BUILDING ADAPTIVE CAPACITY TO FLOOD RISK IN PHILIPPI, CAPE TOWN, THROUGH INFRASTRUCTURE-LED PLANNING INTERVENTIONS

Rose T.T. Mtuleni

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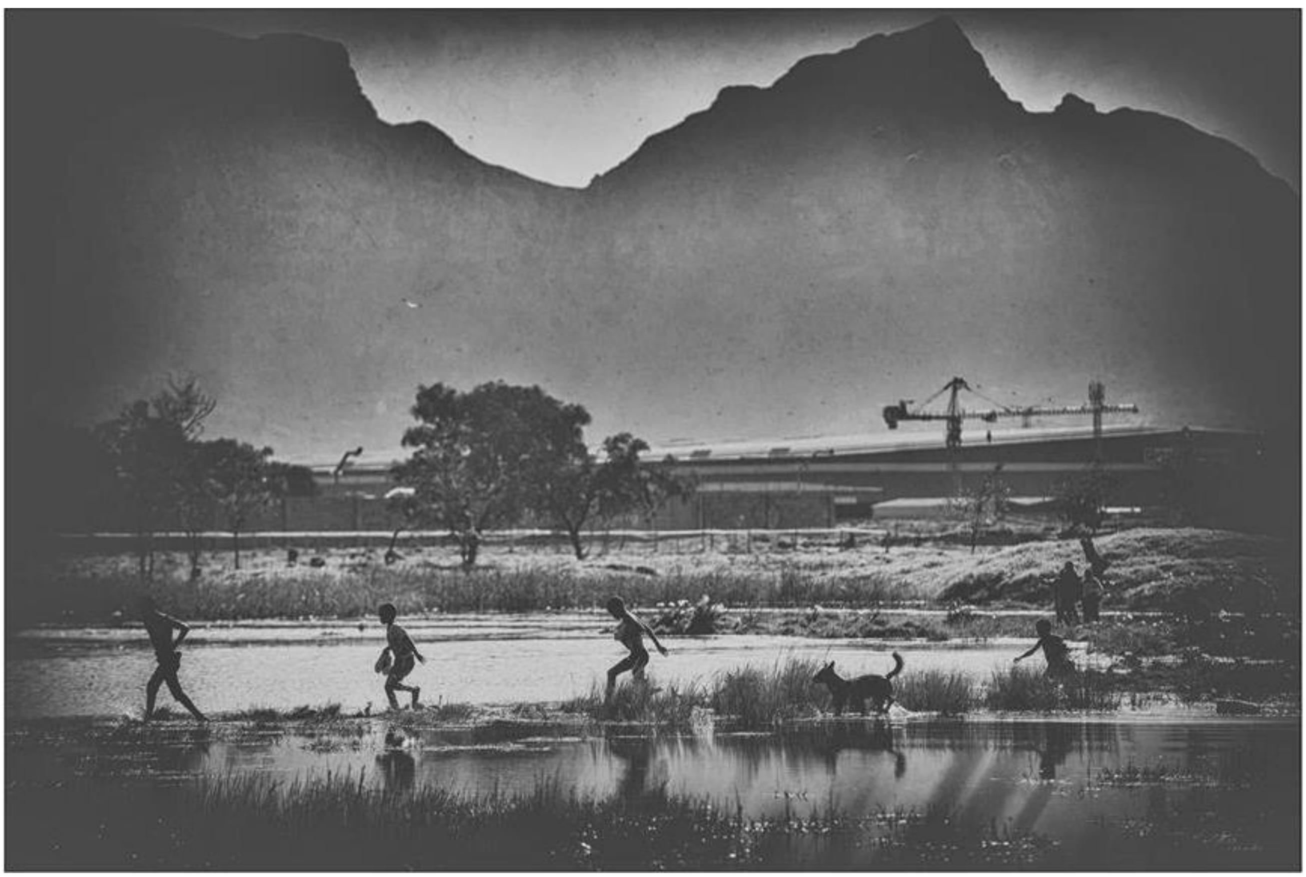
"The great ecosystems are like complex tapestries – a million complicated threads, interwoven, make up the whole picture. Nature can cope with small rents in the fabric; it can even, after a time, cope with major disasters like floods, fires, and earthquakes. What nature cannot cope with is the steady undermining of its fabric by the activities of man."

Gerald Durrell



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Abstract

There is a global trend of increase in urban population growth rates. Much of the population growth occurs in cities of developing countries, with high percentages of the populations living in informal settlements on the peripheries of cities. The often unplanned expansion of cities is increasingly exposing a large number of urban residents and economic assets to disaster risk. The City of Cape Town (CCT) is no exception to the rapid expansion of informal settlements. Heavy winter rainfall leads to flooding in Cape Town, with severe flooding impacts mainly manifesting in low income settlements. Flooding occurs due to the natural setting of Cape Town, and due to lack of adequate water-related infrastructure in some parts of the city. Although infrastructure interventions for flood risk reduction have had some success in reducing flood impacts in some parts of Cape Town, much of the local government response to flooding disasters has been reactive, short term and generally not designed to effectively support informal settlements. The township of Philippi is highly impacted by flooding events, which often compromise the township's safety and public health, and destroy livelihood assets, leaving adverse impacts on local livelihoods.

This dissertation uses Philippi as a case study to assess and investigate how an infrastructure-led planning approach to flood risk can provide solutions and contribute to building better adaptive capacity to flooding, for a rapidly growing population exposed to flooding and lacking adequate water infrastructure services. Utilizing policy review, key informant interviews, Census data, geospatial data mapping and observation, this study identifies the major impediments to enhancement of flood resilience through infrastructure planning in Philippi. It explores the opportunities and potential that Philippi has to set precedent for flood-resilient developments in Cape Town. A Spatial Flood Resilience Framework is presented as a spatial planning tool providing an infrastructure-led planning approach to flood risk and guiding decision-making towards effectively making Philippi more flood-resilient. The study highlights the need for risk-informed local plans to reduce disaster risk in Cape Town and identifies collaborative governance as a significant aspect of the planning and implementation processes for flood risk reduction, as it integrates different actors in working towards a common agenda. This study aims to identify and improve the role of urban planning in moving towards flood resilient neighbourhoods in Cape Town. The study highlights the role of planning in ensuring that development avoids or mitigates flood risk, and identifies flood resilience as a valuable aspect of the spatial quality of a city. Enhancing flood resilience is an essential premise for the facilitation of development in areas of disaster risk and a major step toward socio-spatial justice in the city. The research conducted for the study contributes to the Global South research base and provides a possible precedent for future spatial development plans regarding flood risk in cities of the Global South.

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Abbreviations and Acronyms

CFA	Cape Flats Aquifer
CFR	Cape Floristic Region
CCT	City of Cape Town
CTSDF	Cape Town Spatial Development Framework
FSEPTT	Flood and Storms Emergency Planning Task Team
IDP	Integrated Development Plan
LAP	Local Area Plan
NEMA	National Environmental Management Act
PHA	Philippi Horticultural Area
SFRF	Spatial Flood Resilience Framework
SPLUMA	Spatial Planning and Land Use Management Act
SUDS	Sustainable Urban Drainage Systems

CHAPTER ONE

1. INTRODUCTION

1.1 Context and Purpose of Study

There is a global trend of increase in urban population growth rates, and more than half of the world's population lives in cities today (The World Bank, 2011). The current global urban population of around 3.9 billion is expected to grow to around 6.34 billion by the year 2050 (Swilling, 2016; Kanter, 2016). Much of the population growth is expected in cities of developing countries, where more than 1.2 billion urban residents already live in informal settlements, and this number is expected to grow rapidly (The World Bank, 2011). Rural-urban migration is a major contributor to the expansion of low-income settlements in cities (See Figure 1), as new residents and the urban poor living mainly in informal settlements tend to reside in areas of high disaster risk (Smith & Petley, 2009). The rapidly occurring and often unplanned expansion of cities is increasingly exposing a large number of people and economic assets to disaster risk (The World Bank, 2011). According to the UN-Habitat (2007), Africa and Asia have the highest urban population growth rates globally. More than 61% of the urban population in African cities lives in informal settlements on the peripheries of cities, and at the same time have the fastest rate of increase in natural disaster incidences (UN-Habitat, 2007; Swilling, 2016)

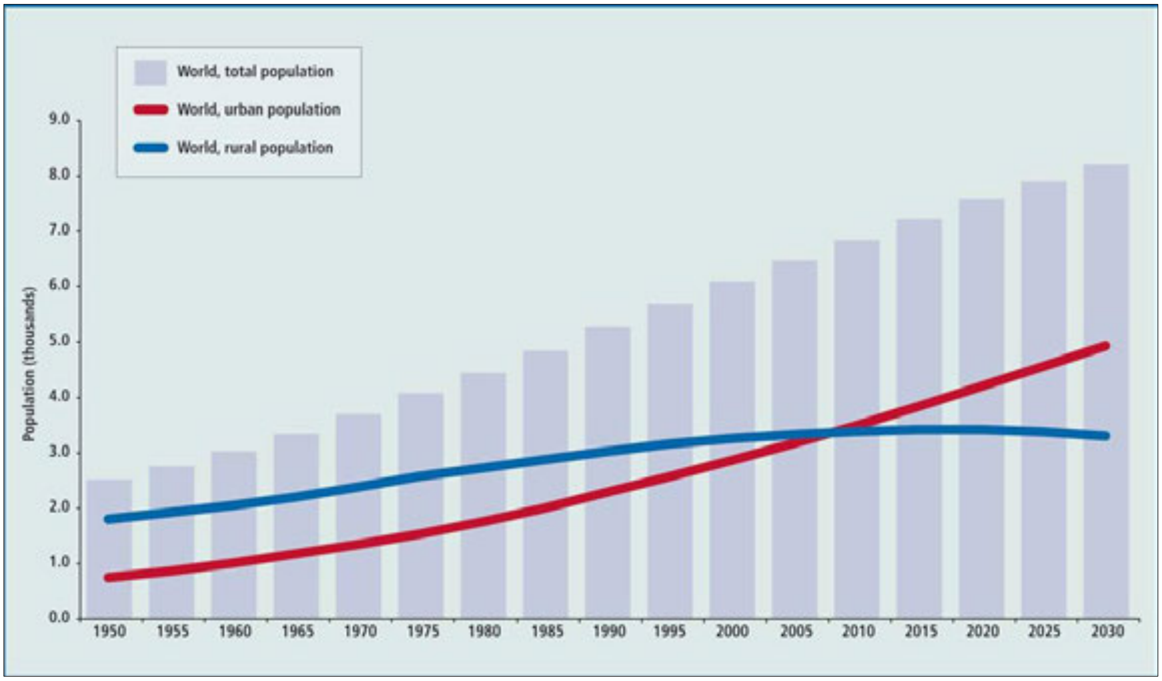

Figure 1, The urban and rural population of the world, 1950-2030 (Kanter, 2016)

The City of Cape Town (CCT) is no exception to the rapid expansion of low income settlements, and rural-urban migrations contribute greatly to the increase in the population of Cape Town. A large number of the migrants have settled in informal settlements because they cannot afford decent housing (Musungu, et al., 2012). Most of Cape Town's informal settlements are located in the south east of the Cape Town Metropolitan area, on the Cape Flats, which is a low-lying, poorly drained area subject to heavy rainfall induced flooding. Urbanization, driven by high in-migration on the Cape Flats has disrupted natural drainage patterns and increased stormwater run-off, making the area more prone to flooding. Fifty six informal settlements in Cape Town, most of which are located on the Cape Flats, have been identified by the CCT as having a high flooding risk (Ziervogel & Smit, 2009). Many of these settlements are located on land that is not suitable for settlements, such as floodplains or wetland areas (Bouchard, et al., 2007). Philippi is one of the largest townships in the Cape Flats. A large percentage of Philippi's population is affected by heavy winter rainfall events that lead to flooding in the area. Flooding events compromise safety and public health, destroy livelihood assets, and produce adverse impacts on livelihoods of the residents of Philippi (Bouchard, et al., 2007). The risk of flooding has been a growing concern on the Cape Flats as a region and in Philippi as a township, particularly in informal settlements. Urbanisation has intensified, and the population is growing and settling on high flood risk land. Climate Change is expected to exacerbate the current flood risk in Philippi through changes in extreme events and flooding intensity (Douglas, et al., 2008).

Although infrastructure interventions for flood risk reduction have had some success in reducing flood impacts in some parts of Cape Town, much of the CCT's response to flooding disasters has been reactive and short term (Ziervogel & Smit, 2009). Current flood risk management techniques implemented by the CCT are not designed to effectively support informal settlements (Musungu, et al., 2012). The CCT's efforts to proactively reduce flood risk and flooding impact in informal settlements have been less effective, predominantly due to institutional and governance constraints that result in a focus on narrow technical solutions (Ziervogel & Smit, 2009). Ziervogel & Smit (2009) suggest that it is essential to enhance adaptive capacity and strengthen flood risk management capacity for improved long term adaptation to flood risk.

Adaptive capacity building involves establishing and reinforcing a system's ability to adapt to change (Adger, 2003). Adaptive capacity is context-specific, meaning that its value and nature varies from one environment to another, in communities and to different individuals over time (Smit & Wandel, 2006). In order to focus on how the urban planning profession can contribute to enhancing adaptation options for flood risk in this study, additional definitions of adaptive capacity building and planning, relevant to flood risk management presented in literature will be also used. The increasing intensity of urbanisation and climate change effects on flood risk in Philippi requires exploration of adaptation options and implementation of sustainable solutions to flood risk. The diversity of land use in Philippi could be perceived as an opportunity for innovative flood risk management solutions that can make Philippi an exemplar of flood-resilient townships in Cape Town.

Appropriate infrastructure and sustainability of infrastructure planning in the CCT is seldom engaged with at the level required (Swilling, 2006). The CCT has shown consideration for flood risk in Philippi at municipal and district level through policies such as the Municipal Disaster Risk Management Framework (Pillay, 2006), the Cape Town Spatial Development Framework (CTSDF) (2012), and the Khayelitsha-Mitchells Plain-Greater Blue Downs District Plan (2012). These existing policies contribute to informing and guiding decision-making in terms of new developments within the city. However, there is still a great need to evaluate settlements in more depth at a local level to ensure that infrastructure investments in Cape Town are effectively targeted to areas of greatest need. It is important that disaster risks are identified and managed accordingly to prevent losses that have severe implications on the quality of life, safety and economic performance of cities (The World Bank, 2011).

This dissertation, therefore, aims to investigate ways in which an infrastructure-led approach to planning interventions can help improve adaptive capacity to reduce the impact of flooding in Philippi. The main objective of this study is to identify and improve the role of planning in moving towards flood resilient neighbourhoods in Cape Town. This study focuses on investigating the social, physical and economic limitations to long term and proactive infrastructure interventions aimed at building adaptive capacity to flood risk in Philippi. The study also focuses on exploring proactive infrastructure-led planning strategies and how they can effectively be incorporated in flood risk management systems to provide solutions for adaptation to flood risk in Philippi. Hereafter, the dissertation proposes a Spatial Flood Resilience Framework that is a planning tool to guide decision-making towards effectively making Philippi more flood-resilient.

1.2 Ethical Position

Many informal settlement residents in South Africa experience fires, flooding, and other environmental health risks as daily chronic risks. Due to unforeseen and sometimes anticipated factors and triggers, these risks can easily upscale to local emergencies (Holloway & Roomaney, 2008). Severe storms are a common occurrence during the winter season in the Western Cape, and Cape Town has seen thousands of low-income residents evacuated from their homes due to flooding. Exposure to flooding in the informal settlements of Cape Town is a function of location of dwellings (typically in areas unsuitable for settlement development), poor design of dwellings, and insufficient formal stormwater drainage. The distribution of flood risk in Cape Town is one of many aspects that demonstrate how spatial injustices continue to be rooted in the physical and social structure of the city, which has been formed through decades of uneven development and service delivery.

Uneven developments need to be engaged and challenged on both social and spatial terms within the city. The philosophical position which underpins this dissertation is, therefore, that development priorities ought to be aimed at parts of the city which are lagging in access to services and opportunities to promote socio-spatial justice. Disaster risk resilience within the city is only one of many aspects of spatial quality values that may contribute significantly to achieving socio-spatial justice. Disaster risk may be a significant barrier to spatial intervention, therefore it needs to be addressed with urgency to increase resilience and relieve affected areas of the hazards associated with disaster risk. Enhancing risk resilience is an important basis for the facilitation of development in areas of disaster risk and a major step toward socio-spatial justice in the city. It is essential that city design and planning has considerations for disaster risk and long-term visions to ensure that its environment and residents are safe and healthy, and that people's livelihoods are sustainable, and remain intact and able to improve without destruction by disaster. Development that seeks to achieve socio-spatial justice needs to have considerations for uncertainties in economic status and ecological systems in order to enable sustainable development of communities and infrastructure, and sustainable economic growth.

1.3 Scope of Study

The scope of this dissertation is limited to flood risk because of the growing population of low income residents of Cape Town located in areas prone to flooding. Flooding is a frequent occurrence in many parts of Cape Town, but different parts of the city are affected in different ways and the poorer communities are the most affected by flooding. This study focuses on building adaptive capacity to flooding, and recognizes flood resilience as a step towards more sustainable livelihoods in Philippi.

This dissertation focuses on an infrastructure-led perspective and approach to planning in enhancing and improving responses to flood risks to improve the adaptive capacity to flooding in Philippi. The dissertation identifies drainage infrastructure as an important aspect of the urban environment and a vital informant of spatial planning for long term flood resilience in Philippi. The purpose underlying this approach is to explore ways in which planning can influence infrastructure development and service delivery to reduce the risk of flooding in areas such as Philippi.

This dissertation has a spatial focus on the township of Philippi only, but the study recognizes the broader context of the location of the site of interest, which includes surrounding neighbourhoods, aspects of the city that may be relevant to the location and study, and the impacts of the study to the city at large. Philippi Township is located in the southeastern part of Cape Town, and on the northwestern part of the Khayelitsha-Mitchells Plain District. The site is surrounded by the Philippi Horticultural Area (PHA) on the west, the township of Nyanga on the north, and Mitchells-Plain on the south. The eastern end of the site is narrow and bordered by the N2 road (Figure 2). Philippi is frequently affected by flooding due to heavy rainfall and inadequate drainage infrastructure (Figure 3).

This site was chosen because it is one of the largest townships in Cape Town, and its rapidly increasing population is made up of a large number of low-income residents, who are vulnerable to flooding impacts. The Philippi Township is located adjacent to the PHA, which is an essential part of the city's food production system, and on the Cape Flats, which is underlain by the Cape Flats Aquifer (CFA). These may be seen as opportunities in terms of water-related infrastructure interventions and planning, to promote sustainable water use and enhance flood resilience in Philippi. The choice to focus on only one township and its attributes for the study allows for a detailed perspective and approach to investigate how infrastructure planning interventions can build better adaptive capacity to flooding, for a township with a rapidly growing population. Since adaptive capacity is context-specific, this scale also allows for an in-depth understanding of the effects of flooding at a local (township) level. Thus, making it easier to have deeper insights into the flooding disaster in Philippi to draw on, and thereafter have better responses to flood risk in Philippi.

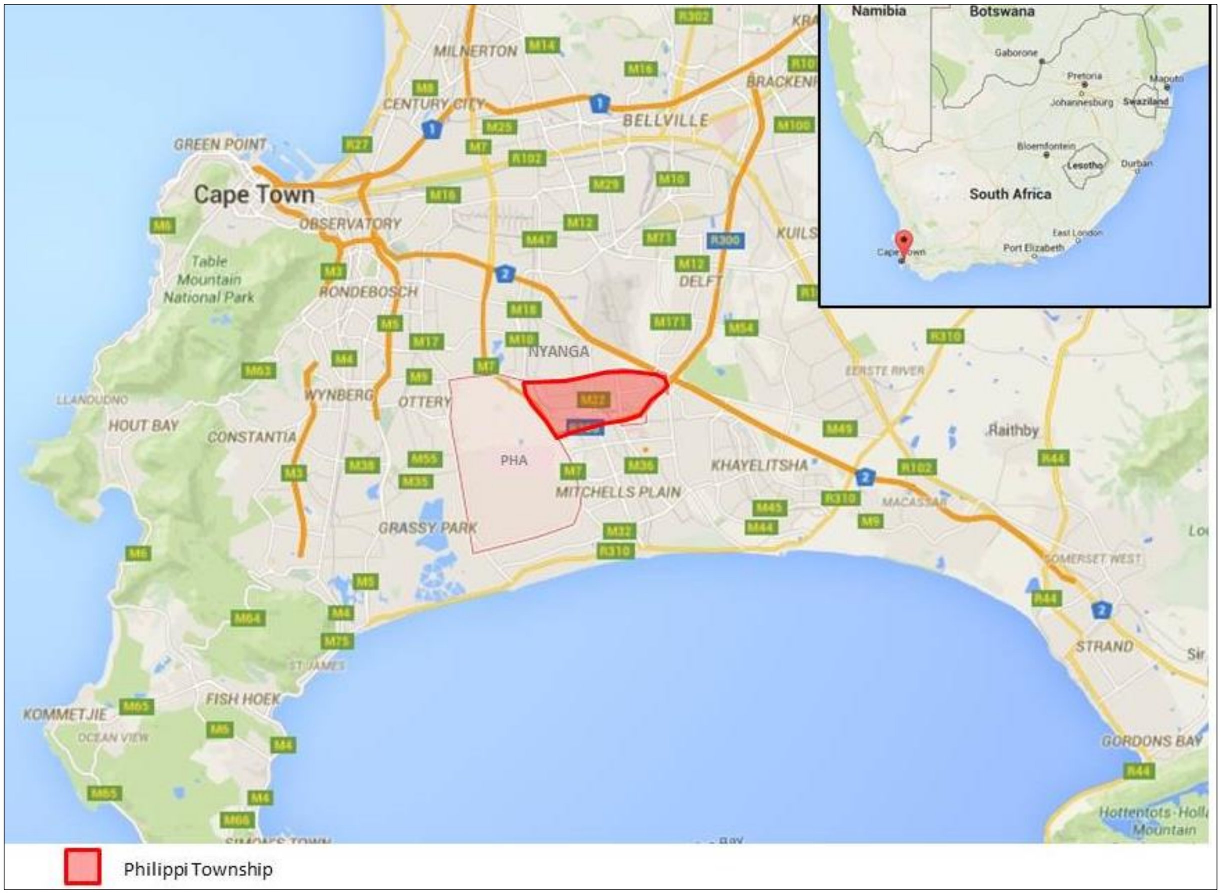

Figure 2, Location of study site, Philippi Township (Google Maps, 2016)

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Heavy rain flooded roads and shacks in the Sweet Home Farm area of Philippi in 2013.
Photo credit: Thomas Holder
Source: http://www.iol.co.za/news/south-africa/western-cape/cold-weather-has-cape-in-its-grasp-1526907

Sewage water from a blocked drain floods the road to the library in Philippi in 2014.
Photo by Siphenathi Mbozo
Source: http://www.groundup.org.za/article/city-blames-irresponsible-residents-philippi-flooding_2301/

Figure 3, Flooding due to heavy rainfall and inadequate drainage infrastructure in Philippi

1.4 Methodology

1.4.1 Research Questions

The outcome of this research is a Spatial Flood Resilience Framework (SFRF) for Philippi, and recommendations for the policy and institutional frameworks guiding the implementation of the SFRF. The scope of this dissertation and the interventions that the research has brought forth are bounded by the research questions outlined below. The research questions are intended to keep the focus of the study within the main areas of research, which are flood risk, infrastructure-led spatial planning, and flood resilience.

The Main research question:

How might an infrastructure-led approach to planning interventions build adaptive capacity to reduce the impact of flooding in Philippi?

Subsidiary questions:

- What are the planning related limitations to implementation of infrastructure interventions for building adaptive capacity to flood risk in Philippi?
- How can an infrastructure-led planning approach be effectively incorporated in flood risk management systems to provide solutions for adaptation to flood risk?
- What is the role of planning in moving towards flood resilient neighbourhoods in Cape Town?

1.4.2 Research Methods

Given the nature of the study and its multidimensional focus, this dissertation uses a range of research methods and techniques to create a robust source and evidence base for the study, and answer the research questions established in Section 1.4.1 above. The dissertation uses a mixed method approach for data collection and research, and a case study method to provide the context of the study.

