rather, the SUDs aspect of GtG has been included insofar as it is perceived to complement the project's regeneration objectives and this has resulted in the adoption of the specific green SUDs model. The following sections (notably 9.4.3) argue that the SUDs aspect of the scheme, as well as the planting, also have an important symbolic value and that this is important to understand in what sense the project is innovative.



Figure 24 Shared space for pedestrians and cyclists.

The concept of green SUDs as described here also provides an entry point for discussion of the relationship between GtG and the concept of the contemporary infrastructure design imaginary. This has been described in Chapter 3 as oriented around a set of principles including rendering infrastructures visible which is further linked to attempts to rethink and problematise conventional models of interaction between people and infrastructures. The case study project illustrates superficial parallels with this vision through the emphasis on the visibility of stormwater infrastructures in urban space and the attempt to maximise their visual aesthetic value. However, in reality, the emphasis on visibility is related to a logic of economic development rather than any ecological critique or ecological-political aesthetic. In addition, this contrasts to some degree with previous projects in Sheffield

which, as described in Section 9.1.2 above, have been concerned to a greater extent with exploring the potential social value of SUDs and rethinking how people understand and interact with water and nature in urban space.

9.3 Expertise and the production of “Grey to Green”

An important objective throughout the thesis has been to investigate who designs infrastructure. This has been conceptualised largely as a question of disciplinary expertise and changing disciplinary roles; in other words, what disciplines and associated forms of expertise, rationalities and measures of success are involved in the infrastructure design process and whether this is subject to change. As described in Chapter 3 (Section 3.5), an important normative claim in the literature is that increasing interdisciplinarity and the involvement of non-professional expertise in the infrastructure design process are required for the potential aesthetic value of infrastructure to be realised in any meaningful sense (Salomon, 2017). However, other authors have argued that the construction of cities as sites of experimentation in ecological and sustainable design has been associated with the emergence of a new technocratic elite, albeit composed of different professional disciplines (Karvonen, 2011; Evans et al., 2016; De Block, 2016). Referring to these debates, the following section discusses the different forms of expertise involved in the production of GtG, beginning with an overview of the extent of community engagement and a description of the role of in-house design expertise. A further important feature of the project is the involvement of academic expertise in influencing the project’s landscape aesthetics, which is also closely related to the question of defining in what sense the project can be understood as innovative.

9.3.1 Design and community engagement

In a review of the policies and practices of urban regeneration in Sheffield over the past 15-20 years, Madanipour et al. (2018, 477) argue that “the views of Sheffielders have been to a large extent absent from the debate”. The authors’ critique further intersects with the GtG case study in their assessment of the proposed redevelopment of the Castle Markets site, which the GtG project is intended to facilitate by rendering the surrounding area more attractive for investors (SCC, 2018b), as a riverside park and tourist attraction. This proposal is described as illustrating “a widening social, cultural and symbolic gap” between

the vision of urban design sanctioned in official masterplans and the requirements of the city's residents (Madanipour et al., 2018, 477).

In the case of GtG, there have been limited opportunities for anyone but a small number of professionals, mostly within SCC, to influence the design process and any such opportunities have been limited to local commercial interests. Consultation has been limited through several technical forms of exclusion at both planning and project levels. According to SCC (nd., 24), public support for the project is sufficiently illustrated by the positive reception of the CCMP of 2013 as demonstrated in a consultation process. This "demonstrated very high levels of approval of the proposals at the level of principle" (SCC, nd., 24). However, the proposals for what later became GtG only appear in outline form in the CCMP and did not reference key aspects such as the incorporation of SUDs or the creation of new green space. Further, the masterplan was never formally adopted and was defined as a draft until a new draft for consultation was published in 2018.

At the project level, no further public consultation was carried out prior to construction. Because the scheme was located in what was formerly a road there was no requirement for SCC to seek planning permission which would have allowed some limited public scrutiny of decision-making (Barclay, 2009). Also relevant is the limited and reactive character of other consultation activities and the fact that they were limited to private-sector stakeholders; one further avenue whereby SCC sought feedback and approval for the GtG project was through the Riverside Business District Association (RBDA), a forum for discussion between SCC and local commercial interests. According to two members, the RBDA approved of the project because it was thought it would have a positive effect on the surrounding area through increased development leading to a reduction in the proportion of vacant buildings and, ultimately, to increased property values. However, even such influential stakeholders clarified that they had a limited impact on the development of the proposals which were described by one member as fixed from the outset. Another group which actively participated and attempted to shape project outcomes to improve facilities for cyclists and pedestrians was a local cycling campaign group. However, according to one member, SCC have not been receptive to their input in that or other developments:

Once the council has decided they're going to do something they're not particularly interested in what anyone else thinks

Last, the primary social benefit of the project was described by SCC (2015) as its contribution to improving the quality of the local environment for residents of adjoining deprived residential areas to the North of Sheffield city centre. However, no active steps were taken to consult about the requirements of such potential users regarding either design within the scheme or, equally important, whether investment in another site might be more beneficial.

During research interviews no clear justification was offered to explain this lack of consultation. The argument made by Madanipour et al. (2018) is that a lack of engagement has been characteristic of regeneration in Sheffield over a relatively long period and that this is linked to the forms of expertise involved because plans have often been written by external consultancies. As discussed below, this explanation does not hold in the case of GtG. Although it was not raised in research interviews as relevant to the approach to consultation, a further pragmatic explanation is that conditions attached to the ERDF funding required that the project be designed and built under significant time pressure. This may have precluded any serious attempt to seek feedback and adapt the proposals accordingly.

9.3.2 In-house design expertise

A recurrent topic of investigation throughout the thesis has arisen from a distinction between global and local perspectives on design knowledge; in other words, to what extent are aesthetics and innovative design perceived as specific to a local context or alternatively constituted by globally-relevant ideas and practices. According to Madanipour et al. (2018), some previous failures of urban regeneration in Sheffield are attributable precisely to a lack of place-specific design expertise. The authors (2018, 478) highlight the role of a “transnational class of mobile urban regeneration professionals who, by nature, have weaker insights into local contexts and needs” and are more likely to rely on “off-the-shelf” solutions. In a contrary sense, this distinction was considered relevant to GtG where four research participants highlighted the importance of “in-house” expertise within SCC as explaining continuity with previous projects, such as Manor Fields, as well as providing opportunities for innovation. According to one of the project planners:

You have an element of continuity and ethos... That is quite unique about Sheffield. You have some consistency of approach while trying to do things differently. We always look at the examples from abroad. We always try to look beyond Sheffield to other cities in the UK and outside the UK.

In practical terms, what is meant by continuity was explained as referring to the retention within SCC of a landscape design team, meaning that landscape design was not outsourced. It was highlighted that several key individual actors involved in previous projects such as the Nursery Street and Manor Fields parks were still employees of SCC and their previous experience had influenced the approach of GtG, specifically the incorporation of SUDs. The availability of in-house expertise was also perceived to provide opportunities for innovation because stability of employment was perceived as allowing design strategies perceived as experimental or innovative to be trialled without significant risk in terms of individual career prospects. Further, according to one of the project planners, the availability of in-house expertise allowed “at-risk” work in the preparation of the funding application for GtG which was not charged at full cost because the contract for detailed design would be awarded to the internal landscape design team if funding was secured.

A further topic of discussion in both the literature review and previous empirical chapters has been the interaction between different professional disciplines which have been taken a proxy for different forms of expertise, rationalities and measures of success. In the case of GtG, however, conflict between established disciplinary models of design was not a relevant concern. This can arguably be related to the fact that a relatively small number of actors were directly responsible for design and that they were largely internal to SCC with some exceptions. Along with the regeneration division, the landscape design team and SUDs advisory body within SCC were largely responsible for the GtG project, including both its infrastructural and aesthetic features. As described in the previous section, they had a common set of reference points in terms of previous projects in Sheffield and a shared understanding of what constituted good design as defined by concepts such as layering and green SUDs. Perhaps most importantly, there was a common acceptance of the project’s objective as economic regeneration, thus foreclosing any potential conflict between design and any other priorities.

The findings therefore illustrate both positive and negative aspects to the model of in-house expertise; it has provided for continuity with previous projects and therefore resulted in the inclusion of SUDs. However, the model of in-house expertise can also be linked to a professionalised design process and a tightly defined set of objectives related to economic regeneration. In addition, as a result of this framing, the continuity with previous projects was limited to design outcomes in the sense of physical changes rather than any of their progressive social or cultural objectives (which were previously described in Section 9.1.2).

9.3.3 Role of academic expertise

An important feature of the case study project is the role of academic expertise. In practical terms, this refers to the advice on planting provided by academic staff in the University of Sheffield's Department of Landscape. This was regarded by all stakeholders as important in the development of the low-maintenance but aesthetically attractive wildflower meadow planting scheme. This illustrates the significance of academic expertise in defining the aesthetics of the project or, alternatively, the convergence of academic and aesthetic expertise.

GtG is not an isolated example of the involvement of the University of Sheffield in urban development in the city. Rather, it is one of a series of landscape and urban design projects, both completed and ongoing, produced in partnership between the University and SCC, including others such as Park Square, Love Square (a "pocket park" adjacent to GtG) and proposals for the redevelopment of the Castle Markets site. These are all described as part of the "Engaged" or "Civic University" strategy. According to the University's strategic plan (UoS, 2015, 9), as a civic university it is "proud of its urban character, [and] driving growth and vibrancy for the city, the region and the globe". The University's strategy for Sheffield's city centre, of which GtG is an example, is to promote "city centre vibrancy linking economic action to cultural activity and urban regeneration" (UoS, nd., 25). According to a University staff member, the principles guiding the University's involvement in urban development in Sheffield city centre are "place-making", a "green city" and a "creative and innovative city". The realisation of projects corresponding to these principles were regarded by the same participant as contributing to the University's objectives both to

attract students and to demonstrate the positive impact of research and the relevance of the University to the broader city:

People don't know about all the work the University does in the city. They are not aware of our role. It is important to have a visible demonstration so that it is apparent to everyone what we are doing.

This evidently highlights one further sense in which the visibility of the green SUDs model can be understood as a product of the strategic priorities of the actors involved rather than the expression of abstract design principles or an attempt to rethink relations between people and infrastructure.