1.4.2.1 The Mixed Method Approach

The mixed method approach is a research method in which quantitative and qualitative methods and techniques are mixed in one overall study (Tashakkori & Teddlie, 2003). All research methods have limitations, bias is inherent in any single research method and each method of research answers specific types of questions and may not be suitable to answer other types (Creswell, 2003). Therefore, it is best to combine qualitative and quantitative research methods, as using a mixed method has the potential to aid in neutralizing biases of the employed research methods through using one method to inform another method (Creswell, 2003; Thomas, 2003).

Qualitative Research Methods

Qualitative research methods rely on the collection of qualitative data. Qualitative methods are mainly subjective, interpreted and text or image based (Yin, 2009). For this research, qualitative research involves an analysis of documents, drawing on various sources of evidence, and seeks to substantiate the study and its findings by using multiple data sources and methods. This is a useful approach to investigating how an infrastructure-led approach to spatial planning might enhance flood resilience in Philippi. It allows for the research to draw on insights from a wide range of sources and integrate them into a meaningful whole, the SFRF, as an intervention. Drawing on research resources from a wide range of local and international sources helps in building a confluence of evidence, which will help enhancing the credibility of this research.

Quantitative Research Methods

Quantitative research methods rely primarily on the collection of quantitative data. Quantitative data is objective, precise and numerically based (Yin, 2009). Quantitative research methods tend to produce measurements and analyses that are easily replicable, and are more susceptible to systematic and random errors (Thomas, 2003). Qualitative methods/techniques used for this research involve the analysis of socio-economic statistics as well as temporal geospatial measurements. This method is essential in capturing quantitative aspects regarding flood risk in Philippi, and for contributing to the resource base that informs the developing of the SFRF for Philippi.

1.4.2.2 The Case Study Method

This dissertation uses the case study method. The case study research method is often preferred as a research method when research is focused on a phenomenon within a real-life setting (Yin, 2003). Yin (2009:18) defines the case study method as:

"*an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between the context and phenomenon are not clearly evident*."

The case study method focuses on providing a detailed account of one or more cases of research interest. The limited scope that is definitive of the case study method facilitates construction of a detailed understanding of what the case entails (Hodkinson & Hodkinson, 2001). Case study research presents the researcher with the freedom to constantly make judgment about the significance of the data and information, and as a result, case study research outcomes may be biased (Yin, 2009). Therefore it is important that the interpretation of case study is done with great care and insight, as the quality of case study research is determined mainly by the quality of insights and thoughts that the researcher brings to bear (Hodkinson & Hodkinson, 2001).

The case study method has been identified as the most appropriate method for this dissertation because the research has a specific spatial focus on Philippi. The case study method allows for the complexities of a place such as Philippi to be understood (Abu-Lughod, 1994), and for the research to produce context-dependent and value-driven outcomes (Flyvbjerg, 2011). The case study method enables the research to reveal how different factors interact to produce the unique environmental, social and economic characteristics of Philippi, and has the capacity to give the researcher and audience deeper insights into the flood risk situation of Philippi (AAPS, 2009). The method has great capacity to adopt a nuanced perception of causality, which makes it a useful method in terms of planning practice, policy making and recommendation for interventions (Duminy, et al., 2014). However, because this specific case study is place-based, it will be difficult to generalise from the research, as case studies usually do not present anything more than themselves (Abu-Lughod, 1994). This case study is, therefore, not necessarily empirically representative of flood risk in other parts of Cape Town or South Africa. To reduce limitations that might occur through the case study method, the case study approach to this dissertation is supplemented by the use of various evidence sources and research techniques.

1.4.3 Research Techniques

This section discusses the research techniques and analytical tools used in the study. A large proportion of the study draws on qualitative information and on secondary sources of data. However, the role of quantitative data has been vital in substantiating qualitative research findings. The techniques employed in this research are essential in answering the research questions and useful in developing a comprehensive investigation of Philippi. A variety of research techniques were used to aid in the investigation of flooding impacts in Philippi. The research techniques used for this study include policy discourse review, mapping and observations, interviews, census information analysis and desktop study.

Policy Discourse Review/Document Analysis

Critical discourse analysis is used as a research technique, as the study will predominantly draw on secondary sources of data. This review involved the analysis of existing policy, flood risk management, water management, infrastructure planning, and climate adaptation documentation. This technique has been useful for this research in revealing the state of policy and legal frameworks and the language and perception regarding the linkage between planning, informality, infrastructure, and flood risk management. A limitation to this research method is that the secondary sources of information used for the study may be biased towards researchers' understanding and interpretations, and could also possibly be dated.

Mapping and Observations

This research has used mapping as a tool for analysis to form spatial representations in identifying opportunities, constraints and areas of concern in Philippi. This included the use of geospatial data and existing maps to spatially identify areas of concern regarding flood risk and water related infrastructure in Philippi, through field observations on site and mapping of geospatial data.

Interviews

This technique involved having open ended discussions with relevant officials, scholars and interested individuals on the research topic. The discussions were held in person and through open-ended email dialogues.

Census Information Analysis

This technique used census to analyse the socioeconomic context of Philippi, and the history and growth of the township over the years. A limitation to this research method is that there is limited current socioeconomic statistics for the study site. The available census data is dated because the most recent census data is for the year 2011.

Desktop Study

This technique is used to acquire preliminary information of the site's conditions and existing management of flood-related management strategies. The technique is also used, through the literature review, to gather information on the existing infrastructure and long term infrastructure plans for Philippi and to understand theoretical standpoints of institutions, individuals and scholars on highlighting infrastructure as the key to making Philippi more flood-resilient.

1.5 Ethical Considerations

It is important to ensure that the research is undertaken with warranted ethics considerations. This research, therefore, makes the best efforts to ensure that participants and third parties are not harmed, and their rights not in any way violated. Confidentiality of participants is guaranteed where requested, and the research methods and techniques are cautious that expectations are not raised in terms of research outcome. This research is a low risk study and all information is treated in a careful and conscientious manner.

1.6 Limitations of Research

A number of limitations have been experienced during this study. The key limitations encountered were the following:

Time constraints: The timeframe of the study was limited to a 5 month period only, which was insufficient to undertake all aspects of the research, conceptual development and writing, and limited the scope for detailed participation and engagement.

Lack of current data: There is a lack of current socioeconomic data. The statistical data available on Philippi is dated and might have limited the depth and breadth to which the study could be undertaken.

Lack of local scale data: There is limited written information on the study area regarding flood risk and infrastructure status quo. This resulted in analysing a large amount of geospatial data to substantiate the argument of the urgency of existing flood risk and promoting long term flood resilience as a solution.

Limited Global South case studies: Although the research tried to maintain a Global South focus for precedents and examples of technical solutions to flood risk in low income areas, the research found a limited number of successful Global South examples of infrastructure interventions in high flood risk informal settlement areas.

1.7 Structure of Dissertation

This dissertation is structured in the following way:

Chapter 2 is a literature review, which looks at local and international literature and case examples on planning, flood risk, flood resilience, infrastructure planning, and adaptation. The literature review is followed by Chapter 3, which is a contextual analysis of Philippi. Chapter 3 includes a detailed contextual analysis of the current state of Philippi's water-related infrastructure and the impact of flood risk on the residents of Philippi and the township itself. This chapter also includes a detailed contextual analysis of the existing policies, plans and frameworks for Philippi. These contextual analyses are carried out in order to inform and guide the development of the SFRF in Chapter 4. Chapter 4 includes the development of the SFRF for Philippi. This framework is an intervention based on the findings of the contextual analysis. It outlines the intervention measures and plans through key strategies identified in order to illustrate how an infrastructure-led approach to planning can enhance the adaptive capacity of Philippi to flood risk. Chapter 5 details the implementation of the strategies identified by the SFRF and identifies responsible actors and allocated timeframes for projects. The final chapter (Chapter 6) concludes the study by reflecting on the process of the research and the lessons learnt, and flagging areas of future research revealed through this study as opportunities to expand on this field of research.

CHAPTER TWO

2. LITERATURE REVIEW

This review looks at literature and research applicable to Infrastructure-led Flood Risk Management and planning for enhancing adaptive capacity of informal settlements to flood risk. Different settlements observe and experience flood risk in various ways due to different local factors influencing the disaster. Although the experience and impacts of flooding vary greatly in different urban environments, it is important for current theories and philosophies used in flood risk management and adaptation practice globally to be well-understood in order to device effective analysis and interventions for Philippi.

This review broadly explores three main themes that have relevance to Infrastructure-led Flood Risk Management for enhancing adaptive capacity of informal settlements. The main themes for this literature review are 'Flood Risk and Urban Informality', 'Flood Resilience and Adaptation' and 'Infrastructure Planning for Flood Risk'. The review starts by looking at the link between flood risk and global perceptions of informality, and the different processes and approaches to flood risk management in urban environments. The review then next explores the concept of flood resilience and ways in which adaptive capacity building is engaged in flood risk management and planning. Infrastructure-led planning for flood resilience is a key focus for this dissertation, therefore, the review finally explores how an infrastructure-led approach to local area planning for flood risk areas is currently operational and the potentials it holds for further expansion and integration into the planning system to improve disaster preparedness and management.

2.1 Flood Risk and Urban Informality

2.1.1 Informality and the Planning System

More than half of the world's population lives in urban areas today, with an additional two billion residents expected in cities in the next two decades (The World Bank, 2009). A large portion of the predicted population growth is expected in medium-sized and small cities in developing countries (The World Bank, 2011), yet more than 1.2 billion urban residents already live in informal settlements and this population is expected to grow (Smith & Petley, 2009). Asia and Africa have the highest urban growth rates globally and are experiencing the highest rates of increase in occurrence of natural disasters (UN-Habitat, 2007). Most cities with rapidly increasing populations, particularly in developing countries, see minimal changes in the management of urbanization processes and disaster risk over extensive time periods, which sees an increase in risk to residents as city populations grow (The World Bank, 2011),

Ooi and Phua (2007) identify that in addition to the impacts of rapid urbanization, governments, particularly at local city level often fail to effectively link the trajectory of economic development to the effects of urban growth. City officials and authorities of cities with rapid urban development are often unprepared or lack the capacity to cope with the diverse demands for basic services and provision of infrastructure to meet social and economic needs (Ooi & Phua, 2007). The process of urbanisation also changes the environment where it occurs. It puts a lot of pressure on land where high population densities are combined with inadequate infrastructure and basic services, increasing disaster risk (Few, 2003). In many cities of developing countries, the urban poor often find themselves living on marginalized parts of the city, in ecologically fragile zones, forming informal settlements. The livelihoods of these marginalized groups heavily depend on natural resources and climate sensitive sectors (Heath, et al., 2012).

Informal settlements are often located in areas of high disaster risk due to social, economic and political exclusion from other parts of the city considered more formal. This occurs mainly as a result of formal exclusionary policies such as apartheid or unequal economic systems (Few, 2003). The scale of informal settlements ranges from a cluster of shacks, to a larger locality such as a neighbourhood, to a settlement comparable in size to many towns or cities (Few, 2003). Informal settlements may occupy state-owned or privately-owned land, and their patterns usually develop and manifest without the guidance of planners, developers or engineers (Heath et al., 2012).

Even though the urban poor have very little choice in deciding where they reside within the city, making these choices remains difficult as the decisions usually involves trade-offs between transport costs, land tenure security, proximity to economic opportunities, service provision, and protection from disaster risk and extreme events. The compromises made through these decisions have resulted in the location of many informal settlements in high risk areas (The World Bank, 2011). In urban areas, access to quality of life remains a commodity in continually specialized markets (Harvey, 2008), and provision of services and infrastructure to the urban poor residing in unlawfully occupied land is hardly considered a legitimate sphere of government action.

The informal sector was first identified as a legitimate source of livelihoods by Keith Hart (Dovey, 2012; Hart, 1973). Hart (1973) argues that informality is diverse, and it possesses legitimate and illegitimate characteristics. Dovey (2012) pinpoints that informality is not simply identified with poverty, underdevelopment and unlawfulness, and is not just the opposite of formality. The widely held perception of informality as illegitimate fails to capture the complexity of the informal sector and informal settlements, and their role in creating opportunities for employment, housing and better livelihoods for the urban poor (Jozipovic, 2015). Large planning practice around the world greatly acknowledges the need for consultation and engagement with residents, which is a substantial practice in the field of planning. However, it pre-eminently does not address the inequalities that city residents face (Watson, 2003). Informality is a reality of many 21^{st} century cities. The scale of informality, particularly in cities of the global south, poses a challenge to the role and significance of urban theory and practice. In most cities, informal settlements remain the only option of housing for a large number of their residents (Jozipovic, 2015).

The 20^{th} century has seen planning emerge as a modernist idea, which envisaged a linear progression of societies towards modernisation. Colonisation and globalisation processes facilitated the international flow of planning ideas from the Global North to the Global South (Healey, 2011). Theories on urbanisation have historically been developed in the Global North, yet today, urbanisation is predominantly taking place in the Global South. (Roy, 2005:51) describes this as the 'paradox of 21st century urbanism'. Although the field of planning has evolved, the role of planning in processes of urbanisation is continuously defined by the idea of planners providing guidance to keep development formalised. Urban planning is continuously rooted in the notion of urbanisation as a formally structured and regulated process (Roy, 2005).

Healey (2011) draws attention to how planning innovations and ideas are transferred at a global level without careful consideration for local politics, culture and social development in complex development contexts. The validity of urban planning ideas becomes questionable as soon as they are dislocated from their original context to disparate contexts. There has been a lot of uncertainty surrounding the role that transferred planning ideas play within the context they land (Healey, 2011). There is doubt and inference as to whether the flow of planning ideas, particularly from the Global North to the Global South, promotes new forms of colonisation or hegemony (Roy, 2010; Watson, 2009), or conveys repressive technologies disregarding potential for local invention (Healey, 2011). However, it is also considered that these notions could be hollow concepts that are easily filled with localized content, but it remains difficult to determine whether the general role they play in developing countries is a positive one (Healey, 2011).

Healey (2011) also argues that most ideas and practices within the planning field are shaped by their origins and the channels through which they have travelled, and suggests that cognisance of origins and travel trajectories should be maintained in the assessment of value and potential impact of transferred ideas. The transfer of ideas from the Global North to the Global South has strengthened the perception of informal settlements as illegitimate, and influenced the continuously capitalised urban government systems, planning, and service provision (Watson, 2009). Such systems in the urban environment have had international backup from global actors such as the World Bank and the International Monetary Fund (IMF) in the past, but in recent years have shifted focus to governance mechanisms (UN-Habitat, 2009). The planning field has, in recent times, seen a major shift towards better recognition of the diverse approaches to development in different contexts (Abbott, 2001). There is growing acknowledgment that informal settlements are economic and social entities in their own right, with a capital base that requires government support to grow. Additionally, it is becoming increasingly recognized that solutions that integrate informal settlements into the formal city ought to be generated within the informal settlement itself (Abbott, 2001).

Current approaches to informal settlements in urban systems of the Global South vary according to context and governance (Jozipovic, 2015). Sectoral approaches are usually the initial response to informality. Sectoral interventions aim at providing basic services to informal settlements without changing the settlement itself, to sustain basic living conditions. This often takes a quantitative approach that determines a standard ratio of facilities per household (Jozipovic, 2015). Tenure regularisation is another approach that accepts the reality of informal settlements. This approach protects the rights of informal settlement residents to remain where they are, and places the residents in a better position to invest in their homes and leverage their property (Mukhija, 2001). In situ upgrading, identifying suitable land for installation of basic infrastructure, and provision of subsidized housing are also some of the common approaches to informal settlements (Mukhija, 2001; Tissington, et al., 2013). The provision of infrastructure, land and housing, and imposing of regularity on the settlements, raises expectations that progressive formalisation of informal settlements becomes more achievable (Mukhija, 2001).

2.1.2 Flood Risk in Urban Informal Settlements

"*Flooding is a natural process and can happen at any time in a wide variety of locations. It constitutes a temporary covering of land by water and presents a risk only when people, their property and/or environmental assets are present in the area which floods*" (OPW Ireland, 2009). The process of flooding can occur in a variety of locations at any time and can significantly impact human lives, livelihoods, activities, property and environments (OPW Ireland, 2009), creating risk associated with flooding events. Flood risk is commonly approached and defined as the combination of the physical and quantifiable aspects of the flooding (**Hazard**) and the potential adverse consequences of the exposure of people and assets to floods, including the susceptibility of any elements at risk to suffer from flood damage (**Vulnerability**) (Apel, et al., 2009; Mileti, 1999; Merz & Thieken, 2004; EU, 2007). For specific flood risk to be put into perspective, it is important that there is an understanding of the source of flood water, the water pathways, and the receptors of the floods. The main and common sources of flooding are higher than normal sea levels and rainfall, and principal pathways include rivers, sewers, drains, surface runoff and river and coastal floodplains and their defence assets. The receptors may include the environment, and people and their property (OPW Ireland, 2009; Merz & Thieken, 2004)

In urban areas, a common cause of flooding is unmanaged surface runoff from precipitation. Runoff occurs when precipitation water is unable to infiltrate due to impermeability of the surface, which may be caused by saturation due to paved or hardened ground (Vojinovic & Abbott, 2012). Urban development may be vulnerable to flood risk, depending on the development type and occupation, and the construction methods used (OPW Ireland, 2009). At household level, the capacity to cope with the occurrence of disaster varies according to type of housing, levels of income, holding of insurance to offset incurred damages, and geographic location within the city (The World Bank, 2011). Therefore, it is a challenge for the urban poor to make choices regarding where they reside within a city, as the decision involves trade-offs between security of tenure, service delivery, economic opportunities, cost, and protection from extreme events (The World Bank, 2011; Few, 2003; Cairncross & Ouano, 1990). As a result, a large number of the urban poor settle in informal settlements, which are often located in high risk areas.

Settling in areas of high flood risk makes not only the people vulnerable to flood risk, but the environment in which they live too. Informal settlements and associated systems tend to experience the effects of flooding more intensely and severely than other parts of the city that are built within formal building and planning regulations (Cairncross & Ouano, 1990). Key social concerns related to flooding in informal settlements involve physical injury and loss of life. Floodwater contaminated by pollutants such as sewage or chemicals may cause serious illnesses, and the result of trauma and stress can be immense, leaving informal settlement residents vulnerable to the threat of flooding. The ability and pace of recovery can vary for different affected people or communities, and most hardly have the financial means to recover and replace lost assets (Cutter, et al., 2008). Effects of flooding may also include soil erosion, land sliding, damage and loss of vegetation, poor water quality, and loss of fauna and habitats. These impacts can be detrimental to the environment.

Flooding causes structural damage to property, including homes, businesses and infrastructure. Assets at risk can include personal belongings, housing, transport infrastructure, public service infrastructure, and commercial, industrial and agricultural enterprises (Douglas, et al., 2008). Flooding of roads or railways damages the infrastructure and denies access to other parts of the city beyond areas affected directly. Flooding of water and electricity distribution infrastructure can result in loss of water and power supply. The damage of property and infrastructure can exacerbate flooding impacts as it can lead to closure of businesses, which has implications for job losses and decline in local and regional economic activity (Vojinovic & Abbott, 2012).

The role that proximity and access to economic opportunity plays in determining where poor households settle within the city indicates the significant role of social pressures in producing and exacerbating flooding impacts. If the sources and impacts of flood risk are not identified and managed accordingly, losses that result from flooding will have severe implications on the quality of life, safety and economic performance of cities (The World Bank, 2011). Therefore, it is important that flood risk is carefully considered and understood. This is an essential step in managing impacts of flooding and making informed decisions, because only when cities are able to locate and understand the nature of risk, can they plan and respond better to flood risk (The World Bank, 2011).

2.1.3 Approaching Flood Risk

An understanding of risk to make risk informed decisions is developed from investigation of the multiple dimensions of risk, which fall under the concerns of flooding probability and flooding consequences as illustrated in Figure 4. These dimensions of risk are all subject to change autonomously or through purposeful intervention. The conventional approach to flood risk has been focused on reducing the probability of flooding through a wide range of structural defence systems, but there is increasing recognition that non-structural actions to minimise exposure offer a dynamic contribution to flood risk management (Sayers, et al., 2013).

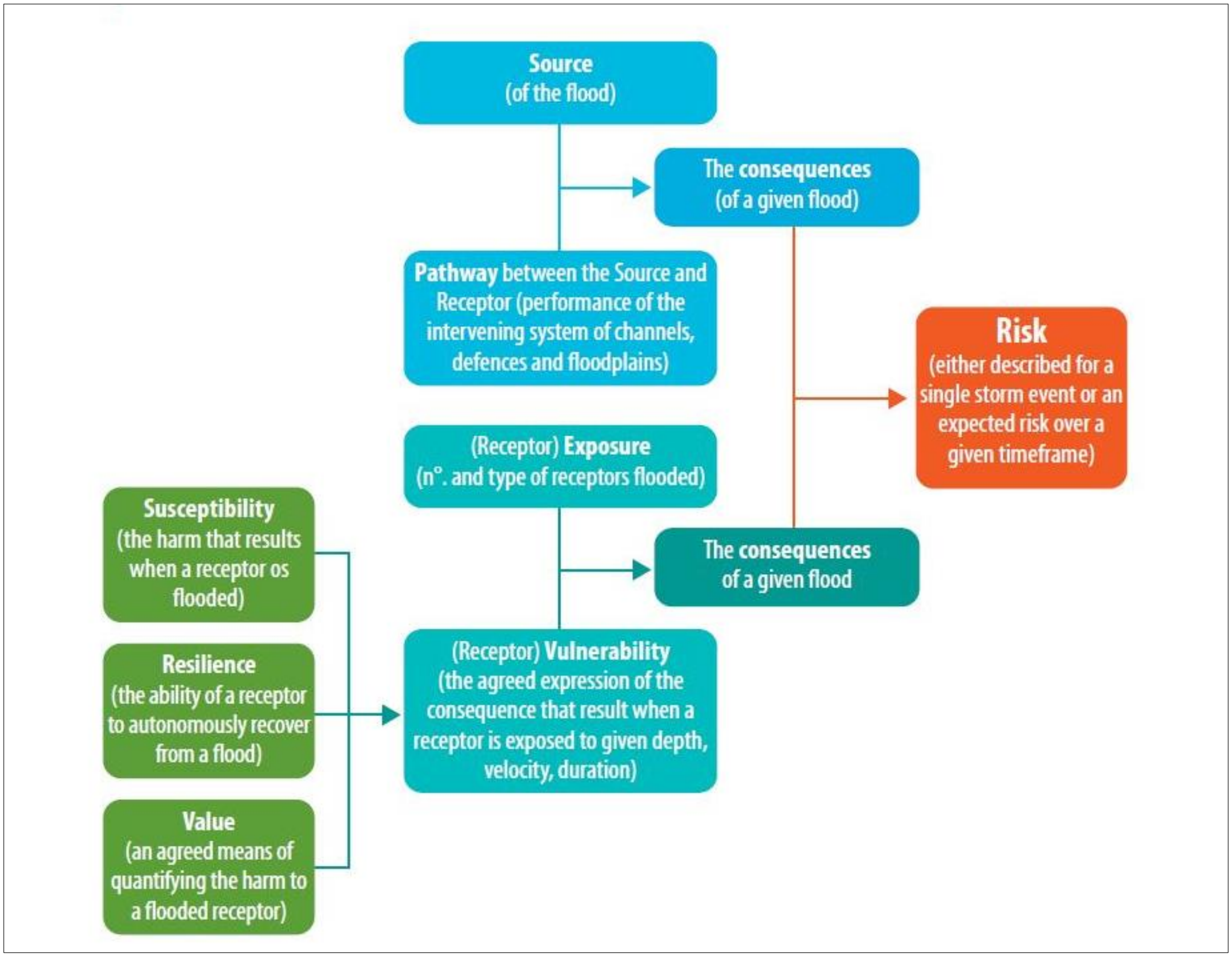

Figure 4, The components of flood risk (Sayers et al, 2013: 4).

Flood risk management is a key element of water management planning. It involves strategy and policy development, as well as plans for implementation and review at different levels of governance. The nature of available data and information on flood risk varies substantially in moving from national to local decision-making, forming complex processes in flood risk management (Sayers et al, 2013). Strategic flood risk management involves explicit trade-offs between promotion of opportunities, reduction of risk and necessary resources for achieving development objectives. A strategic approach to flood risk enables more informed decision-making processes that recognise the importance of integrated multi-sector planning (Sayers et al, 2013).

Sayers et al (2013) identify spatial planning as the most effective approach to mitigation of flood risk through active administration on land and property development. Planning has a significant role to play in flood risk management especially in ensuring that development avoids or mitigates flood risk. The location of development in flood risk areas is a challenging practice, which needs to be fully justified by appropriate spatial planning and sustainable development considerations. Planning constitutes parallel processes to those of flood risk management, and arguably, in all cases, these processes are interdependent. It is essential for this cooperative relationship between planning and flood risk management to be put at the forefront of development in flood risk areas, in order to enhance clarity and thoroughness and encourage efficiency in the planning process through integration (OPW Ireland, 2009). It is imperative that the context of a flood remains the main informant of the approach to management, planning and integration.

2.2 Flood Resilience and Adaptation

Flood management is effective when tangible measures to reduce exposure and susceptibility to flooding, and improve flood resilience are identified. Schelfaut et al. (2011) identify the concept of resilience as one that provides a practical framework to achieve effective flood management. A number of studies have also considered resilience a promising target for hazard prevention and mitigation (Schelfaut, et al., 2011; Adger, et al., 2005; Cutter, et al., 2008; Cutter, et al., 2010). The World Bank (2011: 14) defines resilience as “the ability of a system to withstand or accommodate stresses and shocks such as climate impacts, while still maintaining its function”. In an urban environment, resilience generally depends on whether the system is able to maintain essential assets and ensure access to functions and services that sustain the citizens’ wellbeing (The World Bank, 2011).

Cities are increasingly exposed to a variety of hazards. The potential for hazards to become disasters depends greatly on the degree of exposure of people and assets. In urban areas, the increase and concentration of people and assets in high risk areas is driven by population growth, urbanization, migration and economic development, among other factors (The World Bank, 2011). Hazards such as flooding tend to have more severe social and economic impacts in urban areas than in rural areas due to the high degree of exposure in cities. The vulnerability of a system to flood hazards can be influenced by both physical and qualitative attributes, and reducing it requires strengthening the capacity of the system to cope in order to ensure that the degree of loss emerging from a disaster is minimal. The vulnerability and coping capacity of households and communities to respond to flood risk and disaster remains unequal in most cities of developing countries, with low income residents having poor access to safety nets (The World Bank, 2011).

Urban populations depend on a wide range of interrelated urban systems, which include ecosystems, infrastructure, institutions and knowledge networks. These systems support and are supported by the social agents of a city, including households, individuals, and public and private sectors (The World Bank, 2009). A city's resilience depends on how vulnerable the urban systems are, and the capacity of social agents to apprehend and adjust to stresses and changes resulting from disasters (The World Bank, 2011). Delivering resilience goes beyond reducing the probability of damage through the provision of robust structures (Sayers et al, 2013); it requires the involvement of social agent capacities to approach the urban systems through a continuous understanding of vulnerability and resilience. This not only strengthens urban systems, it also develops and enhances the capacity of agents to efficiently and effectively intervene in them (The World Bank, 2011). An urban system may be considered resilient if it generally exhibits the resilience characteristics defined by the World Bank, shown in Table 1**.**

Table 1, The Characteristics of a resilient urban system, (The World Bank, 2011)

Flexibility and diversity	Ability to perform tasks under various conditions and modify structures to explore new ways of achieving essential goals; Has locational and functional diversity
Redundancy, modularity	Capacity to accommodate extreme events and unexpected demand; Variety of service delivery options
Safe failure	Ability to absorb shocks and cumulative effects in ways that avoid catastrophic failure
Resourcefulness	Capacity to identify issues, determine priorities and mobilise resources
Responsiveness and rapidity	Capacity to organise and re-organise; Establish function and sense of order in advance of and following a failure
Learning	The ability to learn and internalise past experiences and failures, and use the knowledge to alter strategies.

Enhancement of flood resilience contributes great value to operational flood risk management in urban areas. The concept of resilience provides a diverse approach to urban systems, which integrates technical, social, economic, environmental and governance measures towards flood risk. In a rapidly changing world, establishing flood-resistant urban systems assures effective means for adaptive management of disasters (Schelfaut et al, 2011). Sayers et al. (2013) identify adaptive management as one of the approaches, that together with delivering resilience, effectively works towards minimizing damage by disaster, and enabling strategies to change as the environment changes with time. The concept of flood resilience denotes the capacity of a system and its social agents to minimize impacts of flooding and flood risk through some form of adaptation (Few, 2003).

Adaptation to flood risk varies from system to system, and within a system according to characteristics and capacity of the components making up a system to cope and change with changing physical conditions. Generally, the concept of adaptation primarily involves increasing resilience and reducing vulnerability (Heath et al, 2012). Success and efficiency of adapting to climate-related risk depends greatly on the management and governance of the risk, on which longer-term adaptation can build (Heath et al, 2012). There are international efforts to initiate adaptation to climate change and climate related disasters, especially in the water resources sector (Batchelor, et al., 2009). However, there is still a lack of detailed analysis and impact assessment of vulnerability to enable appropriate implementation of adaptation measures in many developing countries (Nath & Behera, 2010).

It is common in many urban contexts, that adaptation requires highly pragmatic evidence of efficiency and effectiveness before it is considered as an investment, as it competes with other investment priorities (Jozipovic 2015). One of the major impediments on adaptation practice and research has been the lack of detailed knowledge and understanding of what adaptation should look like on the ground (Ford, et al., 2010). An analysis of adaptation efforts by Biagini et al. (2014) describes ten categories of adaptation that can help in identifying areas where adaptation can occur: Capacity building, Policy, Information, Planning and management, Technology, Practice and behaviour, Physical Infrastructure, Green infrastructure, Technology, Warning or observing systems, and financing.

Climate change has significant long-term effects on flood risk (OPW Ireland, 2009) and has seen increasing consideration, amongst other factors, in investments, infrastructure, and the planning and management of resource allocations in cities (Taylor, 2013). Although climate change is global, recent studies highlight that cities are sources of adaptation and the tools for adaptation are found within functions of local government from provision of services and areas where adaptation can take place (Agrawal, 2008; Satterthwaite, 2008; Sharma & Tomar, 2010; Wamsler, et al., 2014). Therefore, locally focused adaptation is a more effective approach to building flood resilience in urban systems. Heath et al (2012) maintain that policies on adaptation and adaptive capacity building are effective when adaptation and development are linked by climate change initiatives that address the structural conditions causing vulnerability of the urban poor to climate-related hazards such as flooding. It is anticipated that practical initiatives that build societal adaptive capacity are evident at local (community) scale as they reduce vulnerability (Kates, 2000; Smit & Wandel, 2006).

Approaching resilience and adaptation at city or regional scale can be a challenge, especially when the complexity of the source of risk is not well understood. The different levels of development, access to resources and authority within a city is closely linked with the vulnerability and resilience of its systems (Vale, 2014). This is evident in the high levels of disparity between neighbourhoods in cities with informal settlements or other marginalized residents. Therefore, resilience, vulnerability and risk need a more nuanced approach between different systems and neighbourhoods, to be more effective (Jozipovic, 2015). Numerous opportunities are available to make urban areas more resilient. There is a myriad of structural and non-structural options for new developments within and on the peripheries of urban areas, but there is still limited understanding and realisation within the urban planning field and amongst decision-makers, on the possible synergistic means of addressing flood risk at local scale (Birkmann, et al., 2010; Veerbeek, et al., 2010).

2.3 Infrastructure Planning for Flood Risk

2.3.1 Local Area Planning

Urban areas are experiencing a rapid increase in the scale of potential flood risk, and major structural interventions in flood prevention have generally seen limited success in urban environments. This implies that there is a growing realization that it is important to engage intervention efforts that aim at building assets, particularly of the urban poor, to withstand shocks in order to reduce impacts of flooding (Sanderson, 2000). There is, therefore, a need to support local level action designed to enhance the resistance and resilience of communities to flood risk (Few, 2003), as planning at a local level proactively promotes robust adaptation (Wilson, 2006).

Flood risk manifests itself in various ways depending on its sources and context, so for effective risk and impact assessment outcome, key issues regarding flood risk need to be addressed at the local area plan (LAP) level. LAPs are typically guided by wider area-based plans and policies, which can range from neighbourhood level to national level, and follow the approach staged by guiding policy (OPW Ireland, 2009). The LAP is an important part of the planning process, which allows for detailed and comprehensive strategic spatial planning. Strategic planning for long term flood risk management involves considering futures of flood risk and continuous efforts to increase stability within complex urban systems and social processes that are vulnerable and prone to risk (Hutter, 2007). Hutter (2007) argues that strategic planning is one of the approaches from a professional platform that can improve long term flood risk management. Hutter (2007) also suggests that strategic planning includes careful deployment of the ideas of open and inclusive dialogue for effective flood risk management.

Although spatial planning is increasingly recognised as an essential instrument for flood risk reduction in many parts of the world (Mileti, 1999), there is still evident neglect of the integration of flood mitigation and adaptation measures in spatial plans at local government level (Burby, 1998; Neuvel & van den Brink, 2009). There are a number of factors that may influence the commitment of local government to the adoption and implementation of spatial plans and strategies for flood risk reduction. It is common that there is a mismatch between local government and higher-tier government policies, or trade-offs between other local interests and priorities (Neuvel & van den Brink 2009). Local governments also experience limitations such as lack of technical or political support, lack of public commitment, limited capacities of local authorities, or the lack of recognition of the problem as one that can be solved at local level (Wilson, 2006; Neuvel & van den Brink 2009). Acknowledging the need for adaptation and strategic planning at local level can be challenging, as short term prospects of local plans may conflict longer term implications of climate change and associated risk (Wilson, 2006).

Interventions at local level can target to strengthen political and social capacities and promote community-based technologies for risk reduction. This approach is substantial as it can empower communities affected by flooding, and result in a shift from reinforcing dependence on temporary flood relief efforts (Few, 2003). It harnesses the untapped potential of vulnerable urban communities to reduce and manage risk at local level, and provides support to their efforts in moving towards sustainable futures (Maskrey, 1999; Few, 2003). Studies identify the planning system as a key policy area to anticipate and prevent flood risk impacts and exploit any opportunities associated with it, and identify local government as a key institution in the development of adaptation responses (Wilson, 2006; Neuvel & van den Brink 2009; Hutter, 2007).

2.3.2 Infrastructure-led Planning for Flood Risk

According to Wilson (2006), spatial planning at a local level focuses predominantly on the life-span of infrastructure development and the natural environment. Emphasis on the physical developments and natural systems should challenge short term objectives of many local area development plans and provide incentives for the adoption of climate-adaptive planning policies that are in line with other objectives for development of local communities (Wilson, 2006). The planning and management of urban areas and the way that approaches to planning and management transform in response to social and climate change affects the way flood risk manifests within an urban environment. Some significant effects may include new urban forms and densities of development, and the renewal of existing urban spaces (Wheater & Evans, 2009).

There is a need for a flood management to be balanced against other social, environmental and economic needs, especially the demand for infrastructure and housing, in cities that experience flood risk. Wheater and Evans (2009) identify the need as one for more sharply focused policy tools. In a developing country context, rapid urban population growth, shortage of financial and human resources, and the lack of infrastructure and services in urban areas necessitate more dynamic approaches to planning (Okpala, 2009). Okpala (2009) suggests the need for continual assessment and reassessment of planning approaches and policies, to allow for evaluation of resource availability and existing economic circumstances. Okpala (2009) states that cities are unable to achieve ecological, social, and economic sustainability, without adequately planned spatial and trunk infrastructure frameworks. Okpala (2009) further argues that effective and efficient urban development and planning comprises appropriate provision of transport and water-related infrastructure, institutional and community service facilities, housing, and recreational spaces as basic frameworks on which environmental management and sustainable urban development could be based.

There are significant opportunities in urban areas to make spaces and infrastructure more resilient to flooding. The main challenge, according to Veerbeek et al (2010), is changing the norms for builders, developers, urban planners, and policy- and decision-makers to accept the urgency of moving towards creating urban spaces that are resilient to external stress. Numerous approaches to runoff and flood risk management, including hard infrastructure and ecosystem-based strategies, have been employed across cities around the world (Armitage, 2011). However, stormwater management in cities with informal settlements is complex, as the high quality infrastructure and the formal planning and development processes are often severely deficient or completely lacking for the context (Armitage, 2011).

Informal settlements in many cities develop on ecologically sensitive land, such as floodplains or wetlands, which in some cases would be used to direct water away from formal parts of the city. Due to the typically high densities and populations of informal settlements, installation of drainage systems remains a major challenge, which requires short-term or permanent resettlement of residents (Jozipovic, 2015). It is common that residents of informal settlements subject to risk are reluctant to relocate to better drained areas, as it would, in most cases, mean moving further away from job and economic opportunities, and from existing social support. Drainage and stormwater management will always take lower priority than employment and poverty reduction in a setting where it is common for a large proportion of the population to be functionally unemployed. Thus, the process of improving existing drainage infrastructure and installing more efficient and sustainable drainage systems in informal settlements often occurs “within tense state-civil society relations” (Jozipovic, 2015: 13).

According to Armitage (2011), the fundamental challenges to sustainable urban drainage in informal settlements are associated with the incapacity of local government to deliver sites that are properly serviced for the rapidly increasing rates of population growth in cities. Armitage (2011) further highlights that provision of services and resources is often discouraged by a lack of integration and communication between different departments responsible for service delivery (Armitage, 2011). Interventions that aim at responding to flood risk in informal settlements need to account for the natural setting of the place, technical interventions, and social processes that lead to marginalisation (Jozipovic, 2015), and facilitate collaborative governance through integration of actors involved in the processes.

2.3.3 Infrastructure management

In urban areas, the technical aspects of flood risk are predominantly associated with technological or engineering-driven interventions, and flooding may occur when the interventions are inadequate or fail (Vojinovic & Abbott, 2012). Stormwater management systems are the main form of flood prevention and runoff management in urban areas (Vojinovic & Abbott, 2012), but having stormwater systems in place does not make a city insusceptible to flooding if the systems and infrastructure are limited and poorly designed, constructed or maintained (Jiusto & Kenney, 2015). When stormwater infrastructure fails or is inadequate, such as poor drainage and flood defence systems, and obstructions across overland flow pathways, an area’s susceptibility and exposure to flood risk increases (Vojinovic & Abbott, 2012).

There is increasing recognition of the use of green infrastructure as a valuable adaptation option for stormwater management in urban environments of developing countries (Armitage, 2011 ; Mguni, et al., 2016). The green infrastructure approach to stormwater management is commonly identified as sustainable urban drainage systems (SUDS) (Mguni, et al., 2016). Fryd et al. (2012) describe SUDS as consisting of green or soft components, which depend on natural processes of evapotranspiration, infiltration, conveyance and retention of stormwater using the urban landscape. The growing interest in SUDS to manage urban runoff and associated water quality issues has seen a number of various design solutions created and implemented in different parts of the world (Wheater & Evans, 2009). However, there is still a gap in research and practice regarding the pertinence of SUDS in urban contexts characterised by expanding populations, informality, poor service delivery and deficits in water-related infrastructure (Mguni et al, 2016).

Further exploration of the value of Infrastructure based approaches to flood risk management and the potential that SUDS have as an adequate adaptation measure to flood risk could enhance the inclusion of SUDS as an opportunity for cities to integrate the manifestation of high urbanisation rates into land use policies that support the development of inclusive green infrastructure (Mguni et al, 2016). Acknowledging this opportunity highlights the vulnerability of infrastructure and urban populations to impacts of climate change (Mguni et al, 2016), and facilitates the transformation of many developing country cities from places of climate-related risk and crisis to more sustainable and resilient cities (Novotny, et al., 2010).

2.4 Conclusion

This review has summarised the three main themes of the research and explored the variety of perspectives on how infrastructure-led planning may contribute to the enhancement of flood risk in urban informal settlements. Flood risk is a significant issue of concern in urban informal settlements, which causes structural damage to the physical, economic and social structures of many cities. The role of planning in flood risk management, and the perceptions of urban informality in the urban planning field have been challenged by the scales of urban flood risk and informality in cities of the Global South. Planning has a significant role to play in in ensuring that development avoids or reduces flood risk and enhances flood resilience, which is effective at local scales through the practice of local plans and policies. Enhancement of flood resilience contributes great value to operational flood risk management in urban areas. Great value has been placed on sustainable infrastructure based approaches to flood risk as significant in building long term adaptive capacity. This review has provided a conceptual point of departure from which to begin the contextual analysis of the research; that is for urban planning practice to locate and understand the nature of flood risk, in order to plan and respond better to flood risk.

CHAPTER THREE

3. CONTEXTUAL ANALYSIS

3.1 Introduction

Approximately 54% of the world's population today lives in urban areas, and this total is predicted to increase to 66% in the year 2050 (United Nations, 2014). Urbanisation has posed a challenge to the planning and development of many urban areas, most particularly those of developing countries. Rapidly growing urban areas often result in high informal settlement populations. This presents a conflict of rationalities for urban planning between the increasingly marginalised populations and the techno-managerial and marketised systems (Watson, 2009). Globally, cities are recognising the need to appreciate planning and design for resilience and adaptability to impacts of urban and population densification, disaster risk and climate change. However, most developing countries continue to face challenges with meeting the needs of increasing urban populations including housing, infrastructure and employment.

The literature review has defined the theoretical background of this dissertation. This chapter provides a detailed contextual analysis of the case study site and a summary of findings regarding pre-existent flood risks in Philippi, Cape Town. The chapter profiles Philippi, as a case study, within its broader context and as a township (see Figure 5), and sets out an analysis of the biophysical and socio-economic trends and patterns of Philippi. The chapter also reviews current policy regarding flood risk management, adaptation and development planning, and analyses their applicability and effectiveness in implementing reduction of flood risk and adaptive capacity building, at different levels of government. The aim of this chapter is to analyse the status quo of Philippi in terms of sustainability and flood risk, and to highlight opportunities, risks, key issues and priorities, as regards local spatial planning of the site. The analysis gives context to the flood risk to provide justification and logic for the basis of the chosen approach to the intervention.

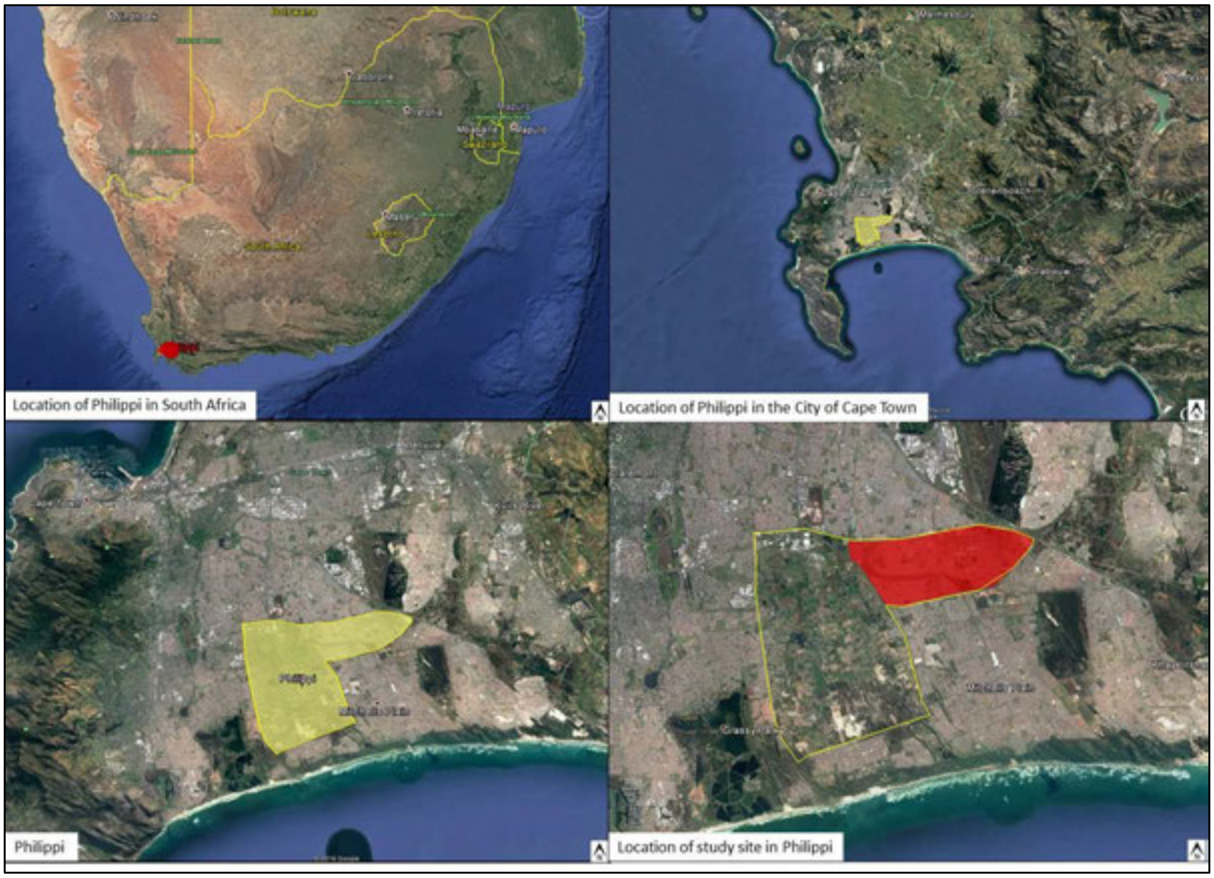

Figure 5, Contextualising the study site (Author, 2016; Google Earth, 2016)

3.2 Profile of Study Site

This section profiles the study area by exploring the biophysical and socioeconomic context of Philippi, and analysing current flood risk on the study site. The biophysical analysis of the study site is done mainly at a scale broader than the site, to give a clearer background and understanding of the natural setting of the site; while the socioeconomic analysis provides an overview of the site's demographics, settlement patterns and services. Flood risk in Philippi is then explored through an analysis of the flooding experience in Philippi and its impacts on the physical and socioeconomic setting of the site.

3.2.1 Socioeconomic Analysis

Philippi is a low-income township on the Cape Flats, a low-lying area located southeast of the Cape Town Metropolitan area. The history of the Philippi Township has been strongly influenced by developments in the country, the city, and for the most part by political developments in surrounding neighbourhoods. The first community of local residents in Philippi is recorded in 1833, but substantial residential growth and development began in the early 1980s (Adlard, 2009). Most of the settlers in

Philippi were originally from the former homelands of Ciskei and Transkei (City of Cape Town, 2007), which were some of the areas established by the apartheid government in South Africa as settlements for the majority of the black population to prevent them from living in urban areas (SAHO, 2015). They settled first in the neighbouring Nyanga, Langa and Gugulethu, and later moved to the squatters of Samora Machel and Browns Farm in Philippi. Philippi had increasingly become a safe haven for local communities in fleeing from violence and political conflict in their former homelands (City of Cape Town, 2007).

During the early 1990s, Philippi became an apartheid domain as it experienced contestations over housing developments and allocation of the settlement to black Africans who had not been allowed to settle in urban areas for a long time (Herrick, et al., n.d.). Today, Philippi is one of the largest townships in Cape Town and its population comprises a number of different groups that settled in the township through different processes and at different times (Herrick, et al., n.d.).

A large portion of land on the west of the Philippi Township is the Philippi Horticultural Area (PHA), which is a largely undeveloped urban agricultural area that serves as the city's breadbasket due to its size, location, and the significant amount of produce it provides for the city. The township of Philippi is made up of the following settlements as illustrated in Figure 6: Browns Farms, Heinz Park, Kosovo Informal, Philippi East, Philippi Park, Philippi SP1, Sweet Home, Weltevreden Valley North 1, and Weltevreden Valley North 2 (City of Cape Town, 2013).

As can be seen in Figure 6, Philippi is located in the centre of Cape Town and serves as a central point of distribution for the Cape Flats. It is surrounded by major roads such as the N2, M7, M9, and the R300, and is connected to the rest of Cape Town by six access routes (WaterStreet, 2016). Philippi presents a range of opportunities and potential, as well as challenges. It is located in close proximity to economic opportunities and transport nodes, but still faces challenges in terms of development, in the form of unemployment, poverty, food insecurity, crime, overcrowding and exposure to environmental hazards such as fire and flooding (Herrick, et al., n.d.).