From SCC's perspective, the value of the partnership with the University has been its contribution to the development of Sheffield as a "knowledge city" and its "potential to harness academic knowledge and research capacity to analysing and tackling the city's challenges in a more systematic way" (SCC, 2018a, 28). According to SCC's Head of Regeneration, GtG "marks a new level of collaboration between the University and the Council, combining regeneration and applied research on a significant scale" (UoS, 2015, 43). On this basis, the case study can be situated as part of a broader movement documented by authors such as May and Perry (2011; 2016) and Marvin and Silver (2016) towards the involvement of universities in urban development. On the part of universities this is motivated by an imperative to demonstrate the relevance of their research amongst other factors while on the part of cities there is increasing receptivity to such partnerships under pressures to demonstrate their ability to compete in the knowledge economy. As described in the following sections, this literature provides a means to problematise the role of academic expertise through an analysis of how it is judged to have value.

9.3.4 Academic expertise, landscape aesthetics and community engagement

The literature on landscape design notes increasing interest in less-intensively managed or "naturalistic" (Hitchmough & Dunnett, 2004) planting in urban areas as driven by several factors including financial and ecological considerations as well as their aesthetic value when compared to conventional park landscapes such as grassed lawns (Gandy, 2013a). This was equally the case in GtG where three key project stakeholders claimed that the

wildflower meadow planting scheme was justified by its aesthetic value. According to one of the project's landscape architects:

...compared to short mown grass. I mean we did even talk about that at one stage could you do a grass bowl with some bulbs in it for seasonal colour but I think what we felt we wanted something which had a very different feel to that.

However, it is widely recognised that the aesthetic value of challenging forms of urban landscape design, such as “naturalistic” forms of planting, is a complex question (as previously discussed in Section 3.4.3 of Chapter 3). As observed by Gandy (2013a, 274), whether “urban wildernesses” are perceived as aesthetically valuable varies between social groups with “younger, wealthier and better educated people more likely to accept the presence of urban wilderness as an alternative to highly managed landscapes” due to knowledge of their ecological value. In contrast, they may be seen by others as symbolic of neglect and disorder. This issue has been discussed in the landscape architecture literature by authors such as Hitchmough and Dunnett (2004, 8) who recognise that professional interpretations of aesthetics are not universally valid with the latter noting “a tendency for all professional groups and disciplines to believe that their perceptions of worth and beauty are intrinsically valid, and that those who hold different views are at best poorly informed”. As a solution, Hitchmough and Dunnett (2004, 14; 29) suggest that planting “must be strongly informed by aesthetic principles if it is to be understood and valued by the public at large” and, further, that decisions should be informed by “an understanding of the site and of the social, political and biological context”. These issues have informed debates about landscape aesthetics in Sheffield in various ways, most notably because the authors cited above are staff members of the University's Department of Landscape and were directly involved in GtG. The question of the acceptability of naturalistic landscapes also arose in the Manor Fields urban SUDs project where, according to Dunnett and Tylecote (2012), it was resolved by considering the history of the site and the preferences of users and residents. On this basis, the role of academic landscape design expertise within GtG could be assumed to provide an intellectual case for balancing ecological and aesthetic criteria and for the latter to be informed by community engagement in design.

In practice, the approach to planting was described by all of the key project stakeholders within SCC as “designed” in the sense of having taken into account aesthetic preferences

for what urban green space should look like, rather than being wholly dictated by ecological value. This was manifest in various aspects of the planting such as seeking to ensure rapid establishment of the planting after construction by sourcing plants from a nursery rather than relying on natural colonisation and by selecting plants based on their providing visual interest throughout the year. On the other hand, the question of the relationship between design and social or cultural context is unclear due to the limited degree of community engagement in the development of the project proposals as described in Section 9.3.1 above. Insofar as the issue of social acceptability of naturalistic planting was addressed by project stakeholders, it was anticipated that a small minority might object but that this should be regarded as insignificant. According to one of the project's landscape architects:

You'll never keep everybody happy. You'll always get people who say it's just a mess really because they'd rather a bedding scheme... I think the general impression has been overwhelming positive.

However, rather than simply being underpinned by an unquestioned assumption that the planting would be well-received, the evidence also suggests that it was intended to have a particular symbolic value within the project which is important to understand in what sense the project might be defined as an example of innovative design. This is implicitly acknowledged in the following quote from one of the project planners:

The SUDs concept came hand in hand with an innovative planting scheme. We could have grassed the area. We didn't need to do what we did but we worked with the Landscape Department at the University.

The most important feature of this statement is to suggest a particular relationship between the incorporation of SUDs and the approach to planting. As illustrated by the quote, which recognises that alternatives were available, this was not a question of function but rather one of representation. This is equally apparent in the previous quotation from one of the project's landscape architects which highlighted that the planting was intended to evoke a "very different feel" to conventional urban landscape aesthetics. One way in which both SUDs and the planting are discursively connected in the above quotation is in the sense that they both represent "innovation". What is further

significant is the close connection established between the role of academic expertise and the character of the project as innovative. In the section below, this argument is developed by highlighting the ambiguity of the concept of low-maintenance planting which illustrates that, to some extent, the involvement of academic expertise is symbolic as well as being financially-motivated.

9.3.5 Low-maintenance landscape design

A second widely-acknowledged impetus towards new forms of urban landscape aesthetics is financial insofar as it is linked to reluctance on the part of public authorities to dedicate sufficient resources to maintain existing park landscapes (Gandy, 2013a; Hitchmough & Dunnett, 2004). In the case of GtG, it was acknowledged by all of the key project stakeholders that reduced spending on maintenance was one of the primary motivations for the project's approach. According to one of the project's landscape architects:

We want the schemes we are doing these days to be maintainable as cheaply and as easily as possible... We want something you can just hack really. It is not really sensitive maintenance but you still needed to think about horticultural knowledge massively [...] because you need to select species that would tolerate the environment.

This also reflects one further sense in which the term 'innovation' was used within the project as finding ways to manage with reduced resources. At the level of policy this is reflected in the CCMP (2013a, 3) which describes the context of financial austerity as a potential source of innovation in urban development because "such conditions... sometimes favour fresh thinking and innovation". Within GtG, this concept of making a virtue of reduced financial resources is reflected in the description of "innovative low-cost but visually and horticulturally rich planting" (SCC, 2018a, 49).

In terms of maintenance, it is intended that the vegetation will be cut back once annually which was contrasted with weekly or monthly maintenance requirements for other conventional green spaces in the city centre. As indicated above, it was also claimed that maintenance would not require specialist expertise which corresponds to the intention to transfer maintenance responsibilities to a non-specialist contractor. It was highlighted by

one stakeholder that the low-maintenance approach was adapted to the financial context due to the differential availability of funding for capital and current spending. This refers to the fact that available resources could only be spent on capital works to establish the scheme and not for ongoing maintenance. In conjunction with the quote above, this illustrates a reconfiguration of relevant expertise within the project from that involved in ongoing maintenance to specialist ecological knowledge prior to construction. Overall, the evidence demonstrates that part of the new context for design is financial in terms of local authorities' capacity for ongoing spending on maintenance of green space and that this is a primary driver of changing landscape aesthetics.

It is also possible to highlight some contradictory aspects to the concept of low-maintenance landscape design (which in this context reflects an aspiration to demonstrate innovation in the sense of the application of academic expertise) while simultaneously seeking to guarantee the urban regeneration outcomes of the project. This emerged, first, through the recognition that low-maintenance planting is potentially a deceptive concept. This is reflected in a general comment from one landscape architect (who was not directly involved in the project):

A lot of the time you want to use species that require low maintenance because that is what the local authorities require to reduce costs and so on [but] you will have to maintain it, that is one of the other challenges. Designing to low maintenance is very hard because plants are not fixed things, they're all basically a bit out of control...

What is noted here is the difficulty of guaranteeing the long-term outcomes because "nature" has its own logic which is not predictable or fully subject to control and therefore some ongoing maintenance will inevitably be required. A further closely related point was that a degree of flexibility and specialist knowledge will be required to manage GtG. According to one of the project's planners:

*With PFI contracts people just want to see whether or not it is an outcome or a milestone in the contract but it is very difficult to specify so I will say:
'You will cut it in January or February'.
'Well is it January or is it February?'*

'When you think it is right.'

This year, because it was such a mild winter, the maintenance contractor left the grasses for a little bit longer.

More specifically, what is being referred to here are the risks associated with transferring responsibility for management of GtG to Amey, a non-specialist outsourcing company which has been awarded a contract for the maintenance and upgrades of streets in Sheffield. The more general point is the difficulty of wholly rationalising the variability and unpredictability of “nature” within the framework of a contract. While these risks remain in the future, in the interim a three-year contract has been awarded to a specialist management company. As described by the same interviewee:

We have a three-year maintenance contract with a local company. Normally any landscape scheme in the city centre would have a year's maintenance and that would point out the defects but we felt that this was so important... That was an additional cost that we had to bear but we thought it was so critical.

This quote evidently highlights the perceived significance of the scheme. In addition, it illustrates that the success of the scheme, as an example of “innovative low-cost” planting, was perceived as so important that, paradoxically, extra resources have been allocated for maintenance (although precise costs have not been provided). This willingness to invest is in stark contrast with the approach to maintenance of urban green space elsewhere in the city in sites judged to be of less direct economic value which have been threatened by the outsourcing of decision-making to Amey (Monbiot, 2017; Bramley, 2018). This suggests that a short-term financial justification for planting choices is partially relevant but that there are also compelling strategic economic development aspirations related to local economic regeneration and also the broader representation of the city as a site of innovative design.

Returning to the question of academic expertise, as described above the GtG project can be situated in an overall context of changing roles for universities in urban development. However, within this overall framework it can also be distinguished as a specific model of engagement between university and city insofar as the primary objectives of the project have not been knowledge production. It is perhaps more accurately described by Marvin

and Silver's (2016, 53) observation that universities are becoming directly involved in urban development and "blurring the lines between campuses and cities". Elsewhere, May and Perry (2011) suggest that changing relationships between universities and cities have important consequences for how academic knowledge is valued as there are increasing pressures to demonstrate its relevance and immediate utility often via a direct contribution to urban economic development. This trend is also evidenced within the case study insofar as the project's overall scope was limited from the outset to commercial property development and the engagement of academic expertise did not provide any challenge to this framing. Arguably, the addition of value to GtG has proceeded partially through an implicit relationship between academic expertise and the description of the project as a site of innovative design which corresponds to the description by May and Perry (2011, 360) of the transformation of academic knowledge into a symbolic asset. Accordingly, one sense in which this project is innovative is because it represents the visible manifestation of cutting-edge technical and ecological knowledge in urban space, irrespective of its actual contribution to resolving social, ecological or even financial problems.