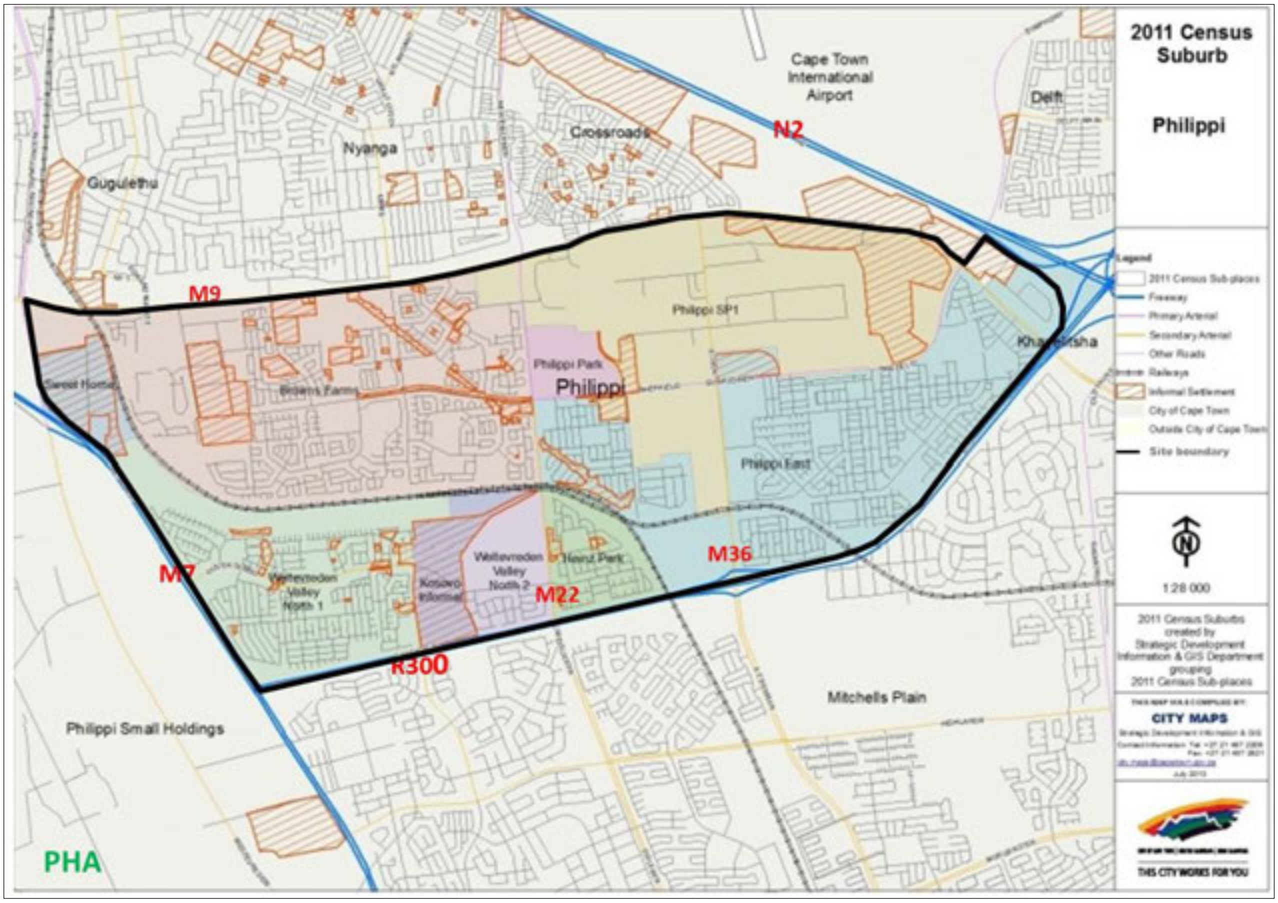

Figure 6, Philippi settlements and surrounding neighbourhoods (City of Cape Town, 2013)

This study is spatially focused on the township of Philippi. This site was chosen because it is where most of the urban development in Philippi as a neighbourhood has taken place and where flood risk and flooding impacts on the residents' livelihoods and the environment have been most evident. It is a significant area in terms of depicting the human-environment interface in Cape Town informal settlements and the management of human-environment relations to harness positive relations for both.

Summary of Population Demographics, Settlement Patterns and Services in Cape Town and Philippi

The City of Cape Town is an amalgamation of seven local municipalities into one metropolitan municipality with a total population of approximately 3.8 million people in 2011, and a population density of 1530 persons/km^2. The City of Cape Town oversees a total area of 2461km^2, and has a recorded population growth rate of 2.6% between the 2001 and 2011 census years (City of Cape

Town , 2012b). The city's population is expected to grow significantly from in-migration and natural births each year. Cape Town experiences a rapid in-migration, especially of people from rural areas and smaller towns, which results in increased pressure on housing and service demands within the city. A large proportion of demands for services and resources are from low income parts of the city, as their affordable costs of living makes them a settlement target for people moving into the city (City of Cape Town , 2012b).

The majority (about 71%) of the population in Cape Town is coloured and black Africans, but the minority of white residents are still in a more privileged position than the most of the city's population in terms of access to services and resources (City of Cape Town , 2012b). In 2011, the city had approximately 1.07 million households, at an average household size of 3.3. 80% of the households live in formal dwellings; while a total of nearly 129 918 informal structures are found in informal settlements. More than 75% of households in Cape Town have access to piped water inside their home or yard and 88% have access to a flush toilet connected to the public sewer system, while 8, 8% of households have no access to sanitation on site (City of Cape Town , 2012b). More than 35% of the households in Cape Town live below the poverty line of less than R 3 500 per month and are registered as indigent. Inequality in Cape Town is shown by a Gini coefficient of 0.58 (City of Cape Town IDP 2012/2013), which is relatively high and indicative of significant differences in income and access to resources and services within the city. 23% of the economically active population in Cape Town remains unemployed (City of Cape Town, 2014).

According to the 2011 census data, Philippi had a total population of 191 025 and 61 797 households at an average household size of 3.09 in 2011 (City of Cape Town, 2013). The population of Philippi is predominantly black Africans, who make up 94% of the township's residents. 77% of the population has access to a flush toilet connected to a public sewerage system, and 67% of households have access to piped water in their dwelling or inside their yard (City of Cape Town, 2013). A large proportion (nearly 80%) of households in Philippi have a monthly income of R3 200 or less and only 44% of Philippi households live in formal dwellings (City of Cape Town, 2013). Table 2 below illustrates a statistical summary of the types of dwellings in Philippi.

Table 2, Profile of dwelling types in Philippi (City of Cape Town, 2013)

Philippi Type of Dwelling	Black African		Coloured		Asian		White		Other		Total	
	Num	%	Num	%	Num	%	Num	%	Num	%	Num	%
Formal Dwelling	25 537	42.9%	1 130	69.5%	30	50.8%	30	54.5%	275	47.6%	27 002	43.7%
Informal dwelling / shack in backyard	13 345	22.4%	272	16.7%	14	23.7%	14	25.5%	196	33.9%	13 841	22.4%
Informal dwelling / shack NOT in backyard	20 213	34.0%	211	13.0%	14	23.7%	8	14.5%	99	17.1%	20 545	33.2%
Other	387	0.7%	13	0.8%	1	1.7%	3	5.5%	8	1.4%	412	0.7%
Total	59 482	100.0%	1 626	100.0%	59	100.0%	55	100.0%	578	100.0%	61 800	100.0%

The township of Philippi has a mix of land uses, but is predominantly classified as a residential area (see Figure 7). A portion of the site is used for industrial purposes. It is rapidly developing and is set to be a significant economic node for the southeast of the Cape Town Metropolitan area (Haferburg & Ossenbrügge, 2003). Land use has an impact on the types and amounts of pollutants found in the water systems. Residential sites like Philippi tend to have water systems polluted by household and sewerage waste. Industrial waste such as chemicals may also be found in water systems on industrial sites (Bowden, 2006). This may pose major implications for surface and underground water systems receiving the pollutants, and significant human and environmental health issues.

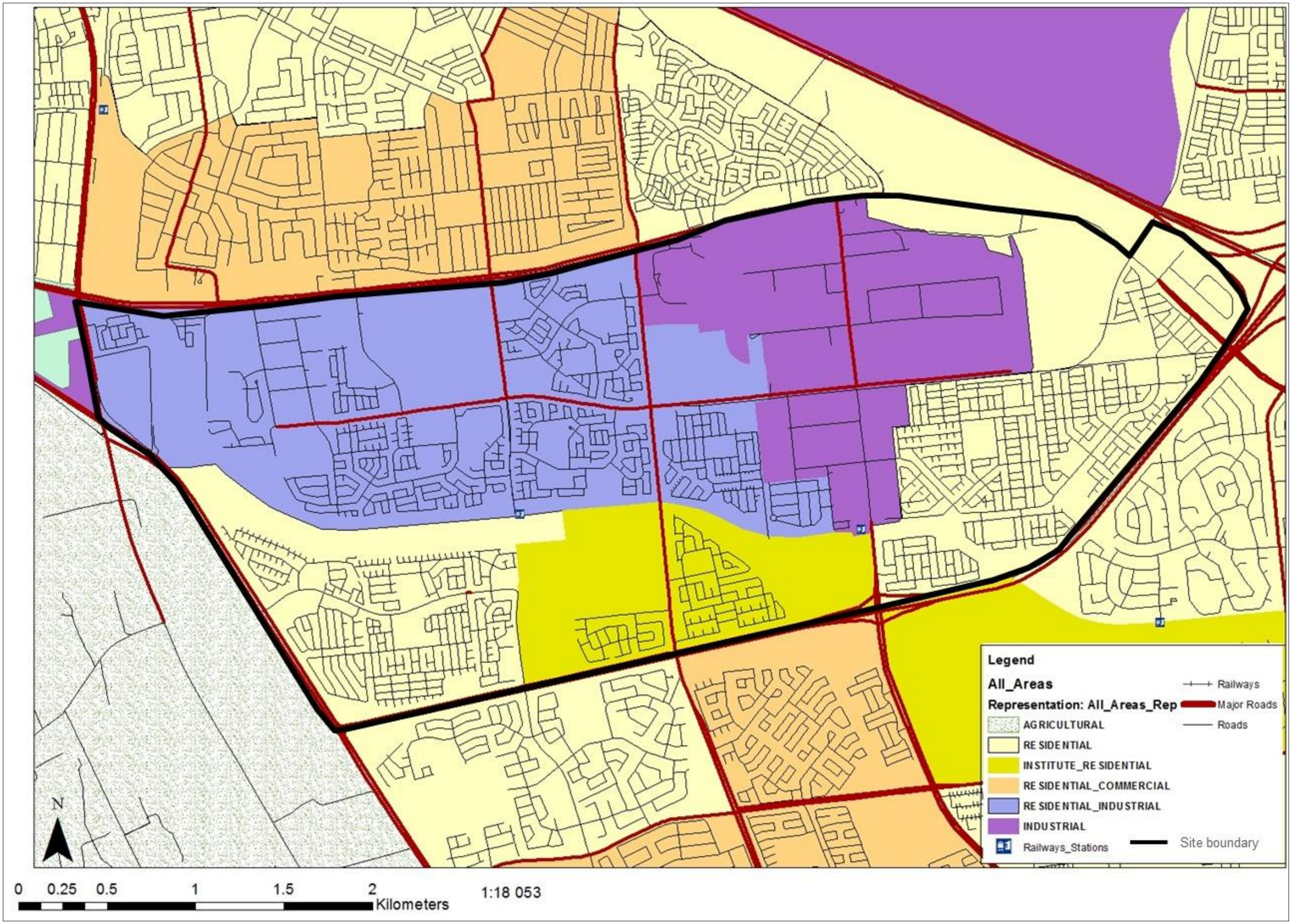

Figure 7, Land Use in Philippi (Author, GIS Technical Library, University of Cape Town, 2016)

3.2.2 Biophysical Analysis of Philippi

Geomorphology and Geology

The topography of the Cape Metropolitan area has been and continues to be shaped predominantly by weathering and hydrological processes. The underlying geology of the area is composed of several rock types, which include mainly the Cape Granite Suite, the Malmesbury Group, the Klipheuwel, the Quarternary Sands, and the Table Mountain Sandstone. The geology produces rich and diverse soil types which set the foundation for the unique species and aesthetics found within Cape Town (City of Cape Town, 2011).

Philippi is located on the Cape Flats (shown in Figure 8), a coastal plain of sands formed within the mountains of the Cape Town Metropolitan area. The Cape Flats is essentially lowland, covering an area of 630km^2. The sands of the Cape Flats are derived from the weathering and deposition of quartzite and sandstones of the Malmesbury Formation and Table Mountain Group, and also from Aeolian sand deposition from beaches in the area (Adelana, et al., 2010). Geology and topography, as well as biodiversity have significant implications for development and planning, particularly land use, within Cape Town, which sees the lowlands often subjected to urban development, as they are generally easily accessible as compared to mountainous areas.

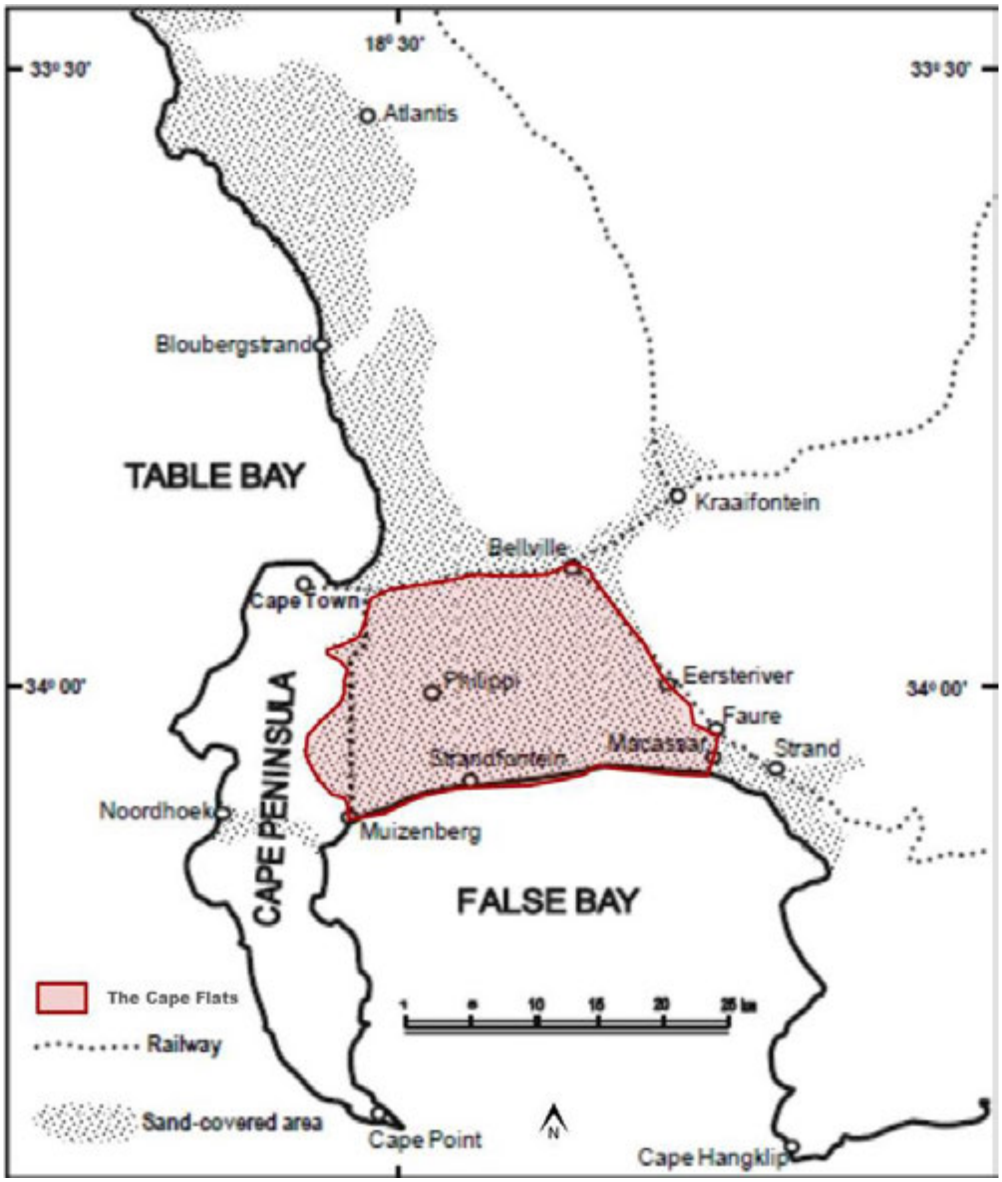

Figure 8, Location of the Cape Flats area in the Cape Town Metropolitan Area (Adelana et al, 2010).

Biodiversity

Philippi is part of a very wide biodiversity network within Southern Africa. The Cape Town Metropolitan area, where the township of Philippi lies, makes part of a world renowned biodiversity hotspot. It is located within one of only six floral kingdoms in the world- the Cape Floristic Region (CFR). The CFR is characterised by a Mediterranean climate in which flora and fauna flourish between a diversity of mountain ranges, and has a wide variety of endemic species under threat of extinction due to habitat loss (Myers, et al., 2000). The Cape Town Metropolitan area accommodates a wide range of freshwater, coastal, marine and terrestrial habitats, which in some parts of the city, are transformed by urban development (see Figure 9) (City of Cape Town, 2012a).

Cape Town's unique biodiversity settings are declining rapidly. More than 60% of the city's initial range of indigenous vegetation, particularly within the lowlands, has been lost (City of Cape Town, 2012a). The loss of vegetation and degradation of ecosystems has had detrimental effects on the ecological functioning of the city's natural systems. Figure 3 illustrates the biodiversity network of the Cape Metropolitan area and how it spatially interacts with urban development within the city.

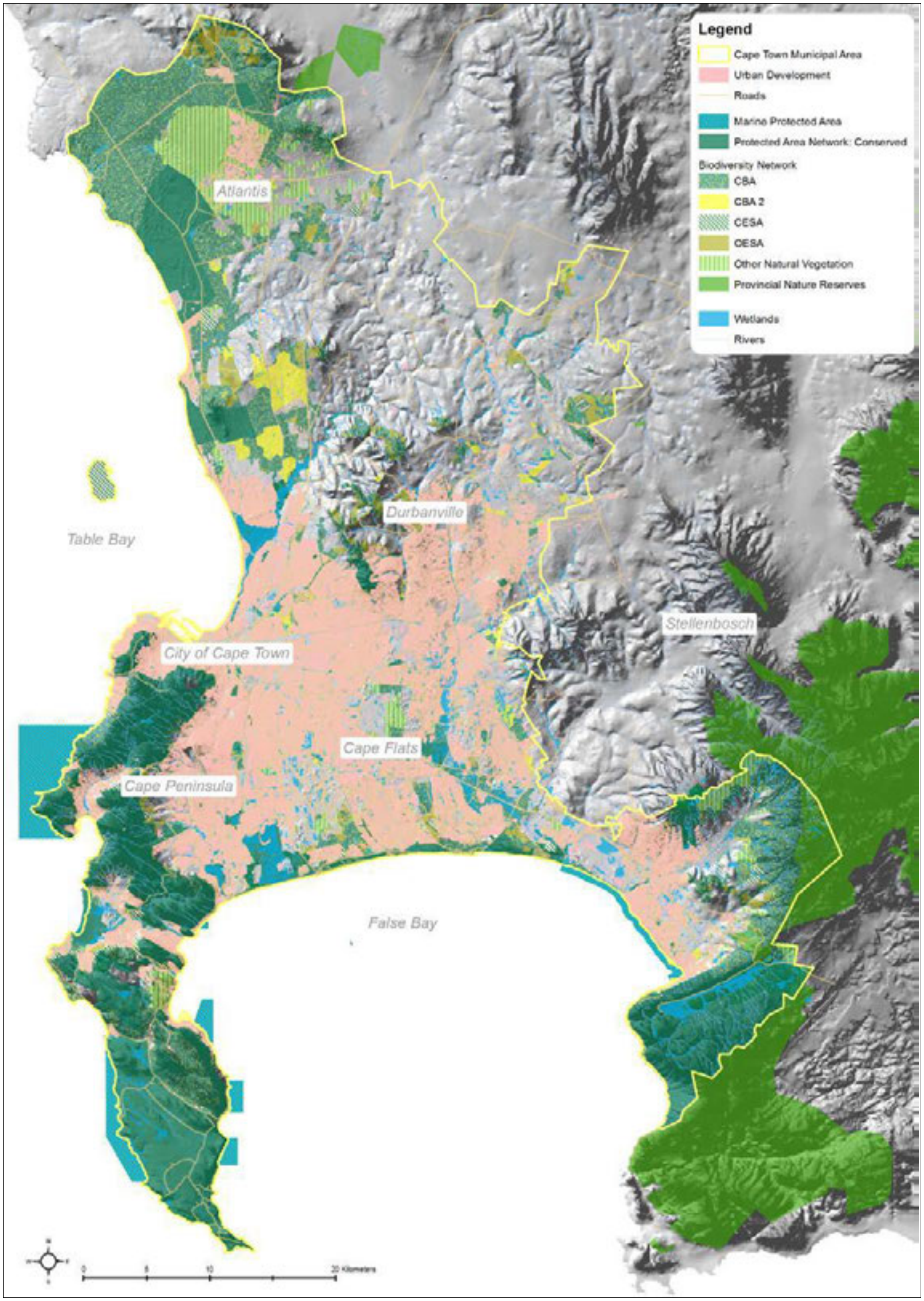

Figure 9, The Cape Town Municipal Area Biodiversity Network Map showing Marine Protected Areas, the Biodiversity Network: Protected Areas, Critical Biodiversity Areas (CBA), Ecological Support Areas (ESA); and other natural remnant (City of Cape Town, 2012a).

Climate

Cape Town has a Mediterranean climate, with wet winters and dry summers. Annual rainfall in Cape Town varies spatially according to topography, with the average annual rainfall for valleys and coastal plains at 515mm and average annual rainfall for mountainous areas at 1500mm (Rowswell & Fairhurst, 2011). This results in drier weather conditions in the Cape Flats area and wetter weather conditions over the Table Mountain Range (Cameron, 2014). Rainfall is primarily brought in by the northwesterly winds that are prevalent during the winter, sometimes strengthened by large cold fronts from the Atlantic Ocean with increasing precipitation (Tadross and Johnston, 2012). Although regional climate models predict increasingly drier climatic conditions overall, there is also an anticipated increase in frequency and intensity of extreme rainfall events in Cape Town (Ziervogel et al., 2014; Tadross & Johnston, 2012).

The winter season, which lasts from June to August, averages a maximum temperature of 18ºC and a minimum temperature of 8.5ºC, while the summer, which lasts from November to March, is warmer and drier, with an average maximum and minimum temperatures of 26ºC and 16ºC, respectively (City of Cape Town, 2011). Figure 10 shows mean monthly rainfall and temperature variation in Cape Town over a period of 73 years, between 1933 and 2006. These climatic conditions in Cape Town significantly impact the ecological function of the city's natural systems as it determines and influences the survival of floral and faunal species, as well as the accumulation and transport of water resources through various water systems, and recharge of groundwater.

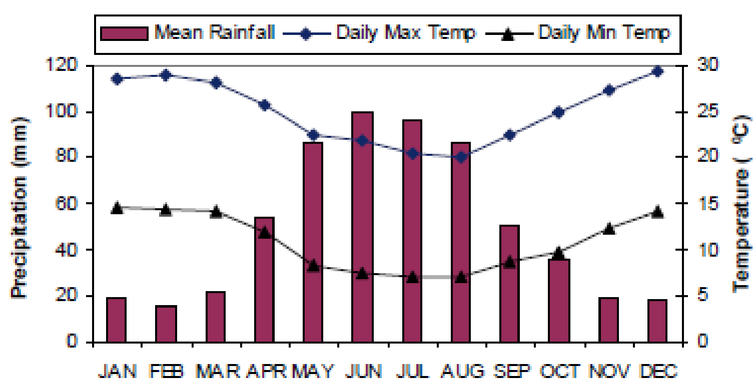

Figure 5

Mean monthly rainfall with maximum and minimum temperature in Cape Town (Station: Cape Town Airport, 1933-2006)

Figure 10, Mean rainfall and temperature in Cape Town (1933-2006) (Adelana et al, 2010)

Hydrology

Cape Town has an extensive freshwater system made up predominantly of vleis and rivers (see Figure 11). The freshwater systems serve as some of the fauna and flora hotspots, and also serve as infrastructure networks for management of stormwater conveyance and treated effluent. Inadequately treated wastewater is the main source of freshwater pollution in Cape Town. Other sources include raw sewage from informal settlements, contaminated urban stormwater, and inadequate urban water infrastructure (City of Cape Town, 2012a). Effects of pollution in the city may be exacerbated by flooding, increasing negative impacts on human and environmental health (City of Cape Town, 2012a). There is a direct interface between stormwater infrastructure and the receiving freshwater and coastal environments in Cape Town. The City has seen some significant improvements in ecosystem health and water quality during the late 2000s and early 2010s, which has served as evidence for increased freshwater systems and stormwater management within the city (City of Cape Town, 2012a). However, many of the Cape Town's freshwater systems remain below suggested water quality standards due to inflows arising from urbanisation (see Figure 12), which continues to be a serious concern in the city (City of Cape Town, 2012a).

The surface-water hydrology of the Cape Flats is characterised by three rivers, the Eerste, Kuils and Diep Rivers and their tributaries, as well as the Zeekoevlei and other open water bodies (Adelana et al, 2010). A large portion of the Cape Flats area is underlain by the Cape Flats Aquifer (CFA), which covers an area in excess of 400km2 (Hay, et al., n.d.). The CFA has the capacity to recharge at rapid rates and has a residence time of approximately 20 years (DWAF, 2008).

The City of Cape Town has a history of water shortages, which have necessitated investigations on the use of groundwater to augment water supply and lower the cost of water delivery in Cape Town. The CFA, among other aquifers in the Cape Town area, is considered to have adequate storage capacity to support its development as a supplementary water supply source for the city (Adelana et al, 2010). The CFA offers the potential to meet up to two thirds (about 18Mm^3/a) of basic water needs in the City of Cape Town (Adelana & Xu, 2006). However, its generally unconfined nature makes it highly susceptible to pollution from the surface (Hay et al, n.d). The CFA is increasingly becoming polluted from land use above it and adjacent to rivers which recharge it. This includes a variety of chemicals leaking from industrial waste and agricultural activity, untreated human waste and high levels of nitrates leaking from wastewater treatment works, toxic materials from landfill sites and cemeteries, and a lack of stormwater, sewer and sanitation services in informal settlements Area (Giljam & Waldron, 2002).This has challenged the City to include groundwater protection in its development plans, as the population and size of the city grows (Adelana et al, 2010).

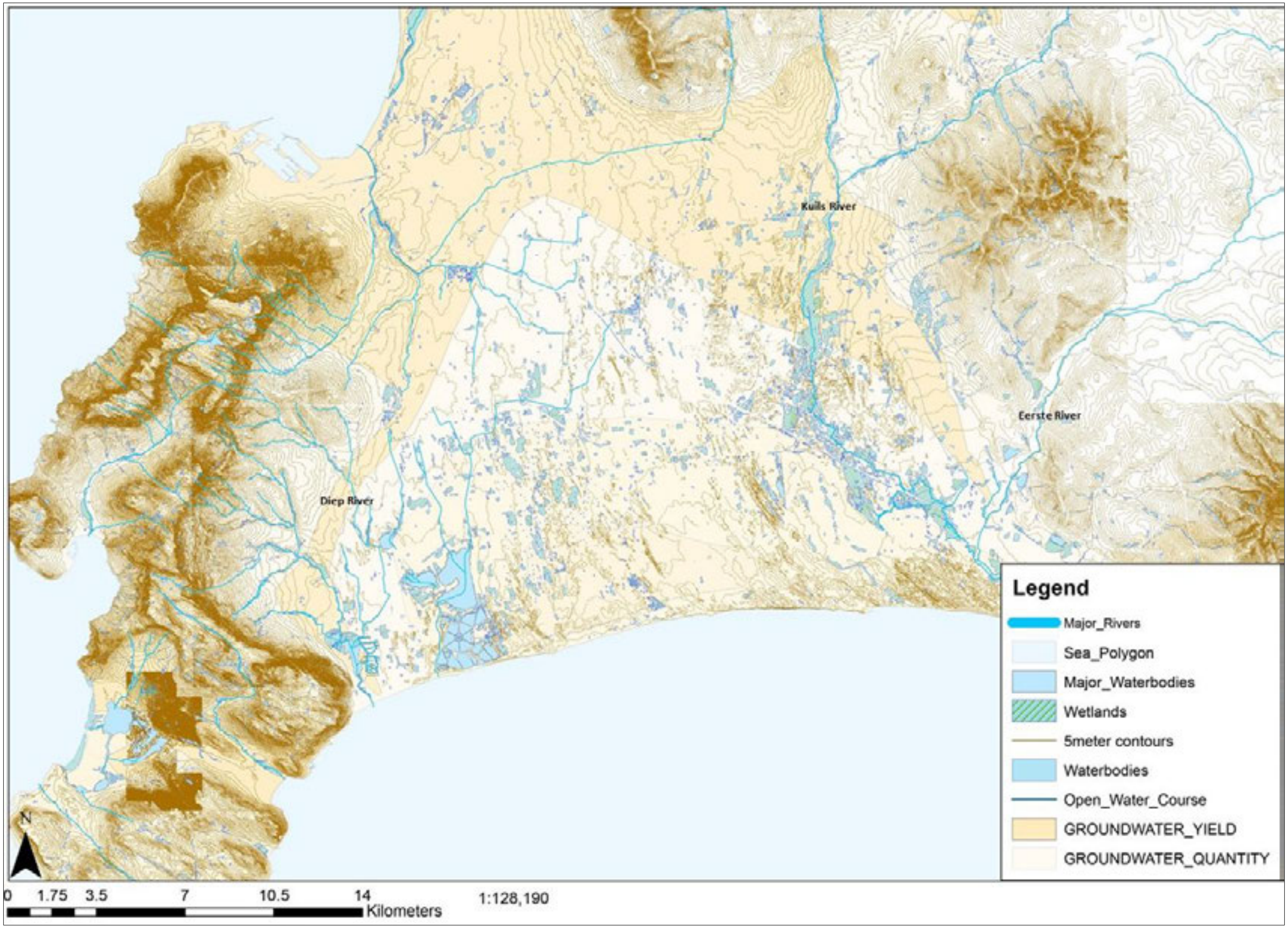

Figure 11, Hydrology of the Cape Flats (Author, GIS Technical Library, University of Cape Town, 2016)

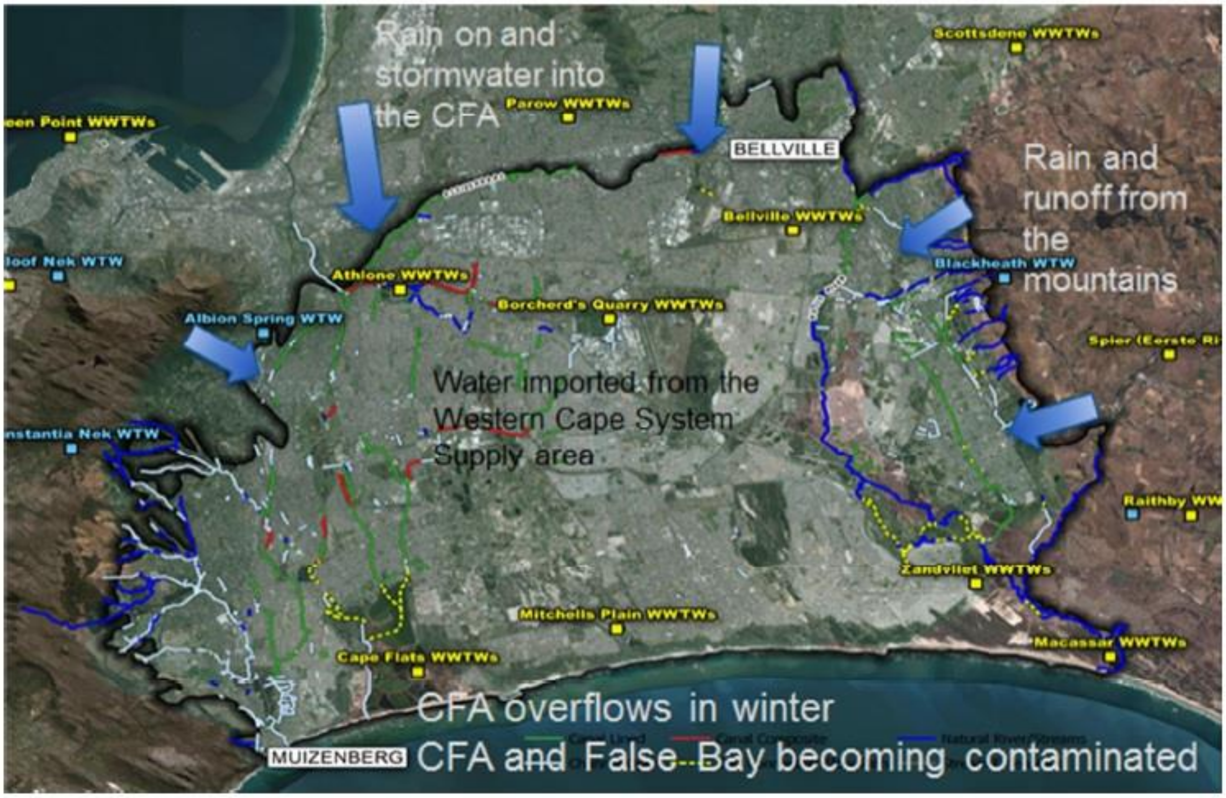

Figure 12, Map illustrating the CFA area and major inflows arising from urbanisation (Adelana et al, 2010).

3.2.3 Flood Risk in Philippi

The Cape Flats area is characterised by urban development such as industrial and agricultural activity, and dense human settlements. Urban expansion on the Cape Flats poses a threat to groundwater quality because anthropogenic contamination from activities at surface directly and indirectly contributes to the recharge of the CFA (Hay et al, n.d). The nature of flooding that occurs on the Cape Flats is characterised by water rising from saturated water tables and flooding from inadequate stormwater systems, and low lying areas such as wetlands and retention ponds, in which informal settlements are often located (Benjamin, 2008; Waddell, 2016). The CFA water from both natural and urban recharge, particularly from areas of informal settlement encroachment in low lying areas, results in flooding when it rains (Hay et al, n.d). In addition to rainfall and runoff from surrounding mountains, the Cape Flats area receives water from WWTWs and stormwater, which results in winter flooding due to the physical nature of the environment, shortage of space in the aquifer, contaminated water entering the aquifer and the often inadequate infrastructure for stormwater drainage (Hay et al, n.d).

Although studies and observations have shown that the impacts of flooding are significant in Philippi (Armitage, et al., 2010; Bouchard, et al., 2007; Drivdal, 2011), existing geospatial data for Cape Town does not classify any part of Philippi as a flood prone area (Figure 13). The parts of Cape Town identified by the geospatial data as flood prone are mainly those associated with major natural watercourses. Periods of heavy or prolonged rainfall fill the wetlands and other large bodies of stagnant water within Philippi (Figure 14), posing human and environmental health concerns. Because Philippi is located on flat terrain, the duration of a flooding event is prolonged as water is drained at a slow rate. Therefore, it takes a long time for the water levels to lower (Bouchard et al, 2007).

While the wetlands in Philippi are generally classified as flood-prone areas (City of Cape Town , 2012c), most of the wetland areas on the site remain natural and undeveloped. The developments surrounding the wetlands are exposed to flood risk associated with the flooding of the wetlands, and a few sections of some informal settlements in Philippi have encroached nearby wetland areas; increasing the exposure of these areas to flood risk (Figures 15 and 16).

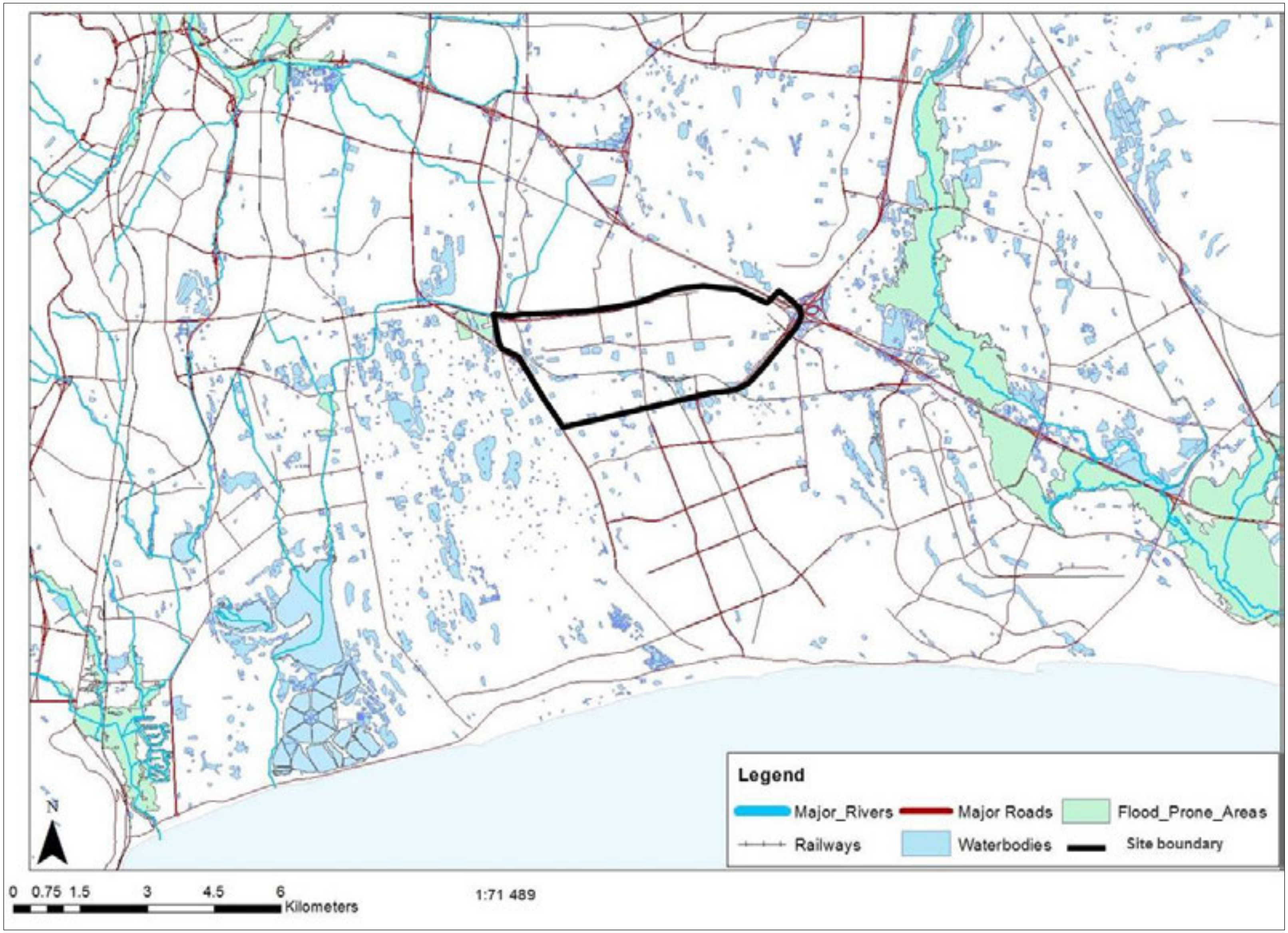

Figure 13, Map showing flood prone areas on the Cape Flats in relation to the study site (Author, GIS Technical Library, University of Cape Town, 2016)

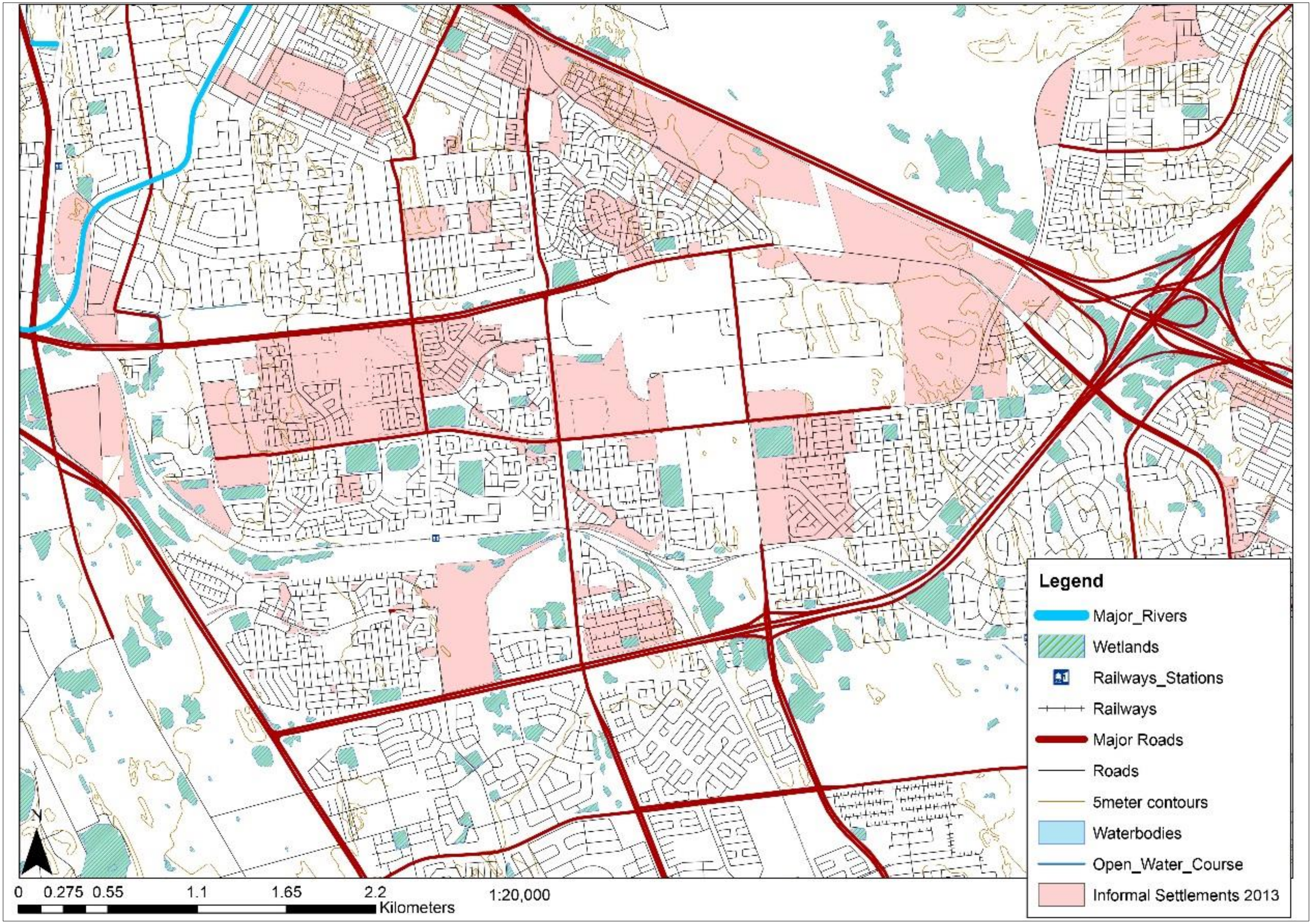

Figure 14, Wetlands and waterbodies in Philippi (Author, GIS Technical Library, University of Cape Town, 2016)

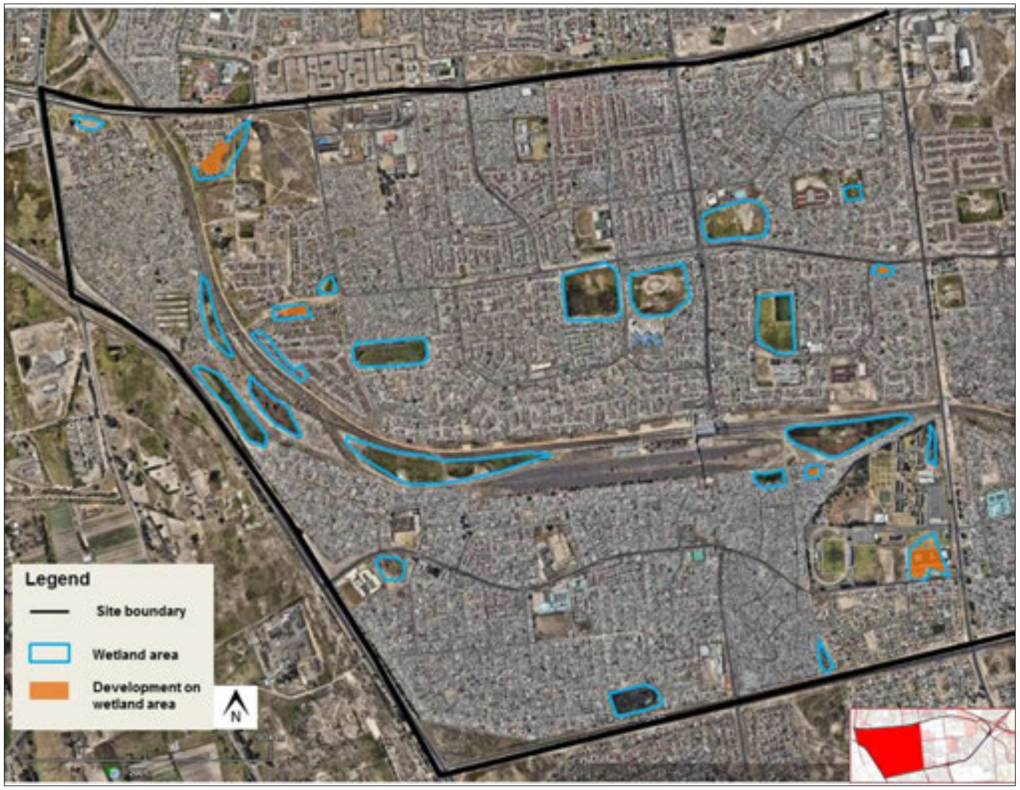

Figure 16, Map showing wetland areas and areas developed within wetland areas on the western section of the site (Author, 2016 Google Earth, 2016)

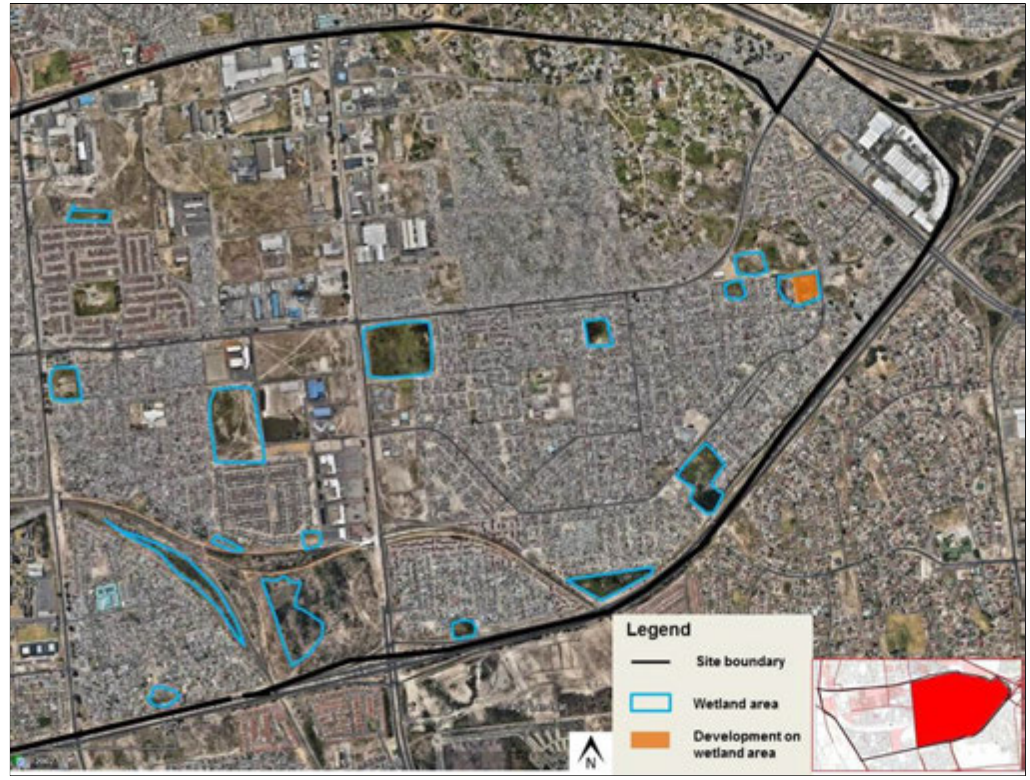

Figure 15, Map showing wetland areas and areas developed within wetland areas on the eastern of the site (Author, 2016; Google Earth, 2016)

The City of Cape Town provides basic water-related services for the settlements including stormwater drains, formal trenches and retention ponds. However, in many cases these services are ineffective because blockages occur consistently due to rubbish build up, silt accumulation and man-made blockages (Bouchard et al, 2007). Very few of the settlements in Philippi have adequate drainage systems because most were formed as a result of illegal land invasions in areas where local government has limited jurisdiction, and human and financial resources, and because the settlements are becoming increasingly dense, making it difficult to upgrade and retrofit existing developments (Armitage et al, 2010). Inadequate water infrastructure contributes significantly to flooding in the settlements of Philippi because the settlements experience more standing waterbodies due to lack of adequate stormwater runoff control. Standing waterbodies and stormwater runoff combine with human and household wastes from sewers, latrines and drains, and spreads throughout dwellings and streets. This poses a threat to the residents' health, as the wastes carry bacteria, parasites and viruses that cause a wide number of infections, and disease can spread rapidly because dwellings are situated in close proximity to one another (Bouchard et al, 2007). When stagnant flood water stands for a long time, it also becomes polluted and smells bad (Drivdal, 2011).