9.4 Institutional context: regeneration and scale

An important research objective is to disentangle the relationship between design and its structural context, such as its institutional and economic setting. As such, this section addresses the constraints imposed on the scale of design in GtG arising from its institutional context within a local urban regeneration initiative. This also relates to a tension within the broader literature on infrastructure design relating to scale; while some authors perceive an engagement with infrastructure as an opportunity to extend their vision "to the scale of the city" (Carlisle & Pevzner, 2013), others argue that, for infrastructures to be reconciled with urban and landscape design, it is important to develop unique, site-specific and decentralised systems (Lukens, 2013; Rosenberg, 2015). The GtG case study provides the basis for a discussion of this issue through an analysis of the provision of transport and stormwater infrastructures.

The scale of intervention for GtG was defined by the CCMP (SCC, 2013a) as the public realm of the Riverside Business District and this in turn reflected its priority to facilitate commercial property development. As previously discussed, as well as SUDs, the scheme involved the redevelopment of transport infrastructure with a stated aspiration to improve

facilities for cyclists and pedestrians; according to the funding application submitted by SCC (2015), the transport infrastructure changes consist of “active travel on a grand scale”. Further, according to SCC, transport infrastructure upgrades as part of this and other local regeneration initiatives will incrementally contribute to improving the provision of sustainable transport infrastructures throughout the city centre because “each strategic area will also contain elements of a city centre-wide traffic programme introducing 20mph zones [and] improved pedestrian and cycle routes which complement and link them” (SCC, 2015, 3). However, this approach was highlighted as problematic by a local cycling campaign group. According to one member:

If you end up with one little pocket of decent stuff that won't necessarily lead to any increase in cycling numbers so people say what was the point of that. That was a waste of money... [SCC] don't do them as transport schemes; 'we're going to build a route from here to here so it will be quite long and narrow.' They do it as part of a regeneration scheme for that area because that's how they get the funding.

As apparent in this quote, this interviewee highlighted that the current model of incremental provision of cycling infrastructure through urban regeneration initiatives is problematic and potentially ineffective because it creates enclaves of high-quality infrastructure rather than making meaningful, systemic improvements to cycling infrastructure. The same interviewee further noted that the SCR has an objective to increase the proportion of journeys taken by bicycle from 1.5% to 11% by 2025 (SCR, 2017) but argued that this would require a more comprehensive and strategic approach to the provision of cycling infrastructure.

More generally, this example highlights a lack of correspondence in scale between one type of infrastructure, that of transport, and the scale of design as defined by the boundaries of the urban regeneration area. In contrast to transport infrastructure, widely-referenced SUDs principles are that of site-specificity and decentralisation which seemingly correspond with the local scale of urban regeneration. On the other hand, one of the GtG professionals recognised the limitations of linking delivery of SUDs to regeneration and suggested that a more strategic approach was required:

A catchment approach of stewardship of the city where you are evolving localised management of water in the green environment

The broader point highlighted by this interviewee was that relying on regeneration as a driver of SUDs in the current case study was linked to its negligible benefits in terms of reduced flood risk because it was sited in an area at a low risk of flooding from stormwater. The further significance of the quote is the implied contrast with the approach of the case study and its simultaneous suggestion for a more ambitious and transformative relationship between infrastructure and design.

9.5 Summary

Table 9.1 below summarises the key results of the GtG case study and highlights the connections between the case study and analytical framework for the research as set out in Chapter 4 (Section 4.3). Overall, the GtG case study illustrates some limited and partial parallels with the concept of a contemporary infrastructure design imaginary as defined in Chapter 3. However, an explicit social and cultural vision has been notably absent from the design vision. Insofar as the project has sought to maximise the aesthetic value and visibility of stormwater infrastructure through the model of green SUDs, this emerged to fulfil the project's objectives of commercial property development. In addition, the evidence shows a degree of continuity with previous projects such as Manor Fields but with a lesser emphasis on how design could contribute to social value as well as to people's understanding and relationship with water in urban space. One aspect of the project which could be described as challenging conventional perceptions of the relationship between nature and city, is that of landscape aesthetics and incorporation of naturalistic planting in the city centre. However, while in the case of Manor Fields, this was explicitly recognised as requiring the co-evolution of the bio-physical environment and cultural context and therefore interaction between professionals and non-professionals, landscape aesthetics in GtG functioned in a superficial manner as visually decorative and as a visual signifier symbol of a capacity for innovation. This analysis is important because it demonstrates that, contrary to the emphasis on contemporaneity in current literature on infrastructure design, the case study arguably represents a retreat from conceptualising infrastructure design as a social and cultural project.

In terms of expertise, the evidence suggests a tightly-controlled and professionalised design process which allowed little contestation or debate on what might constitute innovation in design. There is little evidence, for example, of divergent institutional or disciplinary logics within the project. This can be attributed to the shared interpretation of the project's remit to "create a setting for investment". Also important is the complex role of academic expertise to increase the visual aesthetic and ecological value of the project, to help SCC work within financial constraints and, last, to provide legitimacy to the claim that the model of design represents innovation. This latter function can be linked to a strategy of promoting the city's ability to compete in the knowledge economy. In addition, there are economic and financial pressures which mean that academic expertise is selectively translated into practice, for example, as illustrated by the discussion of landscape aesthetics and community engagement. In other words, while the intellectual background to the project in the form of previous academic research provided a justification for greater community engagement, this was foreclosed by the financial and institutional context.

The question of the context for design and influences on the infrastructure design process has been approached by exploring the evolution of the approach to design to fit available funding opportunities and the associated objectives of economic regeneration and pressures of competition in the knowledge economy. The major contribution of the chapter has been to disentangle these influences, including how aspects of the cultural and intellectual context for the project, referring to issues such as academic expertise and experiences generated by previous water-related projects in Sheffield, have been selectively reinterpreted and translated into practice. The economic context also accounts for the specific model of design adopted, with the emphasis on layering and green SUDs related to the need for visible changes to public space. The key finding of the chapter is that the model of green SUDs constitutes a distinctive relationship between design and infrastructure; in this model, the role of design is not to mitigate negative aesthetic impacts of infrastructure. Instead, infrastructure has been incorporated into the project and selectively rendered visible insofar as it contributes to various interrelated economic development objectives. The green SUDs model makes a negligible contribution to stormwater management and, in fact, has actively undermined other infrastructural programmes such as improvements in cycling and pedestrian facilities. As such, the model arguably corresponds to what Larkin (2013, 333; 335) describes as the "poetic mode" of infrastructure whereby its symbolic value becomes pre-eminent over its technical function,

therefore allowing Sheffield to “participate in a common visual and conceptual paradigm of what it means to be modern,” or, perhaps more accurately, what it means to be “innovative”.

	Influences on infrastructural development				
	Cultural practices	Material	Who designs and what influences their thinking?		Economic development
Potential influences on design	Are there parallels with the 'contemporary infrastructure design imaginary'?	What forms of infrastructure are the objects of design intervention?	What does design or aesthetic expertise mean in a given context?	How is design expertise recruited and institutionally situated?	What is the significance of infrastructure design from an economic development perspective?
Relevance to the case study	There are superficial parallels. However, infrastructural "visibility" emerged a response to economic regeneration objectives rather than being envisaged as part of a social or cultural programme.	The role of design is not to mitigate the aesthetic impact of new sustainable infrastructures. Equally, conflict over space has not been a driver of the design agenda. Instead, the sustainability focus is important from an economic development because its contributes to image and place-branding objectives.	<ul style="list-style-type: none"> • Interdisciplinarity without community engagement (Karvonen, 2011). <p>GtG was the product of interdisciplinary collaboration but without meaningful community engagement. Equally what 'aesthetics' represents in the project is limited to professionally driven visual and ecological changes uninformed by local priorities.</p>	In-house landscape design and engineering expertise within SCC: This allowed a degree of continuity with previous projects such as Manor Fields but overall contributing to a tightly controlled and professionalised design process with a shared understanding of objectives as limited to the "creation of a setting for investment".	<ul style="list-style-type: none"> • Urban entrepreneurialism: place-branding and property values (Harvey, 1989; Gandy, 2011) <p>The approach to design has evolved fit available funding opportunities and the associated objectives of facilitating property development, economic regeneration and demonstrating an ability to compete in the knowledge economy.</p>

Table 5.1 Connections between the theoretical framework and the GtG case study results

Chapter 10 Conclusions

The initial idea for this thesis was to explore different visions of the relationship between cities and urban technologies or infrastructures as reflected, mediated and defined by disciplines such as architecture, landscape architecture and urban design, and to investigate whether these visions might ultimately exert an influence upon the environment and public spaces of cities. This emerged as a topic of particular contemporary relevance due to an apparent increasing level of attention accorded to infrastructure design and related topics and the emergence of new design manifestos and agendas.

This research topic developed on the idea that the contemporary moment in terms of infrastructure design imaginaries might be potentially distinct due to a combination of cultural, ecological, technological and economic, amongst other, pressures. These included that the adoption of new 'sustainable' infrastructural technologies could be leading to new planning and design challenges by requiring the reconfiguration or even appropriation of space in cities. They included the contemporary relevance of design and the implication that responses to the challenges posed by new infrastructures should meet more exacting standards whether purely in terms of visual aesthetics or, alternatively, by extending the scope of design to consider issues such as the meaning and cultural value of infrastructures or even how people understand and interact with them. Further issues which, it was hypothesised, might be relevant to the research topic included an ongoing process of questioning what is meant by aesthetics and who should be involved in defining its meaning. More broadly, they included the idea that contingent drivers of change would likely be relevant to determining where, why and how new approaches to design are realised, such as the fact that design in various forms is increasingly seen as key to the economic success of cities. Related to this, one of the key motivations for the research has been an aspiration to investigate whose vision of the design of urban space is given legitimacy in debates over the planning and design of new infrastructural spaces.

The development of the research topic reflects an engagement with, and attempt to bridge divides between, two distinct bodies of literature. These are, first, the design literature, referring to normative prescriptions regarding how infrastructures might or should be designed articulated by architectural, landscape and urban design theorists and, second,

the urban political ecology literature both on historic examples of iconic infrastructure design and on the cultural and material significance of contemporary sustainable or green urbanism. Applying insights from this latter body of literature has allowed for a critical interrogation of the first and for a theoretically informed exploration of design practice.

As such, the background to the thesis was a set of ongoing debates regarding how infrastructures might be designed, both in terms of outcomes and processes. Developing on this context, the overall aim of the thesis was to explore contemporary meanings and practices of infrastructure design. This has meant exploring the degree to which contemporary meanings, visions or imaginaries of infrastructure design might be different from previous iterations. Further, it has meant investigating which types of infrastructure come to be designed and why, which of the diverse interpretations of design is adopted and who the infrastructure designer mobilised both in contemporary theory and practice might be, including what forms of expertise they embody. Associated with this aim, the research objectives were:

- to make a contribution to the literature through the development of a conceptual and analytical framework for the investigation of infrastructure and design,
- to provide an in-depth analysis of the infrastructure design process, including the distribution of power to influence its outcomes and the types of expertise involved,
- to explore the value of the concept of a new infrastructure design imaginary for understanding contemporary design practice.

Sections 10.1-3 discuss the key findings of each stage of the research, how the research objectives have been addressed and identify the contributions made by the thesis. For the purposes of drawing conclusions, the thesis is divided into three stages, the literature review, the evolution of the research strategy described in Chapters 5-7, and the reports of the case studies. Section 10.4 elaborates on the significance of the research outside the precise field of empirical inquiry and, last, Section 10.5 highlights possible avenues for future research.

10.1 New meanings of infrastructure design: contributions of the literature review

The research project involved, first, a comprehensive survey of literature which is presented in Chapters 2-4. The review includes literature of different categories including from disciplines such as architecture and landscape architecture which is not conventionally included in social science research. This illustrates both that the research topic is one of interest across different disciplines and that the thesis itself is an interdisciplinary effort situated at the juncture of design and social science literatures.

This stage of the research contributed directly to the first research objective, that of adding to the literature by developing a conceptual and analytical framework for the investigation of infrastructure design. Overall, the literature review points to the emergence of new visions of the relationship between infrastructure and cities or what has been termed a contemporary infrastructure design imaginary. This marks the re-emergence of infrastructure design and infrastructural aesthetics as topics of interest amongst design theorists in specific terms, with attention both to its material configuration but also to questions of meaning, cultural resonance and, particularly, the relationship between infrastructural aesthetics and sustainability. In terms of the overall aim of the thesis, this arguably constitutes a new vision or meaning of infrastructure design.

This imaginary has been defined as constituted by three interrelated principles or shared concerns amongst proponents. These are a critique of the invisibility, both literal and metaphorical, of existing infrastructures, a proposal for a new ecological-political aesthetic and the idea that new forms of design and aesthetic expertise should be involved in the infrastructure design process. The first two principles reflect both parallels and disjunctures with previous approaches to infrastructure design. For example, there are apparent similarities with Schwenkel's (2015, 521) description of a modernist "technopolitics of visibility" as a form of design intended to leverage the cultural resonance of infrastructures for a political purpose. However, the contemporary imaginary is situated in the context of the Anthropocene as a cultural response to challenges of sustainability; it is defined by an assumed relationship between the visibility and aesthetics of infrastructures and how people understand their relationship to "nature". This has proceeded by attempts to rethink and redesign the "interfaces" whereby people orient themselves and interact with complex ecological and technological systems. A final feature is that it emphasises

aesthetic or affective relations with “nature”, as a potential mode of argumentation hitherto neglected in debates over sustainability (Meyer, 2008) and which also provides a framework for justifying the involvement of non-experts in infrastructure design processes (Salomon, 2016).

A second, related finding of the literature review is that this imaginary can be situated as one expression of broader trajectories of reimagining what is meant by the key concepts of design and of infrastructure. In the case of design, this refers to the idea that there is an ongoing expansion in what is regarded as within the remit of design which now extends to intangible processes of interaction and relations between people, infrastructures and nature as illustrated by the identification of the interface as a key object of design intervention (e.g. Cowley et al., 2018) both within the broader design literature as well as that on infrastructure. In the case of infrastructure, this reimagining is illustrated by the emergence of concepts such as “landscape infrastructure” which incorporates a new meaning of infrastructure design as a complex technological-aesthetic vision, in the sense that issues such as aesthetics, symbolic value and meaning are thought to be dependent on the adoption of new hybrid infrastructural systems (Lokman, 2017).

This review of literature has responded to the research objective of developing a consistent and rigorous conceptual and analytical framework for the investigation of infrastructure design. What has been described as the contemporary infrastructure design imaginary is constituted by a diffuse set of intellectual reference points, assumptions and common themes which do not lend themselves to systematic analysis. For this reason, it is difficult to make categorical statements about its degree of novelty. However, the argument has systematised our understanding of one strand of debate on the topic of infrastructure design by identifying and exploring a set of parameters to structure the argument on the novelty of contemporary design imaginaries. In addition, the description of this imaginary has been contextualised in historical terms. Its background and origins have been investigated in detail through the discussion of previous approaches in Chapter 2. This responds to critiques by authors such as De Block (2016), that previous writing on this topic has unquestioningly accepted the novelty of the present moment.

The review of literature also contributed to the development of an analytical framework for the investigation of infrastructure design in the sense of issues to be followed up in the

empirical research. This developed from the identification of a set of ambiguous or problematic features of the contemporary infrastructure design imaginary such as conflicted understandings of design and aesthetic expertise and the concept of challenging aesthetics. The analytical framework was further developed through the outline of the infrastructure design process in Chapter 4. This chapter highlighted the scant literature on the topic and proceeded to draw on related fields in order to construct an outline which could provide structure to the analysis of the empirical material. This further explored whether new pressures might come to bear on the design process through the adoption of new forms of landscape based infrastructure in urban space. Overall, it highlighted the cultural, material, institutional and economic contexts as potentially significant influences on where, how and why new approaches to designing infrastructure might be realised.

10.2 Meanings, practices and locating infrastructure design

This stage of the research refers to the work presented in Chapters 5-7. In basic terms, these presented the methodology, the reports of the nine scoping interviews and a literature review on the topic of stormwater design. However, in combination they present and justify the iterative development of the research strategy which occurred alongside a process of seeking to identify case studies of actually existing design practices which would be accessible to research. As such, they can be viewed as closely related and the findings are presented together.

A key finding of this stage of the research was the variety and inconsistency of meanings and practices of infrastructure design. This encompasses further findings such as the limited and partial relevance of new approaches to design outlined in theory for design practice and the continued hidden character of many forms of design. One important set of meanings and practices which emerged from the scoping interviews was the idea that design is a key means of differentiating products in a market setting which was the dominant model in the field of new transport infrastructures and was associated with a reductive set of measures to quantify the value of design. This corresponds to the argument made by authors such as Kimbell (2011) that the aesthetic, symbolic and creative content of products is perceived as increasingly important or, as stated by Lash and Urry (1994, 15), that “the design component comprises an increasing component of the value of goods”. A second set of meanings and, to a limited extent, practices which were identified

at this stage of the research corresponded more closely to the concept of a new infrastructure design imaginary, albeit in a limited and partial sense. This essentially referred to participants' restatement of principles such as that designers should, similar to the argument of authors such as Carlisle and Pevzner (2013), engage with infrastructure as a means to extend their vision and address ecological problems at a scale not previously attempted or through references to principles such as visibility and transparency. However, this vision of design had limited relevance for practice.

A related finding of this stage, which draws both on the methodology as well as on evidence from the scoping interviews, was that many practices of infrastructure design continue to be hidden or inaccessibly embedded in wider production processes and that the terminology to discuss all aspects of what has been defined as within the remit of design in the thesis seemingly does not exist. This is despite the contemporary interest in theorising infrastructure design as a coherent field. The evidence corresponds with arguments made by authors such as Easterling (2014) that the infrastructure design process is routinised and anonymised meaning that the relationship between the production of infrastructures and the shaping of urban spaces is obscured. However, in one instance, an inverse scenario was also identified whereby infrastructure comes to be labelled as designed. The evidence suggested that, within an overall landscape of anonymity, this may be the result of a selective and strategic process of signposting, for example as a response to conflict or opposition as in the case of one self-identified "infrastructure designer". Evidently, the conventional hidden-ness of infrastructure design is likely to give this signposting additional resonance.

The final finding of this stage of the research was the identification of urban stormwater management as a potential site of innovation in design. There are definite parallels between how the role of design is conceptualised in the infrastructure and stormwater design literatures. In both fields, theorists propose that design should create visual and affective connections between people, water and water infrastructure. This is most clearly attributable to the cultural and intellectual context of stormwater design, such as the existence of an established body of aesthetic theory (e.g. Dreiseitl, 2005b), but can also be linked, following the outline of the infrastructure design process, to a range of material, institutional and economic influences which were subsequently explored through the case study research.

Overall, the value of this stage of the research was its contribution to addressing both the research aim and several of the research objectives: as described above, it described meanings and practices of infrastructure design in terms of the types of expertise involved and the measures used to assess its value. In the course of exploring these issues, the analysis also contributed to addressing the research objectives on exploring the relevance of the contemporary infrastructure design imaginary for practice and, to a lesser extent, some of the circumstances in which new approaches to design might be adopted. A further valuable aspect of this stage of the research was its contribution to locating the field of stormwater management and, by extension, the case studies as outliers within the broader field of infrastructure design.

10.3 The infrastructure design process

The case study stage of the research involved an in-depth investigation of processes and outcomes of infrastructure design in two urban stormwater management projects, that of Hans Tavsens Park and Korsgade in Copenhagen, Denmark and “Grey to Green”, in Sheffield, UK. The case study reports were based on a total of 39 interviews with designers and other professional and non-professional stakeholders, a range of documentary and visual sources and other evidence from informal conversations. The case studies allowed the investigation of abstract design principles to be grounded in specific aspects of the case studies. They also allowed an in-depth analysis of the infrastructure design process, including the range of ideas and other influences relevant to the production of the case study projects. The key findings of each case study are provided in Sections 10.3.1-2 below. Table 10.1 outlines of the connections between the empirical data from both case studies and the analytical framework outlined in Section 4.3. A discussion of how the case study research addressed the research objectives is provided in Sections 10.3 below.