Figures 17 and 18 respectively show the status of current stormwater and sewer drainage systems in Philippi. Figure 17 shows that some parts of Philippi lack stormwater drainage systems or have disconnected systems, which implies inadequate stormwater infrastructure. Figure 18 shows a general lack of sewerage drainage systems, especially in informal settlement areas. When compared to the neighbouring settlements of Nyanga north of the site, and part of Mitchells Plain south of the site, it can be concluded that there are significant gaps in the water infrastructure network system of Philippi.

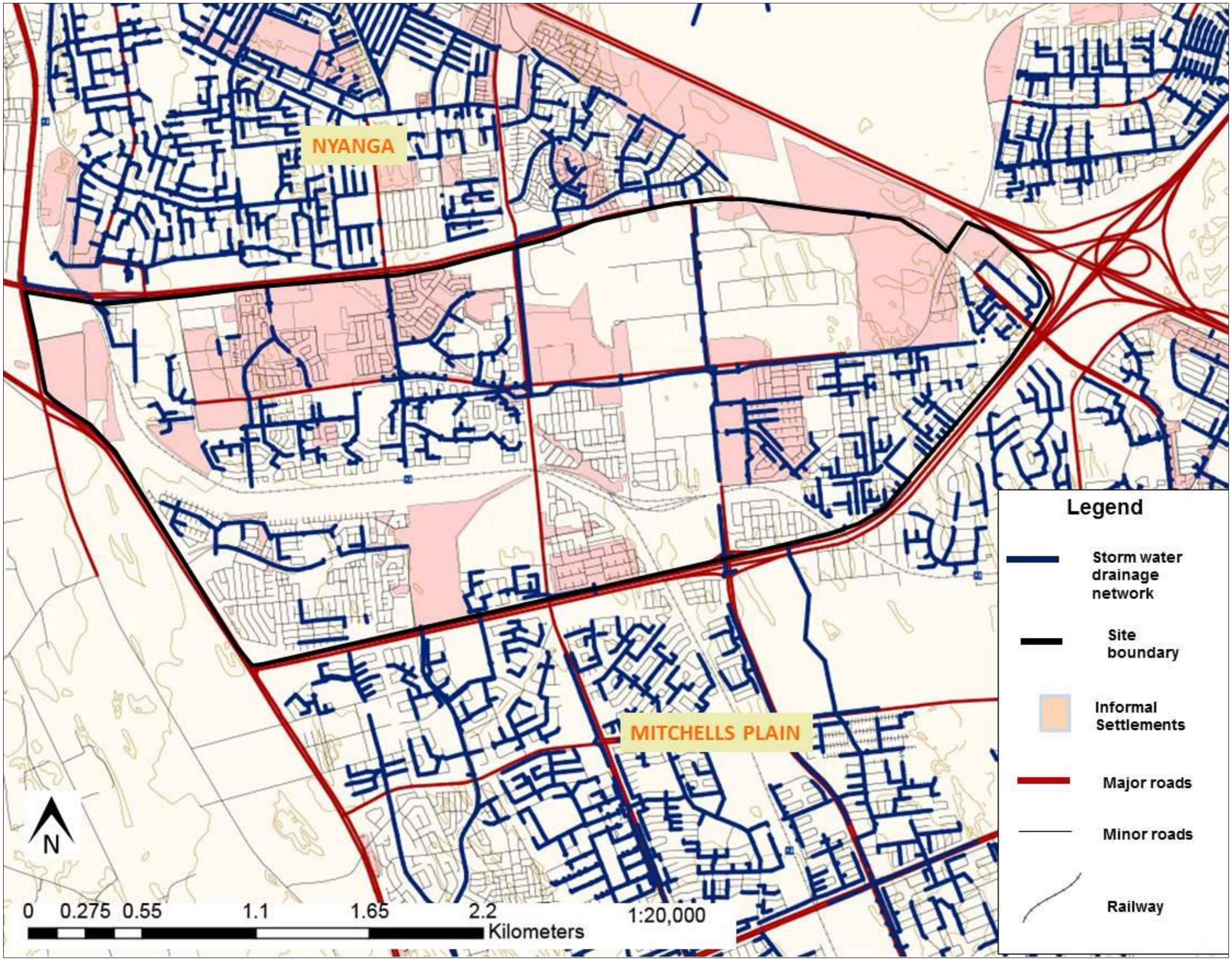

Figure 17, Stormwater drainage system in Philippi (Author, GIS Technical Library, University of Cape Town, 2016)

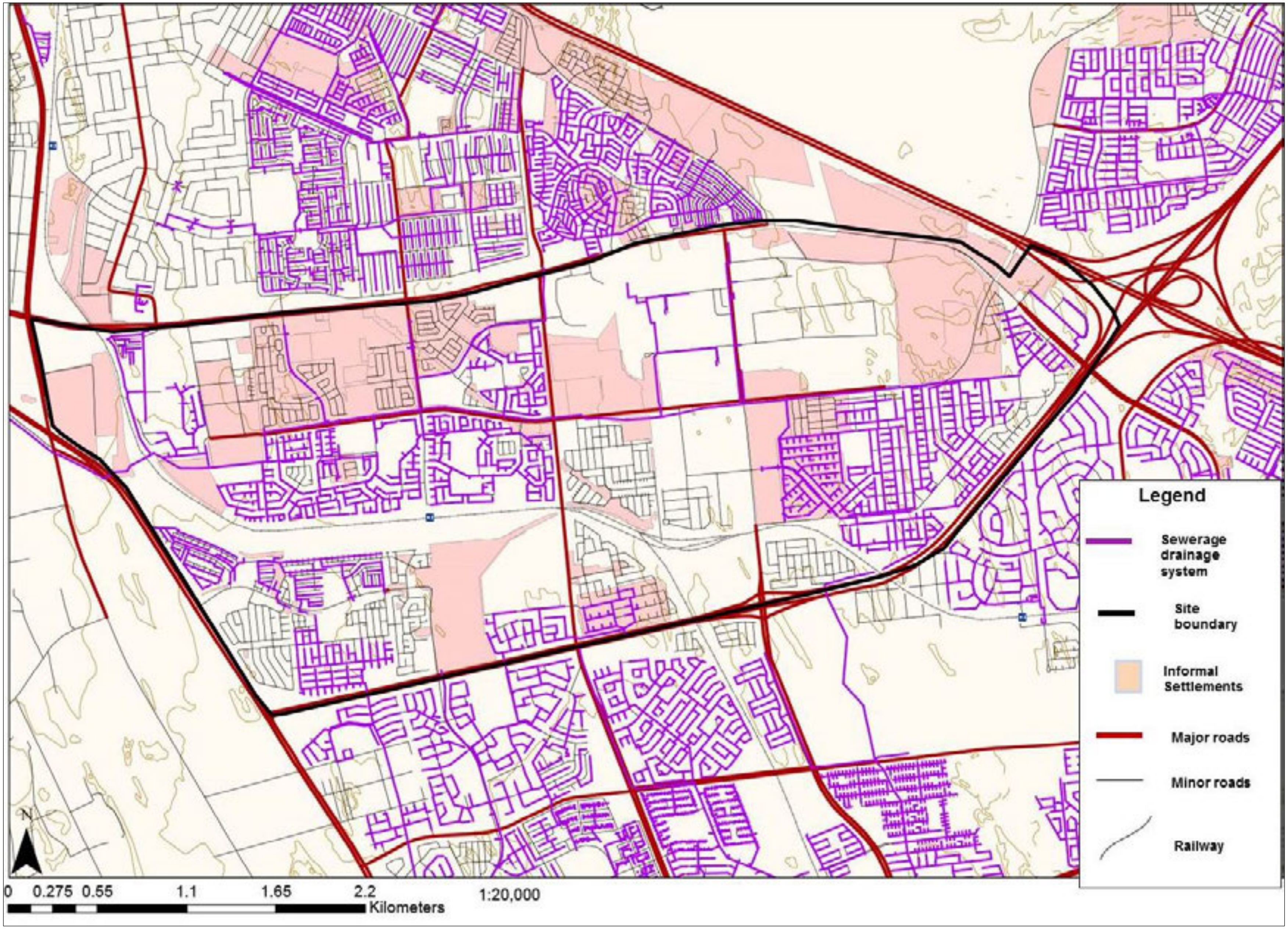

Figure 18, Sewerage drainage system in Philippi (Author, GIS Technical Library, University of Cape Town, 2016)

Another aspect of flood risk in Philippi is that management of flood risk at household and community levels is often not a priority. Many residents, when they first move to the area, view their dwellings as a temporary place of residence, in hope to be relocated or provided with housing (Drivdal, 2011). As more people move into Philippi, space to build and assemble dwellings decreases, and people settle in high flood risk areas as it becomes harder to find a place to live within the city. The overcrowding of spaces in the informal settlements of Philippi has increased flood risk in the area because of the increasing number of people potentially affected by the flooding (Bouchard et al, 2007; Drivdal, 2011). There is also a lack of choice for some residents to protect their homes from flooding because livelihood priorities are primarily placed on other factors such as employment and food security, as the economic situation of residents is often more debilitating than the geographic situation in which they find themselves. While some residents have the means to protect their homes from flooding, others lack the knowledge and means to prevent flooding within their homes (Bouchard et al, 2007)

Impacts of flooding are very apparent in Philippi, especially during the winter season. Flooding impacts in Philippi include health risks, physical dangers and damage, and impact on the social and economic impacts on livelihoods and the city at large. Many of the residents continue to live there because they do not have the means to move to more habitable and flood resilient parts of the city (Bouchard et al, 2007). During intense flooding events, water enters the dwellings and causes damage to the dwelling itself and to the residents' belongings, particularly clothing and furniture. Household assets are usually not insured and the expenses of damage caused by flooding can be difficult to cover for many residents (Drivdal, 2011). Inhabitants are affected in different ways, and some experience more flooding than others do. However, flooding of shared space such as paths between dwellings, and public space and facilities affects almost all residents (Drivdal, 2011). Households, infrastructure and public facilities in Philippi suffer substantial flooding. Flood risk has made areas such as Philippi risky places for developmental investments for the City due to uncertainty of long-term preservation of assets, infrastructure and facilities (Bouchard et al, 2007).

The City has made some efforts to reduce flood risk in Philippi through infrastructure interventions and housing provisions. City efforts have improved the situation for some residents, but some efforts have exacerbated flooding impacts and increased vulnerability of many residents to flood risk (Bouchard et al, 2007). For example, residents of Graveyard Pond, a low lying detention pond in Philippi, were evictees of Phola Park, a settlement north of Philippi, due to the upgrading of Phola Park into a Reconstruction and Development Programme (RDP) housing settlement. The residents of Graveyard

Pond today live in worse conditions with higher flood risk as the development in Phola Park did not benefit a large number of them (Drivdal, 2011).

The arrival of winter brings with it anxiety associated with flooding expectations and impacts among the residents of Philippi as they prepare for the rainy season (Bouchard et al, 2007). Most residents make use of several practical improvements to their dwellings and the paths between the shacks (Drivdal, 2011). Coping mechanisms at household and community level for flooding in Philippi include: Placing household belongings and furniture at higher places and taking them to neighbours who are not affected by flooding, covering roofs and floors with plastic, raising shacks, and adding sand and rubble underneath shacks and in paths (Drivdal, 2011). Although some affected residents temporarily move to friends and family to find better shelter during flooding, many still choose to remain in their shacks (Drivdal, 2011).

The analysis above has identified the causes of flooding in Philippi as wetlands, lack of drainage infrastructure, and inadequate functioning of existing drainage infrastructure. Figure 19, shows the distribution of flood risk in Philippi. It can be deduced from Figure 19, that a large portion of the spatial distribution of flood risk in Philippi is made up of informal settlements lacking stormwater and sewer drainage systems or having inadequate drainage systems.

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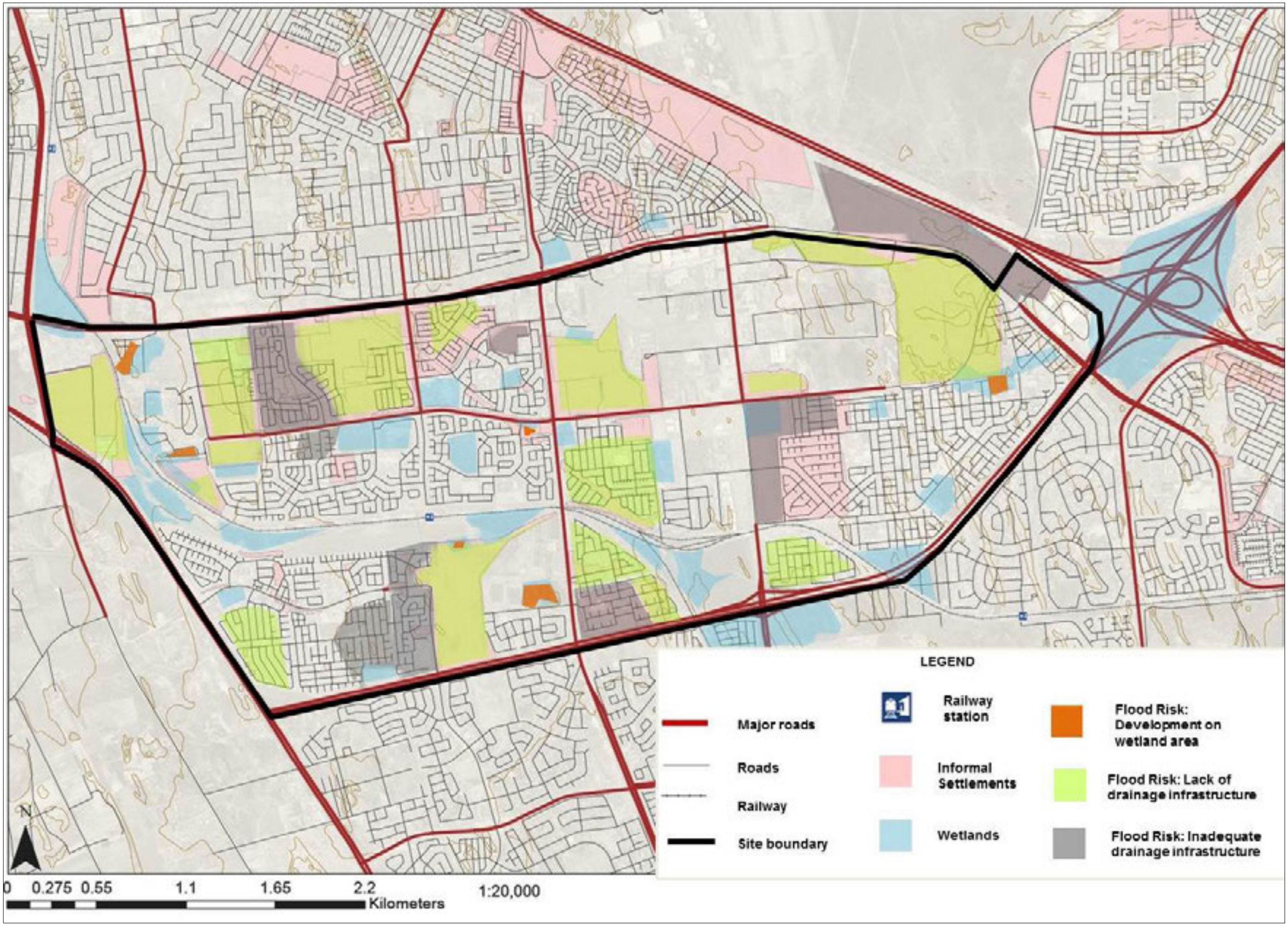

Figure 19, Flood risk in Philippi (Author, GIS Technical Library, University of Cape Town, 2016)

3.3 Current Policy and Institutional Arrangements Regarding Flood Risk in Philippi

3.3.1 National and Provincial Policies on Flood Risk, Adaptation and Infrastructure development

Disaster Management Act (Act 57 of 2002)

The Disaster Management Act makes provision for the prevention and reduction of disaster risk, mitigation of disaster severity, preparedness and effective response to disaster, and post-disaster recovery (Government Gazette, 2003). The Act forms the basis for adaptive planning and resilience building and places responsibility on provincial and municipal authority for context-based disaster risk management.

The National Disaster Management Framework

The National Disaster Management Framework is the legal instrument specified by the Disaster Management Act to address needs for consistency across a diversity of role players and partners, by providing a "coherent, transparent and inclusive" policy on disaster management. The framework recognises a diversity of risks and disasters, and prioritises development measures that seek to reduce the vulnerability of disaster-prone areas, communities and households. The National Disaster Management Framework requires and informs the development of provincial and municipal disaster management plans and frameworks (SA National Disaster Management Framework, 2005)

The National Water Act (36 of 1998)

The National Water Act makes provision for the protection and monitoring of water quality to ensure the sustainability of water resources through integrated management, and the management of water resources for the benefit of all users (City of Cape Town, 2015a). The Act places responsibility for water resource protection on local government and accentuates the need for stormwater quality control.

The National Environmental Management Act (NEMA) (107 of 1998)

The NEMA provides guiding principles for decision-making on issues affecting the environment, promotion of cooperative environmental governance, and coordination of environmental functions exercised by organs of state (Government Gazette, 1998). NEMA largely acknowledges that a large proportion of South African citizens live in environments that are harmful to their health and wellbeing, and delegates developers with the responsibility to prevent practices that have negative impacts on the environment (Vice, 2011). The Act states that:

"*everyone has the right to an environment that is not harmful to his or her health or well-being;…inequality in the distribution of wealth and resources, and the resultant poverty, are among the important causes as well as the results of environmentally harmful practices; sustainable development requires the integration of social, economic and environmental factors in the planning, implementation and evaluation of decisions to ensure that development serves present and future generations*" (page 2)

Spatial Planning and Land Use Management Act (SPLUMA) (16 of 2013)

The SPLUMA sets out the spatial planning system for South Africa. It provides development principles for decision making and norms and standards, and describes the functions of planning at all 3 spheres of government by categorising spatial planning. The Act also sets minimum standards and requirements for land use and land development management, and for the provision of engineering services. (Ogle, 2015; The Spatial Planning and Land Use Management Act, 2013).

Infrastructure Development Act, 2014 (Act No. 23 of 2014)

The Infrastructure Development Act provides for the facilitation and co-ordination of public infrastructure development as a significant element of national social and economic development. The Act seeks to ensure that infrastructure development is given priority in planning, approval and implementation, and that the state's development goals are promoted through infrastructure development. The Act also makes provision for improvement in management of infrastructure during all life-cycle phases, through the processes of including planning, approval, implementation and operations (Infrastructure Development Act, 2014)

Western Cape Planning and Development Act (7 of 1999)

The Western Cape Planning and Development Act provides guidelines for planning and sustainable development, where provincial and regional interests, including environmental protection and land development management, are involved (City of Cape Town, 2015). The Act makes provision for the establishment of a development planning system and consolidation of provincial legislation regarding provincial, regional and municipal planning

Western Cape Disaster Management Framework

The Western Cape Disaster Management Framework is a requirement of the Disaster Management Act. Its functionality is consistent with requirements specified in the National Disaster Management Framework

3.3.2 City of Cape Town Policy on Flood Risk, Adaptation and Infrastructure development

City Of Cape Town Municipal Disaster Risk Management Plan

The City of Cape Town Municipal Disaster Risk Management Plan serves as the mechanism of coordination and cooperation between different stakeholders for disaster risk management in Cape Town. The plan also confirms organisational arrangements and institutional frameworks within the City of Cape Town for disaster mitigation and prevention.

City of Cape Town Management of Urban Stormwater Impacts Policy

The main objective of the City of Cape Town Management of Urban Stormwater Impacts Policy is to minimise the negative impacts of urban stormwater runoff on the environment, through water-sensitive urban design principles in stormwater management and urban planning in Cape Town. The City of Cape Town Management of Urban Stormwater Impacts Policy is regarded as the most advanced policy on stormwater management in South Africa, as it supports water-sensitive urban design principles and SUDS practices (Vice, 2011). This Policy supports the Roads and Stormwater Department objectives to reduce flooding impacts on community livelihoods and regional economies, and maintain and encourage good human health, protect natural environments, and improve and maintain recreational water quality (Roads and Stormwater Department, 2009).

Floodplain and River Corridor Management Policy

The Floodplain and River Corridor Management Policy acknowledges the need for development within the Cape Town Metropolitan area to be carefully managed to avoid developing in high flood risk areas, protect environmental integrity, and ensure that legitimate development enhances the character of adjacent watercourses and wetlands. The policy advocates for a merit based approach with socio-economic considerations to handling proposals within and in close proximity to flood prone areas and environmental buffers (City of Cape Town, 2009).

By-Law Relating to Stormwater Management

The By-law Relating to Stormwater Management makes provision for the regulation of stormwater management and any activities which may have negative impacts on the development, maintenance and operation of stormwater systems in the area of the City of Cape Town (PG6300:2005; Provincial Gazette, 2005). The by-law also stipulates penalties for offences related to stormwater (Vice, 2011).

Water Services Departmental Sector Plan for City of Cape Town

The Water Services Departmental Sector Plan makes provision for integrated planning which includes a public participation process in informing the distribution of water resources and services, and water-related infrastructure in Cape Town.

Framework for Adaptation to Climate Change in the City of Cape Town

The Framework for Adaptation to Climate Change in the City of Cape Town is a consolidated and coordinated approach to the reduction of vulnerability to climate impacts. It serves as a response to the potential impacts of climate change and decision-making guide for development of adaptation options and strategies in the Cape Town Metropolitan area

Cape Town Spatial Development Framework (CTSDF)

The CTSDF is a long-term (±20-year) plan to manage growth and change in Cape Town. One of the main purposes of the SDF is its provision of policy guidance to direct decision making on the nature, form, scale and location of urban development, land use change, infrastructure development, disaster mitigation and environmental resource protection. It provides a long-term vision of the desired spatial form and structure of Cape Town

Integrated Development Plan (IDP)

The IDP is a 5-year plan, which aligns resources and municipal capacity to its overall development goals and guides the budget of the municipality. This plan identifies key development priorities, then develops appropriate strategies and organisational structures and aligns resources with the identified development priorities.

The Khayelitsha-Mitchells Plain District Plan

The District Plan is a medium term plan developed on a ±10 year planning frame that guides spatial development processes within the District. The district plan is informed by the CTSDF. It informs the development of priorities for more detailed local area planning exercises and frameworks that should provide detailed guidance to land use management and public and private investment in the district of Khayelitsha-Mitchells Plain. Figure 20 is a map of the Philippi sub-district of the Khayelitsha-Mitchells Plain District. The District plan outlines the following as some of the main spatial development objectives for the Philippi sub-district:

- Unlock the latent potential of Philippi Industrial
- Intensification and urban form/character

- Protect and support the upgrade of existing public open spaces
- Informal settlements upgrade

There is a lack of spatial representation of flood risk in the Philippi Sub-district Plan. This plan represents flood risk as an aspect of grouped characteristics of the environment to form core(s) as seen in Figure 20 map key. This representation is informed directly by plans from higher tiers of government and shows no existence of flood risk in Philippi. Therefore it undermines the significance of flood risk in Philippi.