10.3.1 The “Copenhagen Model” and Hans Tavsens Park and Korsgade: key findings

A key finding of the Hans Tavsens Park and Korsgade case study, referring to both Chapters 8 and 9, was that stormwater design in Copenhagen has been conceptualised as a question of aesthetics in various senses of the term. This is linked to the adoption of a new model of surface-level stormwater management and a recognition that this represents both a threat

and an opportunity from an urban and landscape design perspective. As described in the Hans Tavsens Park and Korsgade case study, the basic material context, in the sense of the challenge of appropriating space for new infrastructural uses has been translated into a design question of finding “synergies” between new and established uses of spaces, reflecting the wider emphasis on “multifunctionality” in the infrastructure design literature (e.g. Rosenberg, 2015). A recognition of the design implications of new forms of infrastructure has also led to new forms of professional and non-professional expertise becoming involved in the infrastructure design process such as through the model of “co-creation” although this has not been unproblematic or unambiguously successful.

A further important and related finding of the Copenhagen case study was that stormwater design and aesthetics have been understood in broad terms. This includes questions of visual aesthetic and amenity value. However, it further extends to questions of the symbolic and cultural significance of new infrastructural spaces and to questions of how people might interact affectively and materially with both infrastructures and “nature”. This is further entangled with a specific vision of landscape and urban design aesthetics which is heavily reliant on a vision of greening which foresees different forms of green space characterised by the visible and tangible presence of nature in urban space. Similar to the argument of Usher (2018), this is underpinned to some extent by an idea that leveraging an affective connection with nature might translate into new forms of environmentally responsible citizenship, or what Engelmann and McCormack (2017, 242) describe as new forms of “ethical-political awareness”. The research also generated evidence of some of the contradictions of seeking to create seemingly natural spaces in urban space motivated by attempts to provide an affective connection with nature which, in reality, have significant ecological consequences such as those described in the case of the Korsgade water channel. More generally, this illustrates that despite the emphasis on “synergy” there are trade-offs between different logics within complex infrastructural projects, including between different imaginations of ecological sustainability. It also illustrates the selectivity of practices of rendering infrastructure ‘visible’, practices which, in this case, were refracted through both dominant aesthetic paradigms of urban greening and also evolved as a response to economic pressures.

The specific design vision in Copenhagen cannot be considered wholly a response to either material pressures of the appropriation of space or as a normative ecological-political

vision. Rather, a further key finding is the significance of combined and overlapping institutional and economic influences on the infrastructure design process which intersect with to reinforce or constrain the design vision in various different ways. Relevant influences included the entrepreneurial and “context-free” vision of stormwater design which was supported by strategic stakeholders as a means of positioning the city of Copenhagen as a leader in a global market for climate change adaptation “solutions”. This was also a relevant if not a determining influence on the Hans Tavsens Park and Korsgade case study.

A related finding is that the most significant and pervasive economic influence on design in the Hans Tavsens Park and Korsgade project was the idea that the project should contribute to place-branding through creating the image of a strong community oriented around ‘green’ community-based activities. This was arguably both reframed and reinforced through the project’s institutional setting within a local regeneration programme and represented a response to the perceived socio-economic and cultural polarisation of the case study site. Further, it provides an example of what is meant by the complex entanglement of the overall design vision and its broader context. For example, the emphasis on visibility of water and nature in urban space in the Hans Tavsens Park and Korsgade can be understood both as an expression of the normative ecological-political vision described above, as a response to local demands for increased provision of urban green space or, alternatively, it can be situated as an outcome of economic pressures to facilitate property speculation, potentially amounting to an example of the model of “green gentrification” which has been observed elsewhere in Copenhagen by Cucca (2017) and Roy (2018). As such, to paraphrase Roy (2018), the project represents the outcome of a combination of progressive socio-ecological and entrepreneurial pressures.

A further key finding was that the aspirations for co-creation and the engagement of non-professionals in the design process were constrained by a range of different influences. Amongst these was the high-profile character of the project and the aspiration to produce an iconic design which resulted in the emphasis on new, disordered landscape aesthetics, a feature which had ambiguous support amongst local stakeholders. Another constraint was the overall framing of the project, as described above, as involving a vision of aesthetics which relied on urban greening and the participation of residents in sustainability themed social activities. This can be linked to participation in formal consultation activities being

limited to privileged socio-economic groups. Last, certain problematic features of the project can also be linked to questions of professional expertise, specifically the adoption of epistemologies of design which reject the idea of predetermined correct solutions (Cowley et al., 2018; Cowley, 2018) and rather see design as “reconfigurations of the existing rather than radical invention of the new” (Munthe-Kaas & Hoffman, 2017, 287). This was reflected in the self-perception of urban regeneration staff as opportunistically seeking to secure support for local priorities by reinterpreting them in order to match overarching urban agendas. In some instances, these priorities were reinterpreted to the extent that they did not fulfil residents’ demands, such as in the example of the outdoor classrooms. While representing an example of the designer as the “cautious Prometheus” admired by Latour (2009, 1), this also involves a fatalistic acceptance that certain powerful actors should retain an ability to determine the overall framework within which designers operate.

10.3.2 “Grey to Green”, Sheffield

A key finding of the second case study of “Grey to Green” was the reconceptualisation of stormwater infrastructure as a design ‘asset’, in the sense that its primary value was its contribution to economic development. This was manifest most clearly in the fact that the function of stormwater infrastructure in the project was to provide the central design feature for an urban regeneration programme. This implies a distinctive relationship between infrastructure and design in the sense that SUDs structures were included in the project insofar as they contributed to a design or regeneration vision rather than due to their contribution to water management.

A related finding was that the precise model of “green SUDs”, referring to the combination of surface-level water management structures and naturalistic planting, emerged wholly as a response to urban regeneration requirements and other economic pressures rather than, for example, as the outcome of balancing infrastructural and regeneration requirements. In fact, the evidence suggested that it actively undermined the realisation of improvements to cycling and walking infrastructure. The green SUDs model performed the important function of creating visible improvements to the aesthetics of public space which was required in order to improve the aesthetic value of the area and was conceived as a means to attract investment in commercial property development. The visibility of the project

performed the additional functions of manifesting the role of the University of Sheffield in informing urban development in the city and providing an example of the city's capacity for "innovative design" which can be situated as a response to the pressures of competing in the knowledge economy. Albeit in a very different historical and geographical context, the function of infrastructural visibility in the "Grey to Green" case study parallels Schwenkel's (2015, 521) concept of the "technopolitics of visibility" in the sense that the value of infrastructure in this instance is wholly symbolic and spectacular rather than contributing to resolving ecological or social problems. The model can, further, be distinguished from that of the contemporary infrastructure design imaginary. While both incorporate an aspiration to leverage the symbolic and affective power of infrastructure, in the case of "Grey to Green" this has not been linked to problematising or rethinking relations between people, infrastructure and "nature".

Finally, in terms of the forms of expertise involved in the design process, one notable feature of the case study was that it represented both continuity with and divergence from previous examples of water-related urban and landscape design in Sheffield. From one perspective, this illustrates the value of in-house expertise within SCC which provided for a degree of continuity with previous projects. On the other hand, the project involved a less ambitious approach to exploring the social value of water and water infrastructure than these previous examples, which was reflected both in the organisation and structure of the infrastructure design process and in its outcomes. Regarding the design process, although it involved a multidisciplinary collaboration of ecological, planning, engineering, landscape design and academic expertise, this did not lead to democratisation or the involvement of non-professionals. This corresponds with the locally-specific argument made by Madanipour et al. (2018) that the approach to urban design in Sheffield has typically lacked public input and failed to respond to citizens' needs. It also reflects the broader argument made by Karvonen (2011) that increasing interdisciplinarity in ecological design can coexist with technocratic management approaches. These procedural issues are reflected in the case study in an understanding of design as limited to the production of spaces which are visually attractive, are sustainable in technical terms and, most importantly, create opportunities for economic development.

	Influences on infrastructural development				
	Cultural practices	Material	Who designs and what influences their thinking?		Economic development
Potential influences on design	Are there parallels with the 'contemporary infrastructure design imaginary'?	What forms of infrastructure are the objects of design intervention?	What does design or aesthetic expertise mean in a given context?	How is design expertise recruited and institutionally situated?	What is the significance of infrastructure design from an economic development perspective?
Relevance to the empirical results	There is a significant body of evidence of new infrastructure design imaginaries, including aspirations to make infrastructure visible premised on an idea of 'cultural sustainability'. Overall, the analysis shows that these parallels are partly the outcome of contingent material, institutional or economic factors rather than resulting wholly from a changing cultural context.	Stormwater management is a key site of innovative infrastructure design. This is partly due to the possibilities available to rethink relations between people and nature in urban space. It is also due to the need to find ways (both rhetorical and real) to manage conflicting demands on the use of space. Last, it is due to the opportunities offered by new stormwater management systems to contribute to contingent urban agendas for greening and, by extension, to regeneration and economic development. This has resulted in the selective interpretation of the idea of making infrastructure visible, with (often superficial) greening as the dominant aesthetic.	The evidence shows conflicting models of aesthetic expertise from expert-led to more democratic. Incorporating aesthetics as an objective within infrastructural projects does not necessarily result in more democratic decision-making. A discursive commitment to community engagement has not been translated into reality. Further, the case where most progress has made, that of HTPK, illustrates the challenges of community engagement because one affluent, powerful group has had most influence.	The thesis identified a distinctive model of 'infrastructural regeneration', referring to the coordination of projects to deliver new stormwater infrastructures through existing urban regeneration programmes. This represents the formalisation of the idea of synergy between new 'green' or 'sustainable' infrastructures, regeneration and a (closely related) design agenda. This institutional context was a key determinant of the models of decision-making in both case studies including what degree of community engagement was possible and which economic development priorities which were pursued.	Linked to the model of 'infrastructural regeneration', some form of urban entrepreneurialism has been a key influence on both case studies. This has extended from local attempts to boost property development and promote green regeneration to place-branding at the urban space. The emphasis on economic development is linked to expert-led design processes and to visions of design which do not correspond to the needs of communities.

Table 10.1 Connections between the analytical framework and the evidence from the case studies

10.3.3 Objectives and contributions of the case study research

The major contribution of the case study research, and of one of the key contributions of the overall research project, is its in-depth investigation of the infrastructure design process as presented in Chapters 7-9 on Copenhagen and Sheffield. This directly addressed two of the research objectives: first, to provide a detailed understanding of the infrastructure design process and, second, to explore the relationship between the contemporary infrastructure design imaginary and practice.