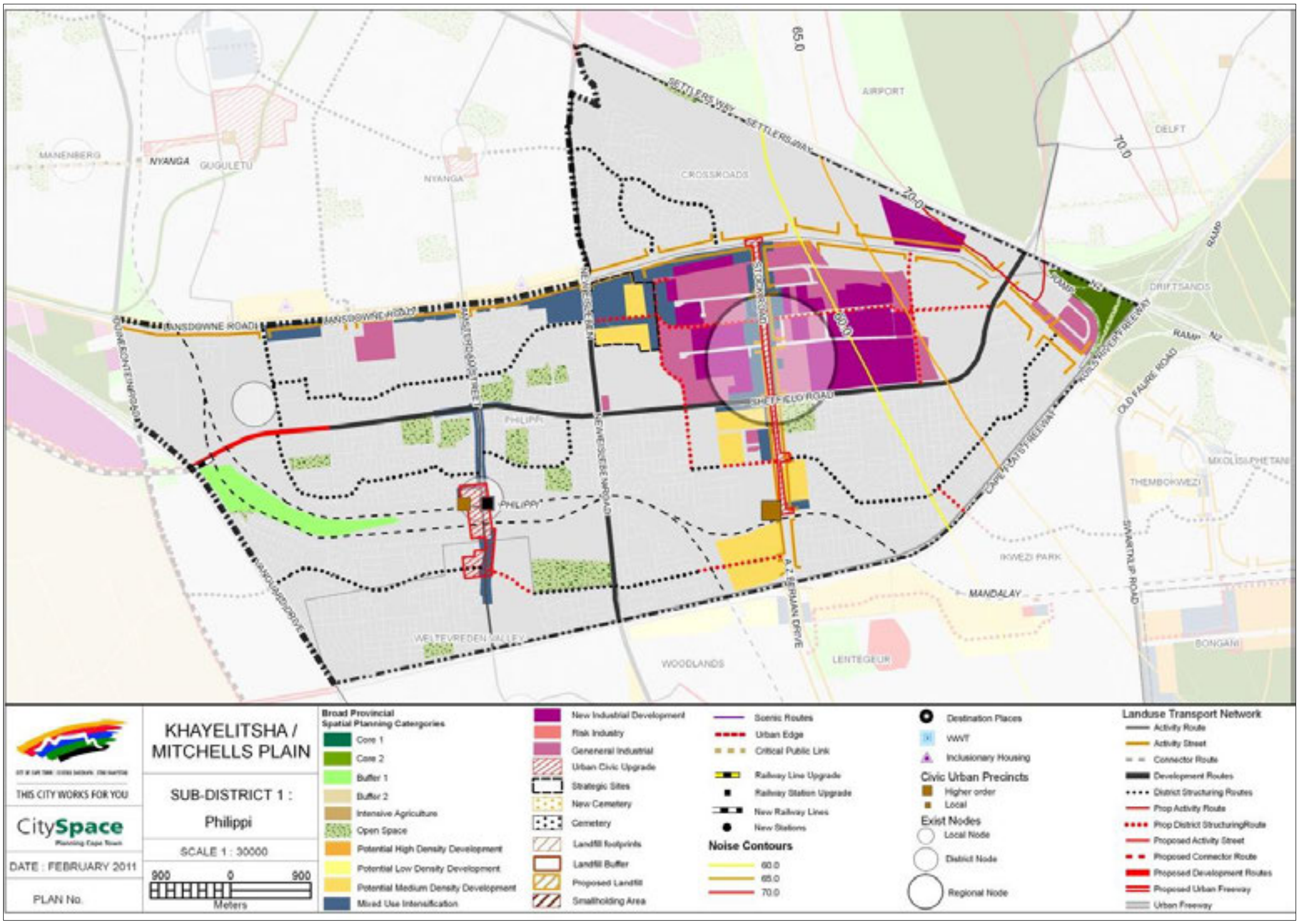

Figure 20, Map of the Philippi sub-district development plan (City of Cape Town, 2012c)

Other relevant municipal policies that broadly or indirectly relate to flood risk management and provision of infrastructure and services in Philippi include the Infrastructure Master Plans, Strategic Framework for a City Development Strategy and other sector-specific policies pertaining to flood risk management and infrastructure planning and development. Most of the national, provincial and local policy presented here has influence on planning and development regarding flood risk in the township Philippi.

3.3.3 Institutional Arrangements

Although Disaster Risk Management policy and legislation explicitly outlines the various institutional arrangements needed, at different levels of government, there is a lack of the necessary institutional structures needed at these levels (Van Niekerk, 2011). It is important for policy to guide and inform the creation and management of institutional structures that enable flood risk management programmes and projects to access, mobilise, and channel resources (Waddell, 2016).

For many years the City of Cape Town has had a fragmented approach to flood risk, which has seen most of the responsibilities for flood risk management left to one state entity alone – the Disaster Risk Management Centre- whose efforts have been mainly short term and reactive (Tierney, 2012). The City of Cape Town has made efforts to shift towards more proactive and collaborative approaches to flood risk management. One of the most innovative institutional structures in Cape Town when it comes to flood risk is the Flood and Storms Emergency Planning Task Team (FSEPTT). Established in 2008, the FSEPTT is a multi-departmental platform, which serves the purpose of addressing flood risk across Cape Town (Desportes, et al., 2016). The FSEPTT is coordinated by the Disaster Risk Management Centre, and is made up of members from around 22 municipal departments, local politicians, waste collection contractors, weather forecasting teams, the media and civil society organisations (Desportes et al., 2016).

Although the FSEPTT is recognized as an innovative, holistic, collaborative and proactive institutional structure, there are very few collaborative efforts and many interventions that are carried out by individual departments (Waddell 2016). Therefore, according to the way it functions, the FSEPTT is a platform for the different actors to share activities and hold each other accountable for their progress. Having different actors dealing with separate intervention activities has led to a shift away from the institution's objective of collaborative governance (Waddell 2016).

There are also other institutional structures, not directly associated with the FSEPTT, that are involved in community-based or development-related work that overlaps with and impacts on flood risk reduction within Cape Town. Some of them partner with the City of Cape Town on activities or projects, but most work directly with informal settlements, with external sources of funding (Waddell, 2016). These structures include local mosques and churches, academic institutions, service providers and contractors, businesses and retail outlets, and local civic organisations involved in education, poverty alleviation and food security.

3.3.4 Review of Policies and institutional arrangements

The various legislation, plans and frameworks explored herein acknowledge the existence and effects of flood risk in the Cape Town municipal area. Four key points can be drawn from the analysis of these documents. Firstly, a majority of these documents have great consideration for the importance of the influence of social and political history on present flood risk (Jozipovic, 2015). This has formed a valuable perspective and approach to planning and development at all levels of government, which is evident in the policies' aims and aspirations for enhanced infrastructure and socio-economic development, and sustainability. However, the policies are predominantly directed towards development and planning for formal parts of the city and informal settlements are seemingly a secondary consideration in planning and policy-making processes.

Secondly, a large part of the policies' response, particularly to flood risk, is short-term and reactive. Although the Cape Town Metropolitan area is considered to have the best run disaster management municipal department in the country (Rylands, 2016), disaster management in the City of Cape Town remains unsustainable because there is continuous effort and financial spending on short-term emergency response to disaster risk (Ziervogel & Smit, 2009; Paundi, 2012). The general lack of longer term solutions to flood risk has led focus away from resolving the root cause of increasing impacts and extent of vulnerability to flood risk within the city, thus, undermining the role of planning and infrastructure development in flood risk management.

In the third place, at local government level, there is still a lack of local (neighbourhood-level) developmental plans with focus on risk reduction and adaptation. Developmental plans generally narrow down to district level, a scale that is still large and to some extent undermines the significance of flood risk at neighbourhood and community scale. It is important that there is a thorough understanding of why and how things happen in a local context because it helps in identifying certain policies or practices that may be transferrable to the context (Jozipovic, 2015).

Finally, the role of disaster risk management as a coordination unit is well-defined at all levels of government. Municipal disaster plans and frameworks are required and informed by national and provincial disaster risk management policy. The disaster risk management framework has placed responsibility of context-based disaster risk management on municipal government to enhance local capacities to deal with disaster related activities (Paundi, 2012). Although the institutional framework for disaster risk management in Cape Town is commendable and generally well-managed, the entity is not institutionally integrated with other development and planning related departments. On the ground, however, the Western Cape Province and CCT practise ad hoc collaborative management of disaster risk (Rylands, 2016).

Many interventions are carried out by individual departments, and very few collaborative efforts have been apparent in working towards flood risk reduction and adaptive capacity building (Waddell 2016). This institutional fragmentation in the approach to flood risk generally results in inefficiency and ineffectiveness in approaches to development in areas vulnerable to disaster risk. For example, a study by Waddell (2016) shows that flood- associated risk highlighted by local authorities in the settlement of Sweet Home in Philippi are not necessarily the same as those prioritised by the communities. This reveals an existence of weak relationships between the state and affected communities and individuals.

3.4 Summary of findings

This section summarises the key findings of the analysis of the current status quo of flood risk in Philippi. Firstly, this section recaps the key issues identified from the analysis of the settlement and existing policy. Then spatial constraints and opportunities are identified, which leads to a brief statement of the key priorities extracted from the analysis, that inform the researchers approach to intervention for the site.

3.4.1 Key Issues

Table 3 Key issues regarding the current status quo on flood risk in Philippi (Author, 2016)

KEY ISSUES	
Policy and Institutional Framework	• Lack of local level spatial plans with focus on risk reduction and adaptation • Fragmentation of institutional framework makes implementation of plans difficult • The informal sector is not sufficiently encouraged,

	invested in or planned for • Response to flood risk is predominantly short-term and reactive • Low investments in the improvement of areas of high disaster risk
Socio-economic	• Many inhabitants are unemployed, live in poverty, and have no means of protecting their dwellings and belongings from flooding, therefore priorities are mainly directed towards maintenance of daily livelihoods • High in-migration rates and lack of settlement options for the residents, due mainly to income and land availability limitations.
Infrastructure & Housing	• Inadequate stormwater and sewer drainage systems, and lack of adequate sanitation • Rapid city in-migration increases number of residents living in informal dwellings and high flood risk areas i.e. increasing number of inhabitants vulnerable to flood risk • Overcrowding of settlements makes it difficult to upgrade and retrofit existing developments

3.4.2 Constraints and Opportunities

Constraints

Philippi is located on low-lying land and on top of an aquifer, which makes its informal settlements and other parts of it with inadequate infrastructure highly susceptible to flooding because the groundwater table elevates to the surface rapidly on low-lying land.The CFA is highly susceptible to pollution from sources from the surface, particularly from areas with inadequate stormwater and sewerage drainage. In Philippi this is a common state in informal settlements, and pollution of surface and groundwater is exacerbated by flooding, posing a threat to human and environmental health. The flooding of wetlands in Philippi also poses a threat to surrounding developments and livelihoods, and limits space for residential development to accommodate the growing population of Philippi.

High densities and overcrowding of informal settlements constrain infrastructure development and upgrading, and the anticipated increase in intensity of flooding in Philippi impedes plans for development and investment in the area. Figure 21 is a constraints map for Philippi.

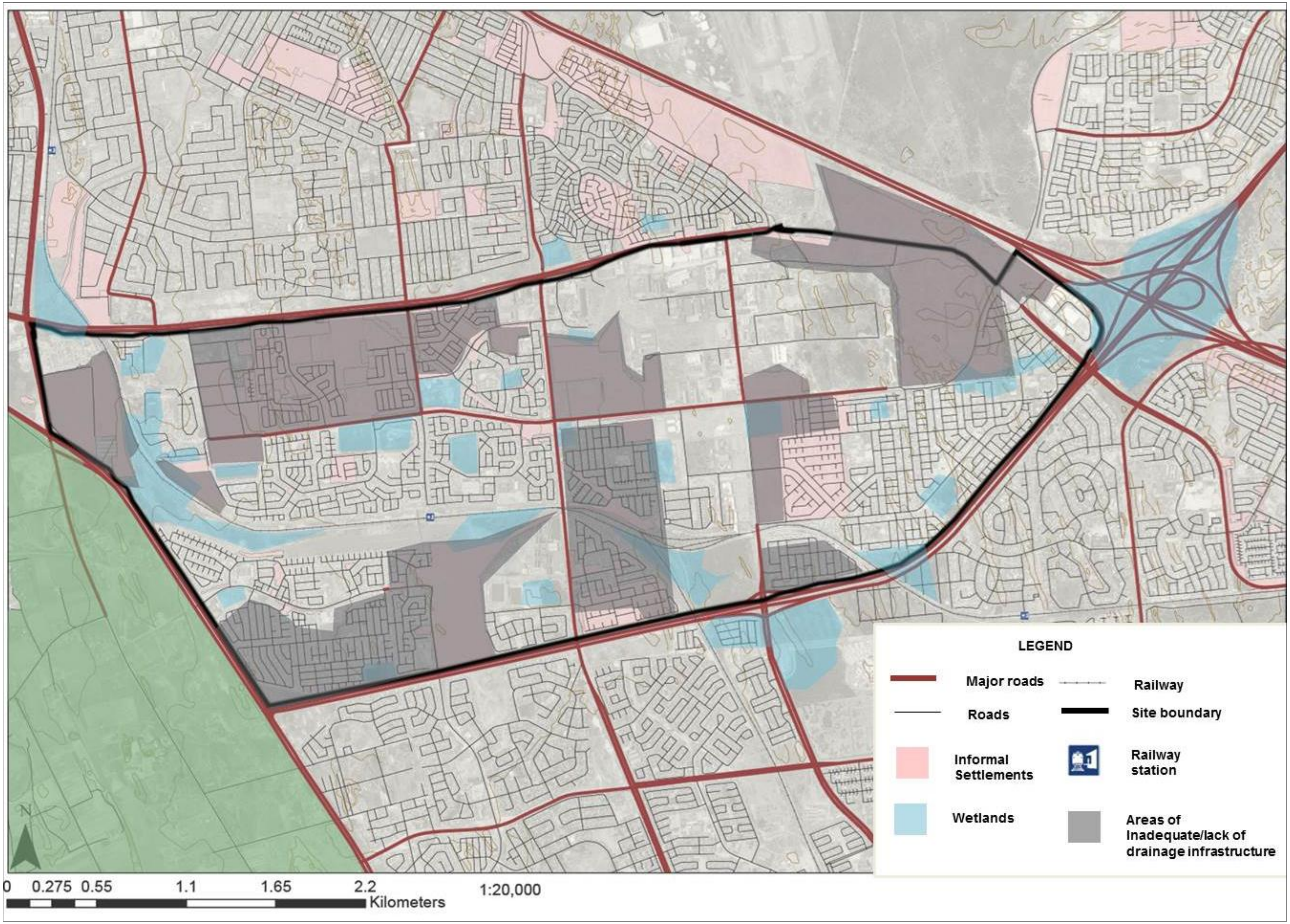

Figure 21, Constraints Map (Author, GIS Technical Library, University of Cape Town, 2016)

Opportunities

The current land use in Philippi and its surrounds provides a lot of opportunities for future development. Philippi is well-located in terms of transport networks within the city. It is surrounded by rail routes and major roads including the N2, M7, R300, and the Lansdowne Road, and is located in close proximity to the Cape Town International Airport, making it ideal for business development.

Philippi is also identified as a growing economic hub with high economic potential, not only for the site itself but for the city and province too. The existing industrial/commercial area in Philippi has been a target for massive social and infrastructural improvement, which could benefit the development and upgrade of informal settlements in Philippi. Philippi is set to become the central business district for the southeast of the Cape Town Metropolitan area (Haferburg & Ossenbrügge, 2003).

The settlements of Philippi are located adjacent to the PHA, an urban agricultural district in Philippi. The PHA has an average farm size of 32ha, which has potential for expansion. Enhancing agricultural activity in the PHA would increase food security and employment opportunities of the residents of surrounding areas, and the city at large. It would also serve as a strategy to secure the area as a place for agricultural land use, as it is regarded by many property development bodies as an area with potential for development. Retaining the PHA for farming activity would attract investment in social services and housing in the surrounding areas, which will boost the emerging economic node in Philippi (Battersby-Lennard & Haysom, 2012).

Within its broader context, the site is underlain by the CFA, which presents opportunities for water storage and reclamation. The CFA can be seen as a potential supplementary source of water for the city, particularly the areas which it comprises. Investment in the CFA as a water source for the city would make urban agriculture in PHA more productive and sustainable due to a proximate water source, and reduce the cost of water delivery for residents in the area. Figure 22 is a spatial representation of the opportunities.

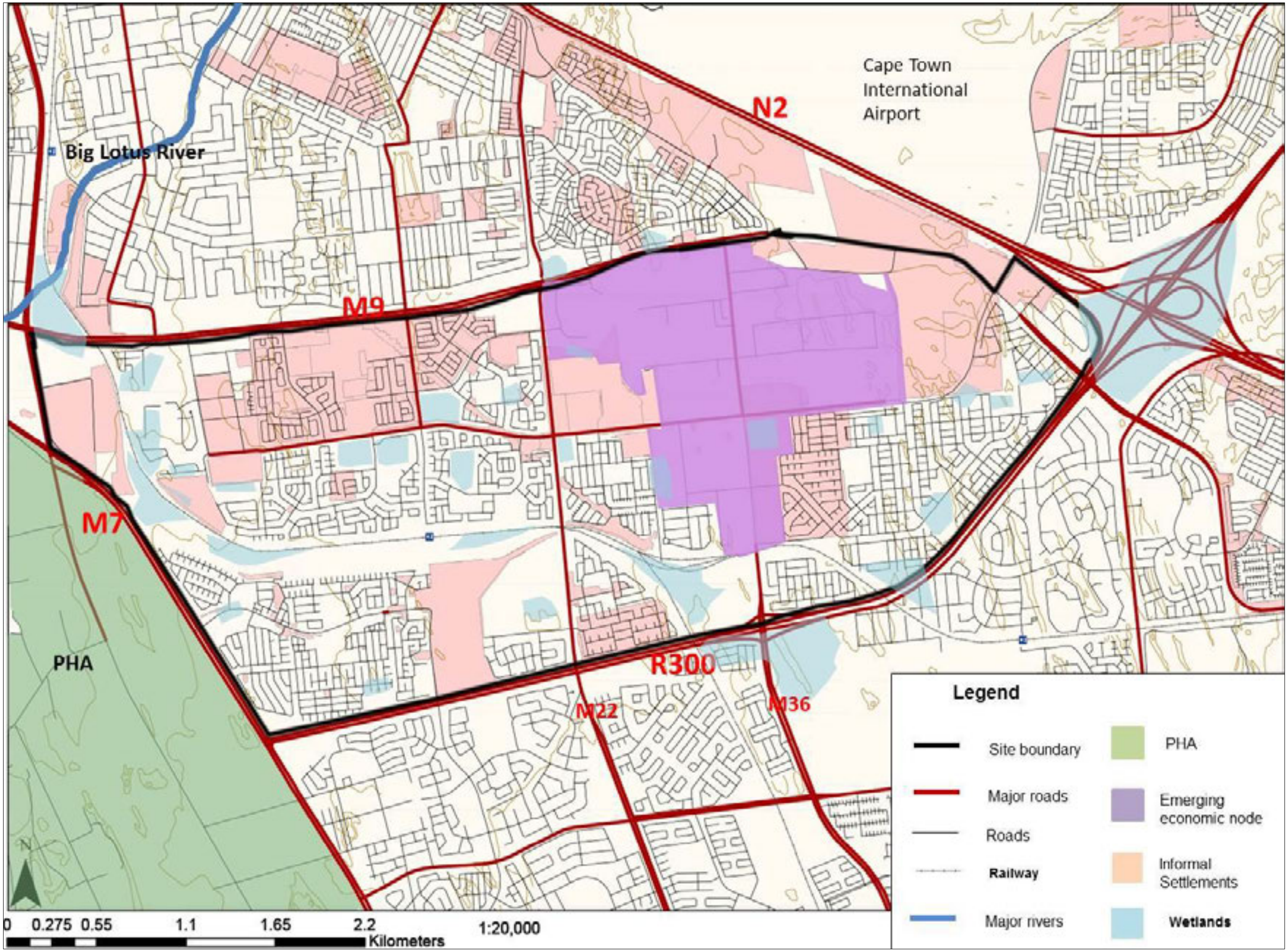

Figure 22, Opportunities Map (Author, GIS Technical Library, University of Cape Town, 2016)

3.5 Key priorities

Challenges facing cities in developing countries are increasingly receiving attention as the urgency of prioritising interventions and moving towards effective implementation in resource-scarce contexts has become more apparent. Analyses and policy agendas are progressively more focusing on potential contributions of diverse forms of urban greening through integrated strategies to enhance resilience, promote urban transformation and reduce vulnerability (Simon, 2016). It is, therefore, essential that any approach to planning and development in Philippi has consideration for risk-informed strategic planning that aims at identifying long term solutions to flood risk and making sustainable local level planning for floor risk in informal settlements a priority. It is important that development and upgrading of a low income settlement with high flood risk like Philippi directs a large amount of focus on building resilience at community and household level to enhance the settlement's appeal and facilitate identification of its potential for developmental investments. One of the strategic approaches to achieving this is through recognising infrastructure as the key to adaptive capacity building and long term planning for flood risk. This is the guiding approach to the interventions for this dissertation.

CHAPTER FOUR

4. PHILIPPI SPATIAL FLOOD RESILIENCE FRAMEWORK (SFRF)

4.1 Introduction

In seeking more robust solutions to flood risk, current flood risk management discourse recognizes the importance of relying on the structural and spatial measures that minimize risk, and on the non-structural measures that complement the structural measures (Waddell, 2016). Robust solutions to flood risk in urban areas can contribute to the reduction of risk, while creating opportunities to promote more resilient and sustainable urban development (Jha, et al., 2012), and contributing to socioeconomic advancement. It is vital for flood risk management to strike a balance between short term approaches that minimize impacts through urban management and maintenance of flood mitigation infrastructure, and longer term approaches that anticipate and help prevent future flood hazard. The balance will be different for each city or neighbourhood, and may be achieved by constructing new flood mitigation infrastructure or radically reshape the urban environment at risk (Jha et al, 2012).

Managing flood risk by adapting infrastructure to the impacts of climate change and climate-related hazard needs to be a key aspect of urban water resource planning and management. This requires a local plan with adaptation objectives to identify the risks, quantify water infrastructure capacities and develop a range of engineered, operational and policy options (Baker, et al., 2012). While infrastructure and adaptation initiatives remain essential in approaching urban flood risk, it is vital to ensure that urban flood risk management is well integrated with urban planning and has great considerations for poverty reduction, climate change, and basic service delivery (Jha et al, 2012). Urban water infrastructure is characterized by long lifespans and costly investments. Once built, there is little choice to go for changes, due to financial, organizational and technical reasons. Therefore, it is important that the basis of planning for flood resilience and implementation of infrastructure interventions has an integrated approach that recognizes that the choices made will affect the environment, the use of resources and people's quality of life (Malmqvist, et al., 2006).

This chapter offers a Spatial Flood Resilience Framework (SFRF) for Philippi, which would serve as a spatial planning tool to guide the improvement of adaptive capacity to flood risk in Philippi. The framework is guided by principles of socio-spatial justice, spatial integration and environmental sustainability.

Socio-spatial justice is an essential guiding principle in local area planning for flood resilience in Philippi. The principle of socio-spatial justice promotes the need to explore sustainable solutions to the impacts of rapid urbanisation, climate change, and risk, on marginalised communities, and to promote level social and economic opportunities within the city. Because the legacy of apartheid still manifests itself in the structure of Cape Town as a city, it is essential to have spatial development that facilitates the spatial integration of people, services and dwellings through strategic spatial development and coordination in planning and management systems to enable equal and efficient access to services and opportunities. The principle of environmental sustainability guides sustainable development and promotes the protection, restoration and enhancement of natural environments in local development interventions. Environmental sustainability is an important guiding principle in neighbourhood- or settlement-level planning because it facilitates the realisation of environmental concerns that are important and significant at all scales, but may be invisible or overlooked at district, city or regional scales.

The SFRF aims to contribute to flood risk reduction and encourage infrastructure interventions as key to building adaptive capacity and resilience to flood impacts in Philippi. The main objective of this SFRF is to guide development towards avoiding flood risk and strengthening flood resilience in Philippi, and to contribute to the health, safety, and wellbeing of Philippi residents. Another objective of the SFRF is to use infrastructure-led planning interventions to unlock opportunities for investment and socioeconomic advancement by making Philippi more investment-ready and attractive for further infrastructural and economic development. It attempts to do this by identification of more sustainable ways to intervene with infrastructure through local area planning. The SFRF also aims to promote human and environmental health by encouraging augmentation of water quality and waste management capacity and support sustainability in terms of residents' livelihoods and water resource use. The SFRF is a spatial plan to guide development in Philippi for the next 25 years (2017-2041). This long term period of the SFRF is chosen to enable long term planning for resilience and adaptation, and to facilitate strategic implementation and monitoring of the strategies and projects set out in the SFRF.

The first section of this chapter sets out the key strategies guiding the recommendations set forth for the SFRF. The strategies are followed by the SFRF, which expands on the spatial aspects of the key strategies and illustrates three conceptual layouts as spatial layers representing the key strategies that subsequently make up the SFRF for Philippi.