Within the wider field of infrastructure studies, many aspects of development and management are described as being blackboxed, referring to their inaccessibility to researchers or any other form of scrutiny. The case study research has opened some of these processes to investigation. It adds to a small number of previous studies in the stormwater, infrastructure design or landscape infrastructure literatures which focus on design not as a foregone conclusion, but rather explore the process, the roles of the actors involved and the range of influences relevant to design. In this thesis, the investigation developed on the outline of the infrastructure design process provided in Chapter 4 which identified a range of cultural, material, economic and institutional influences relevant to providing a situated account of infrastructure design. This outline later provided themes for analysis of the evidence collected and the range of influences on design have been discussed in the findings of each case study. Within the case studies, the investigation has encompassed diverse influences from the intentions of designers and the minutiae of funding agreements to broad trajectories of socio-economic change at the urban scale. Evidence from the in-depth case study research demonstrated the complex and indeterminate character of the infrastructure design process which emerged as a messy amalgam of different actors and influences. Further, the case studies demonstrated the impossibility of identifying a singular designer and, instead, found that there were diverse constituencies of actors concerned with aesthetics and design in various forms.

The second objective relevant to the case studies has been the investigation of key facets of the approach to design in each case study in order to understand their relationship to what has been defined as the contemporary infrastructure design imaginary. This has not been an esoteric exercise but rather a means to connect features of the case studies to the broader literature, providing context and grounds for analysis or critique. This evidently

developed on the literature review in which this imaginary was defined. Within the case studies, it involved detailed investigation of specific features of the design vision and of the intentions of designers which, similar to the argument made by Gandy (2013a), emerged as useful but unreliable guides to understanding the projects' reality. Overall, the evidence suggests the limited and partial relevance of this imaginary for practice. It was most apparent in the Copenhagen case study insofar as stormwater design in that instance incorporated an aspiration to create affective connections between people, infrastructure and "nature", while the example of "Grey to Green" provided very superficial parallels.

More generally, it is difficult to categorically attribute any specific aspect of the approach to design in either case study to one singular theoretical or cultural current; many features, including those which seemingly correspond to the contemporary infrastructure design imaginary, can equally be understood as influenced by some aspect of the institutional or economic setting for design. This latter point is best illustrated by the reconceptualisation of the infrastructural landscape of Hans Tavsens Park as an educational space which resulted from an opportunistic alliance between designers and the division of the Copenhagen local government responsible for funding educational facilities. This further led to a recognition that in both cases seemingly avant-garde design agendas have co-evolved with and in some instances directly supported, socially and cultural exclusive processes of transformation.

The in-depth analysis of the infrastructure design process represents a significant contribution to the two primary bodies of literature with which the thesis has engaged. These are, first, that on landscape infrastructure and infrastructure design more generally and, second, the urban political ecology literature concerned with the ideological and rhetorical significance of infrastructural aesthetics. In terms of the contribution to the landscape infrastructure and design literatures, this in general terms to the addition of a set of detailed empirical case studies to a body of literature which has hitherto been composed of speculative proposals and manifestos or, where case studies are used, by conclusions informed solely by the author's judgement rather than that of those involved in or affected by a given project. More specifically, the contribution made by this research to the landscape infrastructure literature includes the mutability of the common idea of making infrastructures visible or transparent. The results showed that rendering infrastructures visible is not straightforward but is rather a selective process of

representation which involves making choices about what should be emphasised or aestheticized, with a tendency to over-emphasise visually the 'green' rather than 'grey' infrastructural underpinnings of new 'sustainable' infrastructures. This relates to a further contribution which is that design theorists should consider how their ideas might be (re)interpreted and manipulated by other actors during the process of implementation, and more broadly, that there is a need to incorporate social scientific concerns for power and politics into the literature on infrastructure design.

The case study research also directly contributes to the urban political ecology literature through its analysis of the politics of infrastructural visibility in the contemporary moment. The development of the research topic was directly influenced by works such as Kaika and Swygedouw (2001), Kaika (2005), Gandy, (1999; 2003; 2011) and Schwenkel (2015) which analyse the ideological function of visually impressive, iconic examples of infrastructure design in Victorian and modernist cities. These authors argue that the ideological function of making infrastructures visible was previously about manifesting narratives of social progress through technological development and domination over nature. One of the key contributions of the thesis has been to update this account by analysing the politics of infrastructural visibility in the contemporary moment. The results demonstrate that there are obvious parallels with Victorian and modernist infrastructure design through a shared rhetorical commitment to making infrastructures 'visible', 'transparent' and understandable and because contemporary infrastructure design is a similarly carefully constructed project of image-making. However, rather than dominating nature, contemporary examples of high-profile and innovative design are oriented towards representing the city as being in harmony with the natural world. The thesis demonstrates that this is the outcome of often convergent economic, cultural and political, amongst other, trends but a recurrent feature has been the significance of economic drivers of the adoption of green design strategies, both for local property development and through place-marketing at the urban level to brand cities as sites of innovative design, creativity and sustainability. In summary, the thesis should be regarded as a significant contribution to the urban political ecological literature on infrastructure design due to this combined identification of new infrastructural aesthetics and the often entrepreneurial urban strategies driving its adoption.

10.4 Significance of the thesis

The thesis has value outside the specific field of empirical research, that of stormwater design in relatively affluent cities of the Global North. It has implications for understanding design across different fields of infrastructure and in different geographical settings, of sustainable city imaginaries and, more broadly, highlights the value of aesthetics as an avenue to critique neoliberal urban management.

The findings and argument of the thesis are relevant to various types of infrastructure, most obviously those with a real or rhetorical connection to 'sustainability' but extending to any example where conflict takes place on the terrain of aesthetics and closely related questions of the 'correct' relationship between technologies, nature and society. Within the sphere of architectural and design theory, there is an ongoing attempt to reimagine the place of nature in cities, a development which is both necessary and urgent. However, the thesis has aimed to explore the complexities and political function of visions of future cities infrastructures which leverage aesthetics and therefore could be used to justify the re-appropriation of space for infrastructural uses. The thesis shows that claims of design benefits, multi-functionality or an assumed connection between landscape or green infrastructures and aesthetics made by design theorists or others should not be accepted without question. Neither should it be accepted that a transition from infrastructure being the domain engineering expertise to one in which aesthetic experts have greater influence, will necessarily translate into outcomes which are better from a social or ecological perspective. To counteract these assumptions, the thesis has identified a number of avenues for inquiry and critique which could be applied to interrogate the infrastructure design process in many different sectors. These include the idea that the adoption of new design imaginaries which value 'visibility' seemingly often relates to conflicts over the appropriation of space, that it is important to understand the politics of expertise in infrastructure projects and question whose interpretation of aesthetics is given legitimacy and, last, that there is a direct economic rationale for certain expert-led approaches to design, the primacy of which should be questioned. As such, the thesis improves our understanding of the origins and implications of infrastructural and broader sustainable urban imaginaries which leverage aesthetics as part of their rhetorical appeal.

The thesis also has implications for planning and design in cities outside the Global North. The majority of the empirical research has been concerned with the design of infrastructures represented as typologies which could be standardised and transferred to different geographical contexts. This is underpinned by an assumption that design visions emphasising urban greening with a social subtext favouring environmentally conscious citizenship are equally transferable. One relevant example is the frequently referenced idea that Copenhagen represents an example to be followed in the planning and design new stormwater management systems or “Sponge Cities” in China (e.g. Feng et al., 2017). There are obvious flaws in this reasoning. First, it is based on an idealised view of stormwater design in Copenhagen which, as highlighted in this thesis, does not un-problematically fulfil the promise of social, ecological and economic benefits. Second, new infrastructures, for example ‘nature-based climate solutions’, are often constructed as discreet technologies and not as public spaces or landscapes which would require consideration of aesthetics. When questions of aesthetics are granted attention, they are often constructed as a further dimension of new infrastructures which is subsumable to rational and technocratic management. This is linked to the emergence of a global market in consultancy services in urban sustainability and, associated with this, a transnational class of experts whose legitimacy derives not only from technological and ecological expertise but also from a presumed mastery of aesthetics. These findings should be taken into account when arguments are made for the international transferability of infrastructures and associated forms of landscape and urban design. Overall, the significance of the thesis for cities outside the Global North is to highlight that claims of the unqualified success of sustainable or landscape infrastructures should be closely scrutinised and the assumptions regarding expertise which underpin their transferability should be challenged.

Overall the thesis was motivated by an aspiration to critically interrogate current imaginaries of the future of cities in the context of climate change and other environmental challenges, of which infrastructural change is one important dimension. This entailed exploring what are primarily elite perspectives on future urban development with a view to understanding their affective appeal, resonance and utopian horizon. What it has revealed is the superficiality of elite visions of urban transformation, in many of which “nature” plays a visually decorative role unrelated to real change in the relationship between cities and their resource bases and unresponsive to the real priorities of local communities, both aesthetic and otherwise. These superficial visions arguably exemplify the tendency of

neoliberalism to try to monopolise ideas of creativity and pleasure while, in reality, holding out the prospect of empty and unsatisfying spectacles (Dean and Fisher, 2014). This leads to recognition of the need to for a more meaningful definition of aesthetics and for an affirmation of residents' right to "aesthetic justice" (Foster, 2010, 319).

10.5 Future research

Overall, the key contributions of the thesis are, first, that it has described a field of research on the topic of infrastructure design, developing a conceptual and analytical framework for its investigation, and, second, that it has added to our understanding of the infrastructure design process through its detailed investigation of the case study projects. At the same time, due to constraints of time and resources, the thesis has only provided an outline of a much broader field and it has required a series of choices which have affected the scope and direction of inquiry. As such, there are a range of avenues for future research which remain to be explored.

First, the description of what has been termed a contemporary infrastructure design imaginary is based on a survey of literature which is evidently not comprehensive, there is an emphasis on novelty which arguably risks overstating the distinctiveness of the present moment and the analysis has focused on one strand of debate within the literature on infrastructure design. As such, there is a further opportunity to develop more detailed and nuanced understandings of different and, perhaps, conflicting visions of the relationship between cities and technology. This might ultimately respond to the urgent task of both understanding and articulating visions of urban futures which are both (aesthetically) attractive, and therefore might garner popular support, as well as being meaningfully sustainable (e.g. Aldana Cohen, 2017).

Second, the evidence collected is derived from a set of case studies in a specific field of infrastructure, that of stormwater management. An obvious avenue for future research is to apply the conceptual and analytical framework developed in this thesis to different fields of design practice beyond stormwater management. In addition, this field and the case studies were arrived at following the iterative development of the research strategy as previously discussed. A range of implicit assumptions and the characteristics of the author were important influences in this process. This refers especially to the author's response to

the interpersonal and social challenges of researching a topic in the unfamiliar professional and social environment of design practices and amongst professional designers in the scoping phase of the research. Future research might be able to approach these challenges differently and to open up to investigation some of the design processes which have been described as hidden.

Last, in both case studies, the sample of interview participants was largely limited to professionals and other stakeholders with a formal role in the design process as had been set out in the initial research design. As has been discussed throughout, it emerged that significant constituencies of local residents and other citizens were unrepresented both in formal consultation mechanisms and in the evidence collected. Results should therefore be taken as partial and as reflecting the intentions of designers rather than definite outcomes or how the projects will ultimately be interpreted by their as-yet-unidentified users. This simultaneously constitutes a significant research gap which is the investigation of how new infrastructural landscapes are used, understood and experienced and whether these practices correspond to or exceed the intentions of designers.

END

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Appendices

Appendix 1 Design practices and other firms contacted in scoping phase

		Relevant Projects	Country
1.	SWA Landscape	"Landscape of Automation" (SWA, nd.)	USA
2.	Terreform One	Post-carbon city state: rezoned circular economy	USA
3.	Michael Singer Studio	Infrastructure design guidelines (ED & MS Studio, 2007)	USA
4.	Heatherwick Studio	BEI Teesside waste-to-energy plant	UK
5.	Bjarke Ingels Group	Amager Bakke waste-to-energy plant	Denmark
6.	Amager Resource Centre	Amager Bakke waste-to-energy plant	Denmark
7.	Priestmangoode	"Moving Platforms"	UK
8.	Ooze Architects	Emscher wastewater treatment park, Germany	Germany
9.	James Corner/ Field Operations	Fresh Kills Park, NYC	USA
10.	The Living	Pier 35 EcoPark, Living Light	USA
11.	Fries and Moltke	Dublin waste-to-energy plant	Ireland
12.	Habiter Autrement	Stockholm Energy Systems	France/Sweden
13.	Costain		UK
14.	Landolt + Brown	Crossrail	UK
15.	HS2 Design Panel	HS2 Design Review	UK
16.	Barber and Osgerby	Crossrail	UK
17.	National Infrastructure Commission		UK
18.	Foster + Partners	Fuel Station of the Future (Howarth, 2016).	UK
19.	Hawkins Brown	Crossrail – "Platform for Design: Stations, art and public space"	UK
20.	IBA Hamburg	Energiebunker	Germany
21.	FFBK	Datacube, Basel	Switzerland
22.	Studio Egret West	London Underground Design Idiom	UK
23.	Allies and Morrison	Abbey Mills Pumping Station (Design Council, 2012)	UK
24.	Gensler	The London Underline	Multinational
25.	AECOM	Dublin waste-to-energy plant	Multinational
26.	AKT II	Birmingham New Street Station	UK
27.	Infrastructure Planning Unit - Planning Inspectorate		UK
28.	HeHe	Nuage Vert (Evans, 2008).	Finland
29.	TIPSlab	Parkades of the Future (TIPSlab, 2014).	Canada
30.	Atkins	Journeys of the Future (nd.)	Multinational

Appendix 2: Scoping phase interviewees

	Professional role	Reason for requesting interview	Country	Date	Duration
1	Design consultant	Coordinator of design reviews for infrastructure projects in different sectors	UK	March 2017	00:36
2	Architect/ academic researcher	Community-led design including within rail projects	UK	Sept 2016	00:34
3	Architect/ academic researcher	Director of an academic/design research institute, researching the impact of low-carbon transport technologies on urban space	Canada	Aug 2016	00:47
4	Design consultant/ academic researcher	Design review (architecture and urban design) for major urban rail projects	UK	Jul 2016	00:41
5	Landscape architect	Landscape architect in a practice specialising in new approaches to infrastructure design including waste management and energy facilities.	USA	Dec 2016	01:21
6	Transport planner	Contributor to report on future transport technologies and urban space	UK	Oct 2016	00:45
7	Design consultant in transport sector	Contributor to report on future transport technologies and urban space	UK	Nov 2016	
8	Manager and transport technology consultant	Author of reports on transport automation, 'mobility-as-a-service' and urban design	UK	Nov 2016	00:31
9	Architect/ academic researcher	Architectural historian and author on topic of infrastructure design	UK	Oct 2016	00:29

Appendix 3 Sample interview schedule: scoping phase

1. What does the idea of infrastructure design mean to you?
2. What does innovative design mean in this context?
3. In your experience, do designers have the scope to significantly improve the results of projects?
4. In projects you have been involved with, how have the designers been recruited?
5. As a designer, what aspects of infrastructure projects are you concerned with?
6. In your experience, do you think the approach to design within infrastructure projects is changing?
7. If so, what do you think is driving the adoption of new approaches to design?
8. Do you think the adoption of concepts such as design thinking by the private-sector is leading to new approaches to infrastructure design.
8. If new approaches to design are adopted, who do you think benefits from them?
9. What do you think are the barriers to better design standards?
10. In fields that you are interested in, are there any examples of innovative infrastructure design that you are aware of?
11. Are there any particular cities that are adopting new approaches to design?

Appendix 4 Sample interview schedule: Hans Tavsens Park and Korsgade

1. Could you describe your role and everyday work?
2. What is the most important aspect of this project from a design of aesthetic perspective?
3. Could you describe how the designers were recruited?
4. Do you think the competition led to the best possible design being selected?
5. Have there been any examples of conflict between the water management function of the project and its design or aesthetic aspects?
6. There is a very distinctive model of landscape design in the stormwater projects in Copenhagen including visible water and wild nature, what do you think are the influences leading to this model being adopted?
7. Are there any tensions between the city's requirements in terms of creating a new stormwater system and what the residents in the area want?
8. Do you think the fact that the project is being organised by the Omradefornyelse is an important influence?
9. Could you describe your understanding of how funding is divided between the Omradefornyelse and HOFOR?
10. Do you think this medfinansiering system is working well?
11. How would you describe the social environment in this area?
12. Could you describe the role of the project group in the project?
13. Do you think the project is meeting the needs of all of the residents here?
14. What does the idea of cocreation mean in this project?
15. What are the challenges to implementing cocreation in practice?
16. Is there anyone else that I should speak to?

Appendix 5 Sample interview schedule: Grey to Green

1. Can you describe your role and everyday work?
2. Could you describe the background and objectives of the Grey to Green project?

3. Who was responsible for the landscape design?
4. What do you think is the most important aspect of the project from a design or aesthetic perspective?
5. Were there any examples of conflict between the water management function of the project and its design or aesthetic aspects?
6. Are there any guidelines on design or aesthetics that you looked at?
7. Are there any other cities or projects that you regard as examples to follow?
8. How did the University of Sheffield become involved in the project?
9. What was the impact of the Landscape Department's involvement?
10. Who were the other important stakeholders in the project?
11. What methods were used to inform or engage the public with the project?
- 12.. What benefits do you hope the project will have?
13. What arrangements for management or maintenance have been put in place?
14. Did the maintenance contractor have any influence on the design process?
15. Is there anyone else that I should speak to?

Appendix 6 Hans Tavsens Park and Korsgade interviewees

	Date	In person or Skype	Role	Duration	Repeat interview?
1.	Aug 2017	In person	HTPK project group member/community representative	01:25	Y
2.	Aug 2017	In person	HTPK project group member/community representative	00:34	Y
3.	Aug 2017	In person	HTPK project planner	01:07	Y
4.	June 2017	Skype	Architect/urban designer and member of team competing in the Nordic Built Cities Challenge	00:55	N
5.	June 2017	Skype	Architect and member of team competing in the Nordic Built Cities Challenge	00:55	N
6.	June 2017	Skype	Researcher on stormwater management in Copenhagen	00:32	N
7.	June 2017	Skype	Researcher on urban sustainability in Copenhagen	00:36	N
8.	June 2017	Skype	Hydraulic engineer in HTPK project	00:53	N
9.	May 2017	In person	HTPK local resident	00:25	N
10.	May 2017	In person	HTPK project group member/ representative of local schools	00:42	N
11.	May 2017	In person	Landscape architect responsible for Tassigne Plads project	00:52	N
12.	May 2017	In person	Norrebro local sustainability officer	01:02	Y
13.	May 2017	In person	HTPK project group member/community representative	00:55	Y
14.	May 2017	In person	HTPK project planner	01:12	Y
15.	May 2017	In person	Landscape architect and member of a team competing in the Nordic Built Cities Challenge competition	00:36	N
16.	May 2017	In person	Landscape architect and member of a team competing in the Nordic Built Cities Challenge competition	01:19	N
17.	April 2017	Skype	Engineer (member of one of the three teams in Nordic Built Cities Challenge)	00:50	N
18.	April 2017	Skype	HTPK project group member/community representative	00:49	Y

19.	April 2017	Skype	Engineering consultant (representative of one of the three teams in Nordic Built Cities Challenge)	00:31	N
20.	April 2017	Skype	Green economy consultant	00:49	N
21.	March 2017	Skype	Nordic Built Cities Challenge coordinator	00:38	N
22.	March 2017	Skype	Ecological consultant involved in Tassigne Plads project, contributor to stormwater design guidelines for Copenhagen (KK & SLA, 2016)	01:06	N
23.	Feb 2017	Skype	Planner in local regeneration agency for Tassigne Plads	00:52	N
24.	Feb 2017	Skype	Planner involved in development of Copenhagen stormwater management strategy	01:05	N
25.	Jan 2017	In person	Community representative involved in planning of Tassigne Plads project	00:54	N
26.	Jan 2017	In person	Architect involved in development of Copenhagen stormwater management strategy	00:45	Y

Appendix 7 Site visits to Hans Tavsens Park and Korsgade, Copenhagen

	Date/Duration	Data collection activities
1	Five days (January 2017)	<ul style="list-style-type: none"> • Research interviews (2), including one key policy-maker in Copenhagen local government involved in the formulation of the stormwater management plan • Initial site visit to HTPK • Site visits to other existing and proposed stormwater management projects: Tåsinge Plads, Lindevangsparken, Sankt Annæ Plads and Enghaveparken
2	Two weeks (May 2017)	<ul style="list-style-type: none"> • Research interviews (8) • Participant observation and site visits • Collection of visual evidence (photos)
3	Ten days (August 2017)	<ul style="list-style-type: none"> • Follow up research interviews with three of the most important participants and stakeholders • Participant observation: the site visits was planned to coincide with the Nørrebro urban gardening open week which allowed attendance at community events and conversations about ecology and urban development in Nørrebro and about the management of community spaces.

Appendix 8 Grey to Green Interviewees

	Date	Role	Duration
1.	Aug 2017	Sheffield City Region Combined Authority planner with responsibility for infrastructure funding applications	00:41
2.	Jul 2017	University of Sheffield representative	00:32
3.	Jul 2017	Landscape architect/SUDs designer with experience of working in Sheffield (not directly involved in GtG)	00:59
4.	Jul 2017	Ecologist/planning consultant with experience of working in Sheffield (not directly involved in GtG)	00:45
5.	Jul 2017	SUDs engineer with experience of working in Sheffield (not directly involved in GtG)	00:36
6.	June 2017	Member of Riverside Business District Association and representative of local commercial interests	00:21
7.	June 2017	Member of Riverside Business District Association and representative of local commercial interests	00:34
8.	June 2017	Representative of Cycle Sheffield, a sustainable transport campaign group	00:27
9.	June 2017	SUDs designer and planner with experience of working in Sheffield (not directly involved in GtG)	00:58
10.	June 2017	Ecological consultant with experience of facilitating community involvement in management of waterways in Sheffield (not directly involved in GtG)	00:41
11.	April 2017	SCC landscape architect and member of the GtG project team	01:38
12.	April 2017	SCC planner and member of the GtG project team	00:55
13.	March 2017	SCC SUDs engineer and member of the GtG project team	00:44

Appendix 9 Documentary and visual sources for the Hans Tavsens Park and Korsgade case study

Source	Translation required?	How identified?
Bydelsplan for Nørrebro 2017 – 2020 (Nørrebro Lokaludvalg, 2017)	Y	Literature and policy review
Climate Adaptation Copenhagen (SLA & Ramboll, nd.)	N	Literature and policy review
Cloudburst and Culture (Effekt, 2017)	N	Referenced by interview participant
Competition programme: Copenhagen Denmark – Cloudburst and Culture: Renewal of Hans Tavsens Park and Korsgade (KK & NI, 2015)	N	Literature and policy review
Copenhagen Climate Change Adaptation Plan (KK, 2011)	N	Literature and policy review
Copenhagen Cloudburst Management Plan (KK, 2012)	N	Literature and policy review
Det Gode Naboskab - Boligsocial Helhedsplan for Indre Nørrebro 2013-2016 (FSB, 2013)	Y	Literature and policy review
Dommerbetænkning: Nordic Built Cities Challenge: Hans Tavsens Park, Blågård Skole og Korsgade (ON, 2016)	Y	Referenced by interview participant
Fællesskab København (TMF, 2015)	Y	Literature and policy review
Indre Nørrebro Kvarterplan 2014-2020 (ON, 2014)	Y	Referenced by interview participant
Jury statement: “Cloudburst and Culture”: Renewal of Hans Tavsens Park and Korsgade in Nørrebro (TMF, 2016a)	N	Literature and policy review
Konkretisering af Skybrudsplan: Nørrebro 2013 (Ramboll, 2013a)	Y	Referenced by interview participant
Nordic Built Cities: Competition details and criteria (Nordic Innovation, nd.)	N	Literature and policy review
Ny klimakonkurrence (Third Nature, 2016)	Y	Literature and policy review
The Empowerment of Aesthetics (Andersson, 2014)	N	Referenced by interview participant
The Soul of Nørrebro (SL, nd.)	N	Literature and policy review
Urban Nature and Climate Change Adaptation (KK & SLA, 2016)	N	Referenced by interview participant
Vandselskabers finansiering af klimatilpasning (KFST, 2016)	Y	Referenced by interview participant
Vinderprojekt for skybrudsløsninger på Nørrebro kåret (TMF, 2016b)	Y	Literature and policy review

Appendix 10 Documentary sources for the Grey to Green case study

Source	How identified?
An innovative partnership response to the management of urban river corridors – Sheffield’s River Stewardship Company (Wild et al., 2008)	Referenced by interview participant
Creating a Setting for Investment: Project Report (CSI, 2008)	Referenced by interview participant
Enhancing ruderal perennials in Manor Fields Park, Sheffield (Tylecote & Dunnett, 2012)	Literature and policy review
Grey to Green, Sheffield: An Introduction (SCC, 2016)	Literature and policy review
Integrating Sustainable Urban Drainage Systems (SUDS) into inner city regeneration schemes in Sheffield (Sheffield Wildlife Trust & Ponds Conservation Trust, 2002)	Referenced by interview participant
Introduction to naturalistic planting in urban landscapes (Hitchmough & Dunnett, 2004)	Literature and policy review
Managing Household Run-off in Public Open Space: A case study on the new district park for Manor – Sheffield (Nowell & Bray, 2005)	Referenced by interview participant
National Flood Resilience Review (DEFRA, 2016)	Literature and policy review
SCRIF Stage 1A: Full Business Case (SCC, 2015)	Referenced by interview participant
SCRIF Stage 1A: Outline Business Case (SCC, nd.)	Literature and policy review
Sheffield City Centre Masterplan 2013: Consultation Draft (SCC, 2013a)	Referenced by interview participant
Sheffield City Council Executive Leader Report 19 th August 2014 (SCC, 2014)	Literature and policy review
Sheffield Flood Risk Management Strategy (SCC, 2013b)	Literature and policy review
Sheffield Waterways Strategy (Sheffield Waterways Strategy Group, 2014)	Literature and policy review
Sheffield's Lower Don Valley: recession and regeneration (Ramsden, 1993)	Literature and policy review
Strategic Plan 2015-2025 (UoS, 2015)	Literature and policy review
Sustainable Urban Drainage Systems (SUDS) – More than a Drainage Solution (Kennedy et al., 2007)	Literature and policy review
The River Don: a linear urban wildscape (Rotherham, 2012)	Literature and policy review
This is Sheffield: Our City Centre Plan 2018-2028 (SCC, 2018a)	Literature and policy review

Appendix 11 Coding schedule for data analysis: scoping phase

Themes	Codes
Design visions: visibility and interactivity	References to idea that infrastructure is not /should be visible
	References to idea that infrastructure should not be visible/is intrusive or aesthetically negative
Sources of ideas	Links to academic knowledge and design theorists
	Community engagement or participation in design processes
	References to recruitment of design expertise
Influences on the design process	Questions of funding and sources of investment
	References to changing or new context for infrastructure design
	Design as a financial asset in a market context
	What are the drivers of innovation?
	What are the barriers to innovation?
	Technological change as an influence on design
	Urban context or setting as an influence
Existence of opposition or resistance to conventional approaches to design	
Disciplinary divisions and expertise	References to design expertise and capacities of the designer
	Existence of competing disciplinary logics
	Design as design-thinking, service design, product design
Significance of sustainability	What is meant by 'multifunctionality': to what extent is it linked to ecological sustainability?
	What types of infrastructure are referenced as sites of design intervention?
Definition of design	Professional expertise, characteristics and sector of practice of participants
	Design as design-thinking, service design or product design
	What terminology used to describe design or aesthetics

Appendix 12 Coding schedule for data analysis: Hans Tavsens Park and Korsgade

Themes	Codes
Decision-making and distribution of agency	Nordic Built Cities competition and decision-making
	Role of the HTPK project group
	Disciplinary divisions and professional cultures: references to different approaches linked to disciplines
	Synergies or conflicts between local priorities and the urban agenda
	Role of the local regeneration agency
Contested aesthetics	Terminology for issues related to design and aesthetics: terms used to understand the design dimension of HTPK
	Idea that aesthetics should/should not 'challenge' perceptions of beauty or sustainability
	Acceptability of wild nature
	Acceptability of visible water or water infrastructure
Defining the "Copenhagen Model"	Copenhagen and international reputation as leader in green climate adaptation
	Copenhagen and industrial development/exporting sustainable solutions
	What are identified as the drivers of change towards adoption of new approaches to adaptation
	Design competitions: What are the strengths and weaknesses
	Design expertise and skills of designers: why is 'design' important within the Copenhagen Model
Complexity of the HTPK project	Factual uncertainties and inconsistencies between respondents
	References to level of complexity of the HTPK project
Conflicting logics with in the HTPK project	Synergies/conflicts between the urban regeneration and climate change adaptation agendas
	Infrastructural logics: need for standardisable or replicable solutions
	Infrastructural logics: need for coordinated planning of entire network rather than piecemeal development
Design vision: visible infrastructures	Education and infrastructure: references to idea of infrastructure as having educational value
	Visibility of water and water infrastructure
	Fablab: function and origins
Competing models of sustainable design and connections to expertise	Social innovation or co-creation: interpretations
	References to barriers to inclusive/participatory design
	References to positive/negative examples of inclusive/participatory design
	References to success and how success might be defined
Sources of ideas for design	Connections to academic knowledge
	Sources of ideas for design within HTPK

Norrebro: local social and ecological context	Attachment to and significance of the existing park
	Gentrification and changing demographics: in the past and possibility of future change
	Housing: pressures on housing including regulation of housing market
	Inequality and marginalisation in Norrebro
	Priorities of residents
	Need for social integration including through green social activities
	How community spaces are/would be managed

Appendix 13 Coding schedule Grey to Green

Themes	Codes
Design vision and aesthetics	Terminology used to describe design or aesthetics
	Environmental education or significance of visible infrastructure
	Aspiration for disordered landscape aesthetic and/or visible water
	References to costs of creating 'natural' landscape in the city
Sources of ideas	Desire for innovation
	What is the role of the University of Sheffield Landscape Department
	Sheffield previous examples of landscape and water-related design
	In-house design and significance of the SCC landscape design team
	Role of communities and participation
Influences on the design process: economic development	Reference to Riverside local development context and aspirations
	What do local businesses want?
	SCC's role as a facilitator of development
	What are the project's objectives and what are the criteria for success?
	Linkages to Castlegate regeneration
Influences on the design process: financial context	Maintenance and management
	Funding for design: process of accessing funding through SCRIF
	Financial context as an influence on planting choices
Other influences	Policy context for SUDs in Sheffield or other pressures related to flooding
	Community opposition or resistance to economic development logics
Expertise	How is legitimacy of design expertise established?
	What is the role of academic knowledge
	References to conflicting disciplinary perspectives
Existence of material or technological pressures	Cycling infrastructure and allocation of space for pedestrians and cyclists
	Concept of linear regeneration in Sheffield and implications for cycling
	Existence of constraints on available space