4.2 Key Strategies

This dissertation recognizes flood risk in Philippi as a phenomenon that coevolves from relationships and interfaces between social systems, technical systems and the natural environment. This perspective facilitates the coupling of infrastructure interventions and spatial planning, which is the overall approach used in drawing up the SFRF for Philippi. This section briefly summarises the key strategies used in approaching and proposing the SFRF. The key strategies are four key interrelated components that make up the SFRF (see Figure 23),

Reducing flood risk through land use planning: The notion behind this approach is the use of land use planning as a flood risk mitigation measure with the potential to guide future development towards decreasing vulnerability and exposure to flood risk in Philippi.

Reducing flood risk through flood-aware residential development: This approach involves minimizing flood damage to housing and inhabitants' property through flood aware residential design, which includes structural adaptations to dwellings and residential areas to reduce flooding impacts.

Enhance water infrastructure systems: Because flood risk is not the only water-related issue in Philippi, it is important that efficiency guides the planning and management of water infrastructure networks. Resources such as land and water are increasingly becoming scarce in Cape Town; therefore, this approach promotes efficiency by encouraging the multi-functionality of water infrastructure systems to inclusively address some of the social, technical and natural systems issues affecting Philippi.

Improving policy and institutional arrangements: The enhancement of the policy and institutional frameworks is important to ensure effective and efficient future spatial planning and flood risk management in Philippi. This strategy is explored in chapter 5.

Figure 23, Diagram illustrating a summary of the key strategies used in approaching the intervention to building adaptive capacity to flood risk in Philippi (Author, 2016)

4.3 Reducing risk through land use planning

Land use planning is an essential flood risk mitigation measure with the potential to avoid exposure to flood hazards and to reduce exposure and vulnerability over time in already urbanized areas. Given that Philippi is located on lowland and is prone to flooding, it is necessary for land use development controls on the site to be informed by its topographical and geographical characteristics. Land use categorization in Philippi should be based on the risk of flooding and should be able to guide the identification of measures to protect the natural depressions which serve as waterbodies on the site in order to prevent further flood risk from encroachment by new residents and developers.

This strategy involves highlighting the areas of wetland-associated flood risk on the site and classifying them as flood zones, where no residential development or any land use that includes hardening of surfaces that may exacerbate flooding impacts. Because construction of informal settlements has already taken place on a large part of Philippi, and demand for land and housing in the city is high, it is necessary to consider alternative uses for the land identified as wetland-associated high flood risk (for example Figure 24 and 25), to ensure that informal settlements do not further develop in these flood zones. The choices of alternative uses of land in a flood zone need to be carefully planned and it should be ensured that they are compatible with adjacent land use, and do not intensify exposure and vulnerability to flooding on the site or transfer the risk elsewhere. Wetland areas may also be enhanced to allow for their restoration and rehabilitation or alternative land uses that enhance the stormwater management systems on site may be introduced on some wetlands to increase flood resilience. The example in Figure 3, particularly, is of global north origin and extra care should be taken in implementation of ideas from the global north, and where necessary, alterations may be made to the exported ideas or designs to suit the context of Philippi. This does not, however, imply that all global south examples of land use alternatives for flood zones are suitable. The feasibility of all precedent alternatives need to be thoroughly evaluated before implementation.

The general recommendation implied by this strategy is that minimal changes occur in the current land use categorisation, which is mainly residential with a variety of micro-enterprises on a large portion of the site (Charman & Petersen, 2015), and a growing industrial node on the northeast section of the site (Figure 26). The industrial node is an economic hub for Philippi and has great potential to attract further economic, infrastructural and social investment in Philippi and surrounding neighbourhoods. This strategy identifies the industrial node as an essential catalytic section of the site that attracts investment and spreads potential for investment to the rest of the site, to benefit residential development and infrastructure interventions in reducing the impacts of flood risk on the site. Figure 26 is a conceptual layout of the spatial layer representing this strategy in the SFRF.

source:http://www.terraforce.com/erosion-control/storm-water-and-erosion-control/storm-water-management-decorwall-block-system/

The detention pond captures storm water runoff from the surrounding area, where it is stored and potentially used for irrigation. The pond absorbs excess water to protect against flooding. It releases run-off into nearby streams and storm water drainage pipes. The pond has an interlocking, permeable retaining wall system, which limits the space lost around the detention pond, allows for infiltration, and creates the largest pond possible in the space available. This type of detention pond can be used as an alternative land use for smaller wetlands or flood zones in Philippi.

Figure 24, Precedent for alternative flood zone land use: Detention pond in Kuilsriver, Cape Town (South Africa)

Figure 25, Precedent for alternative flood zone land use: Water Square design in Rotterdam (Netherlands)

(Source: http://www.urbanisten.nl/wp/?portfolio=waterpleinen)

The water square combines water storage with the improvement of the quality of urban public space. Throughout most of the year, the water square is dry and used as a recreational space. When heavy rains occur, rainwater that is collected from the surrounding is filtered and flows into the water square. The rainwater is held in the square until the drainage system has enough capacity again to transfer the water offsite to the nearest open water system or into the main stormwater drainage system. The water square may be an effective land use alternative for flood zones in Philippi because of the multiple uses and benefits that it would provide to the local community and to the water infrastructure network in controlling water to avoid the local impacts of flooding.

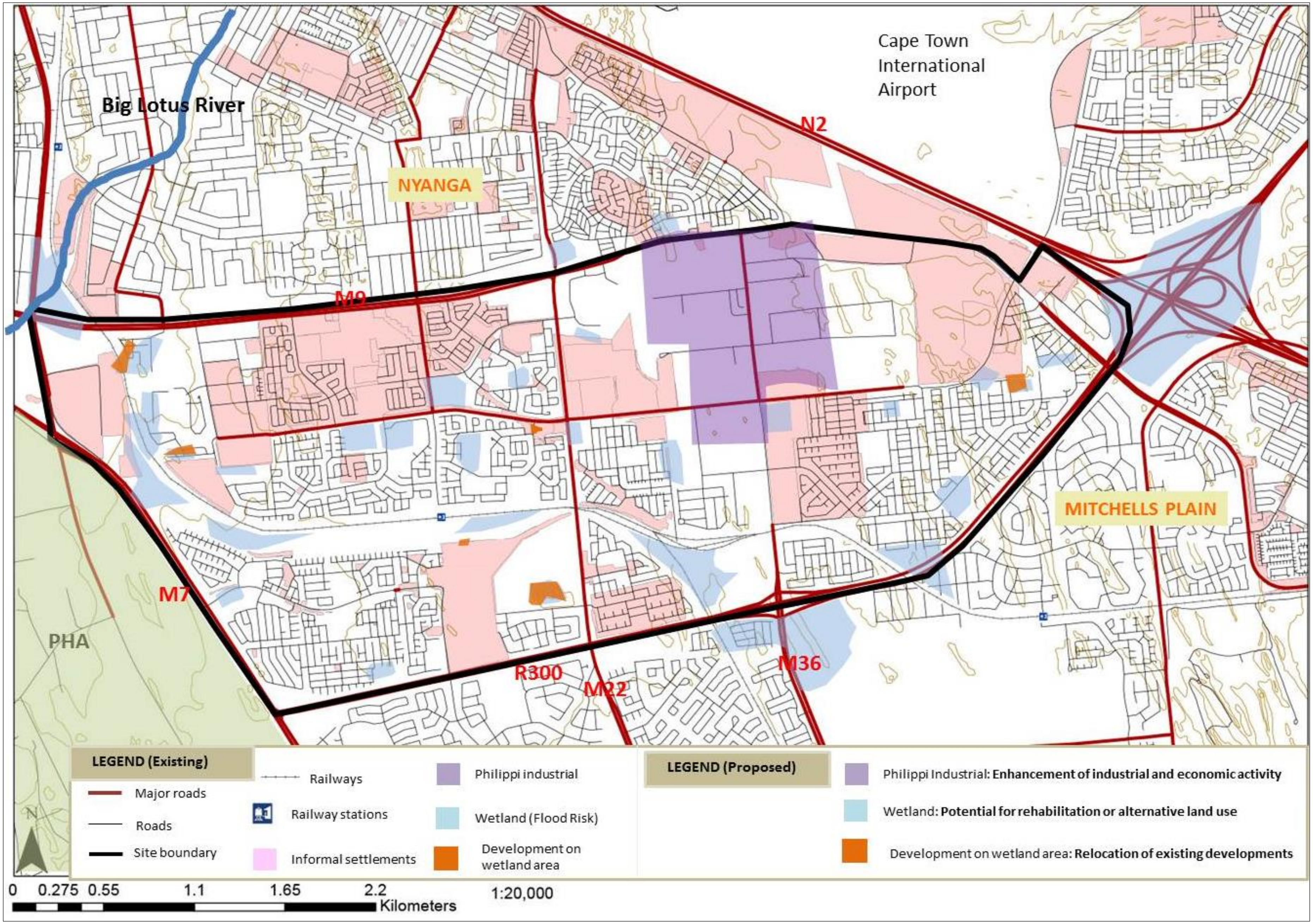

Figure 26, Map showing the first spatial layer of the SFRF: a conceptual representation of flood risk reduction through land use planning in Philippi (Author, GIS Technical Library, University of Cape Town, 2016)

4.4 Reducing risk through flood-aware residential development

Finding alternative uses for high flood risk areas, particularly those of current residential land use in informal Philippi, will require reorientation of existing development and relocation of existing dwellings to areas that are less susceptible to flooding. This strategy is a recommendation for upgrading of informal settlements in Philippi to accommodate relocation from flood zones, speed up the processes of low-income housing provision, improve security of tenure, enhance flood resilience in buildings through adaptable designs, and reduce unplanned high-risk informal settlements. The plan to upgrade the informal settlements would imply that eventually the informal settlements of Philippi would be considered as formal parts of the city.

It is important for settlement upgrade development in Philippi to consider flood resilience and adaptation in housing design and development. The type of housing development for the settlement upgrade should be designed to withstand possible flooding in the area and be kept out of the high flood risk zone. Flood-proofing residential developments would require resilient design, which involves various structural adaptations to the buildings, outdoor spaces and infrastructures to reduce flooding impacts. The settlement upgrade developments should maintain high densities, in order to accommodate the existing and future population and dwelling densities, and also the relocation of residents settled in high flood risk areas.

The informal settlement upgrade model in Figure 27 below is adapted from Architect Laurie Baker's model for upgrading slums in India (The Hindu, 1997). It presents an option that could be considered in reorienting Philippi to promote efficient and sustainable land use and increase adaptive capacity to flood risk. This model supports relocation of residents from high flood risk zones and increasing density by building upward extensions to residential developments to allow them to accommodate other uses that directly benefit the communities, such as small scale retail, public open space and public amenities. The model makes provision for a stepped-tier progression of density from low to medium density flood resistant housing development adjacent to the identified flood risk zone, to higher density residential and mixed use development further from the flood risk zones. Figure 28 is a conceptual layout of the second spatial layer of the SFRF representing the strategy to reduce flood risk through flood-aware residential development.

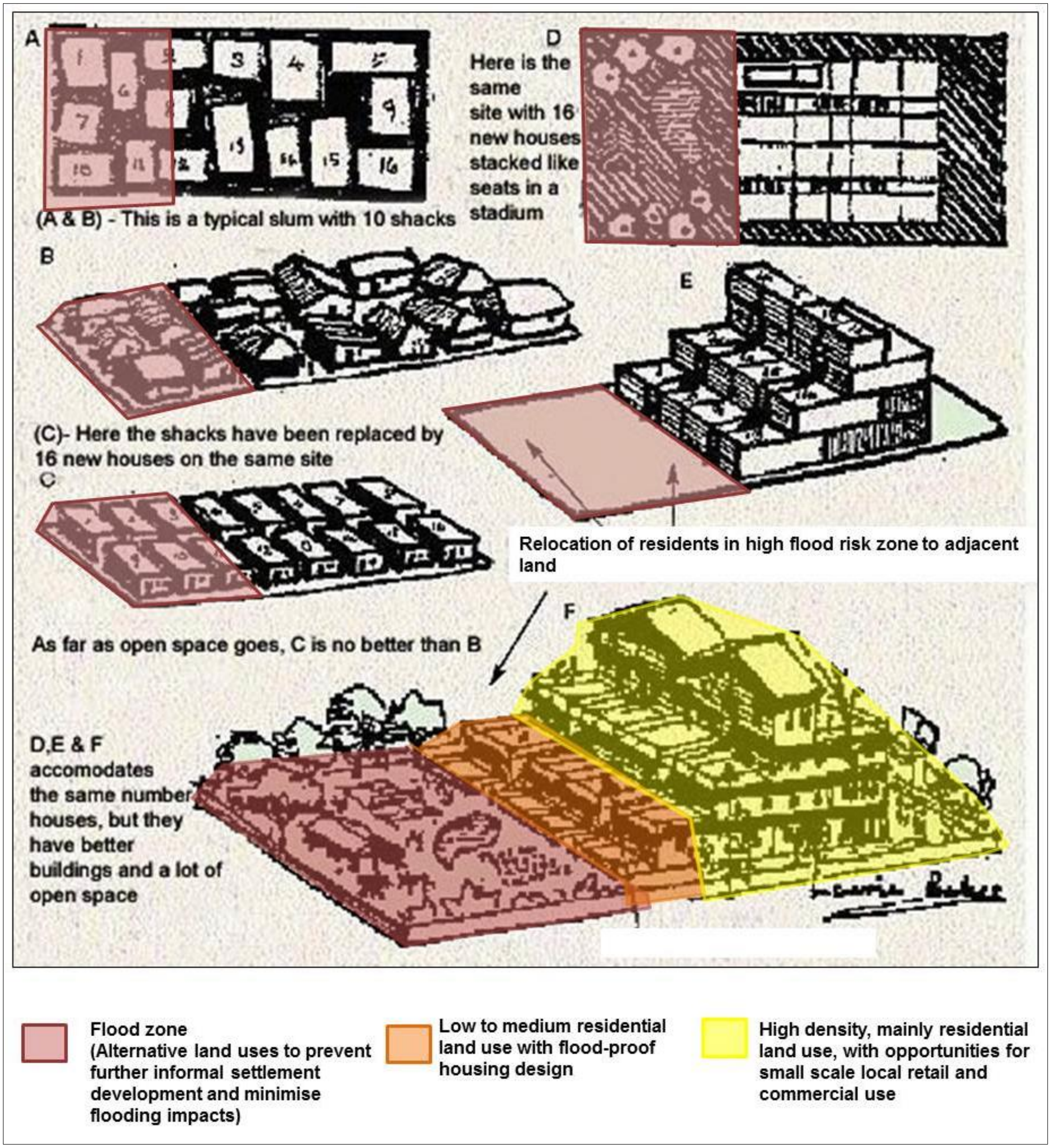

Figure 27, Informal settlement upgrading model, showing an option of layout and density concept for residential development adjacent to flood zones. [Model adapted from "Architect Laurie baker's idea on "What can we do with a slum?"] (*The Hindu, 1997)*

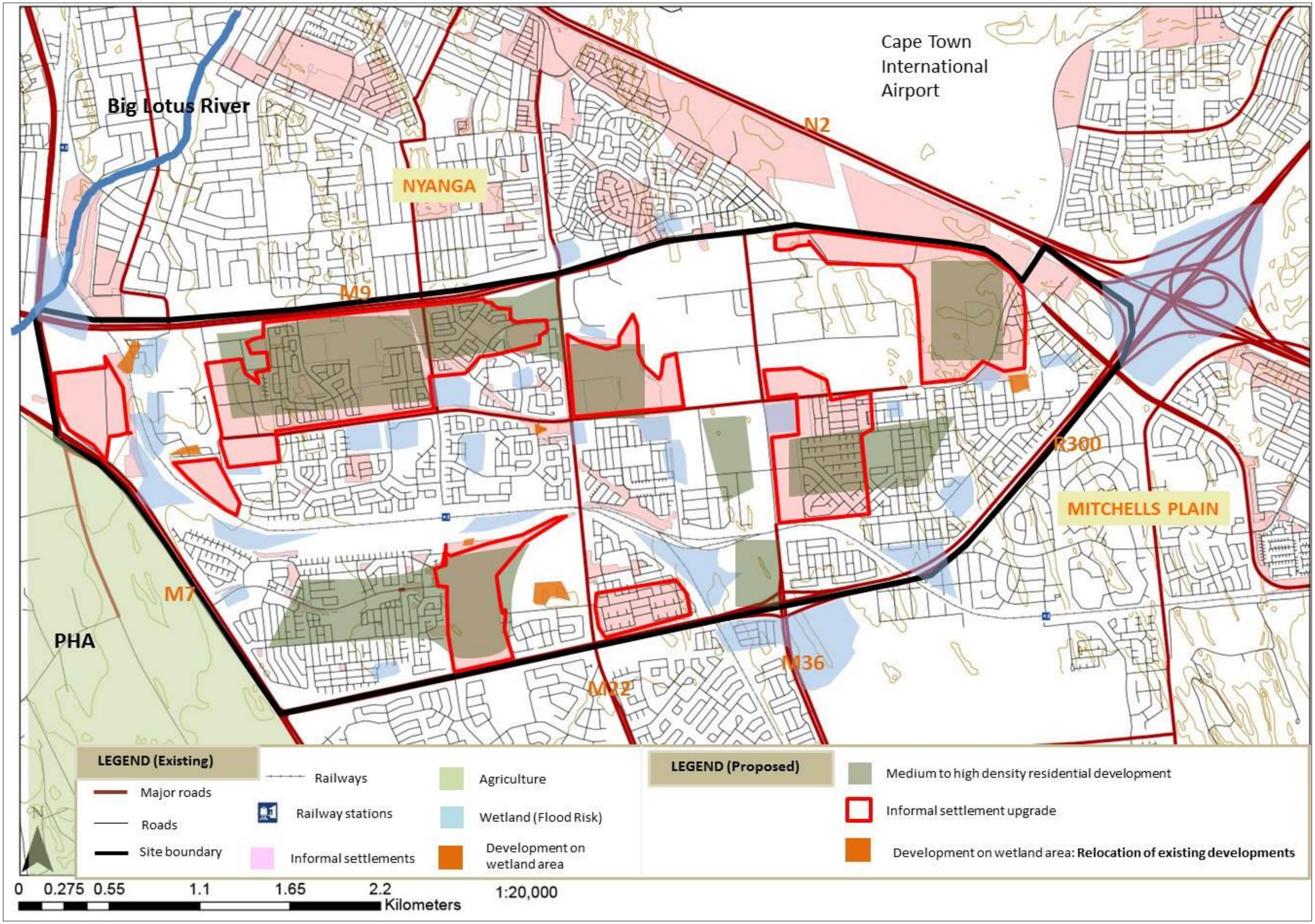

Figure 28, Map showing the second spatial layer of the FRF: a conceptual representation of flood risk reduction through flood-aware residential development in Philippi (Author, GIS Technical Library, University of Cape Town, 2016)

4.5 Enhancing water infrastructure systems

To ensure that flooding impacts are kept at a minimum in Philippi, it is important that there is adequate control and management of overland flow and flow paths. A large part of the informal settlements in Philippi needs improved stormwater and sewer drainage systems. Parts of Philippi with inadequate drainage systems should receive maintenance and rehabilitation services, and those with no access to any kind of drainage should be provided with stormwater and sewer drainage systems. The stormwater and sewer drainage capacity should be increased and associated infrastructure and facilities located and designed to function effectively during and immediately after a flood. Infrastructural design for water-related infrastructure should include sustainable measures to promote multi-functional use of the water infrastructure networks.

Due to its location on an aquifer which is inclined to experience saturarion, infiltration measures alone in Philippi are not dependable. Flood storage could be used as a way of storing excess water from stormwater drainage systems. Flood storage would be advantageous to the adjacent PHA for urban farming purposes to increase yield and quality of produce, and to the industrial and residential areas in Philippi and surrounding areas for industrial and household non-potable water use. Flood storage may also contribute to recharging the CFA and increase its capacity and potential for water reclamation and future water supply to the city. Flood storage may be implemented in different places using various methods to capture the water, and at different scales, depending on the source of water collection and the intended uses. Flood storage needs to be part of a greater water infrastructure network (Figure 29), which collects water from the flood zones and wetlands in Philippi and other parts of the Cape Flats, to strengthen resilience of land uses and livelihoods adjacent to the flood zones. It enhances the water infrastructure network system and has the potential to deliver multi-functional benefits in meeting objectives for flood risk reduction, adaptation, health, social inclusion, food security and employment, for Philippi and surrounds, and for the city at large.

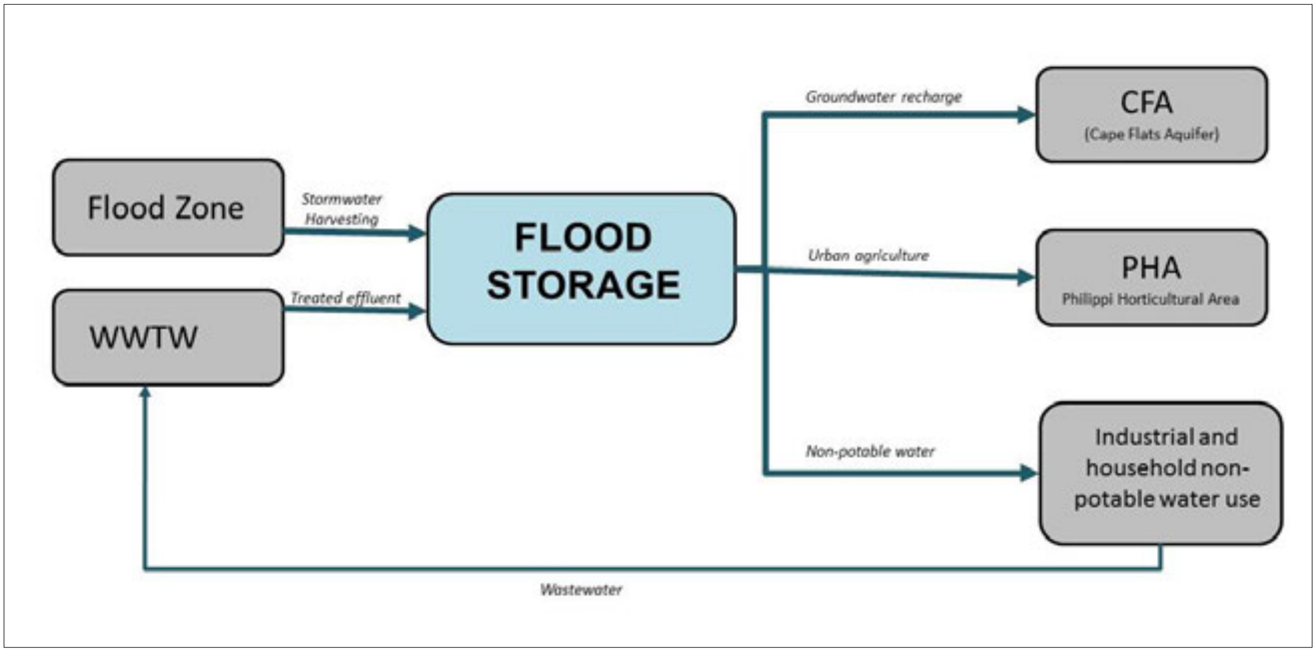

Figure 29, diagrammatic illustration of a sustainable water infrastructure network that promotes flood risk reduction
(Author, 2016)

Whether they are restored to a healthier natural state or identified for alternative land uses to enhance flood resilience, wetlands in Philippi need to be protected to ensure that the water infrastructure system functions efficiently and effectively without compromising the value of the natural environment. Solutions to water infrastructure networks should have great considerations for SUDS to manage urban runoff and associated water quality issues, and as a valuable adaptation measure to flood risk in Philippi. Implementing SUDS measures and design solutions in Philippi would identify as an acknowledgement of the vulnerability of infrastructure and the growing population of Philippi to climate change. It would also facilitate the transformation of Philippi from an area of climate-related risk to a more sustainable and resilient neighbourhood with flexible and adaptable features to accommodate future changes social, economic and climatic conditions.

An example of SUDS that may be valuable to the water infrastructure system in Philippi is the establishment of ecological buffers around or along water bodies (Figure 30) as a way of reducing the impacts of flooding in Philippi. Ecological buffering of wetlands and river systems that form part of the water infrastructure network system may provide multiple benefits beyond flood risk reduction. The use of ecological buffers as part of the infrastructure network could provide balance between the natural and built environments and contribute to the aesthetics of the environment. Ecological buffering also promotes the regulation of development and land use through the protection of wetlands, rivers and natural habitats, and provides public spaces for recreational and local commercial activity. Other SUDS examples that may be appropriate for enhancing the water infrastructure and stormwater management systems in Philippi are explored in the next section.

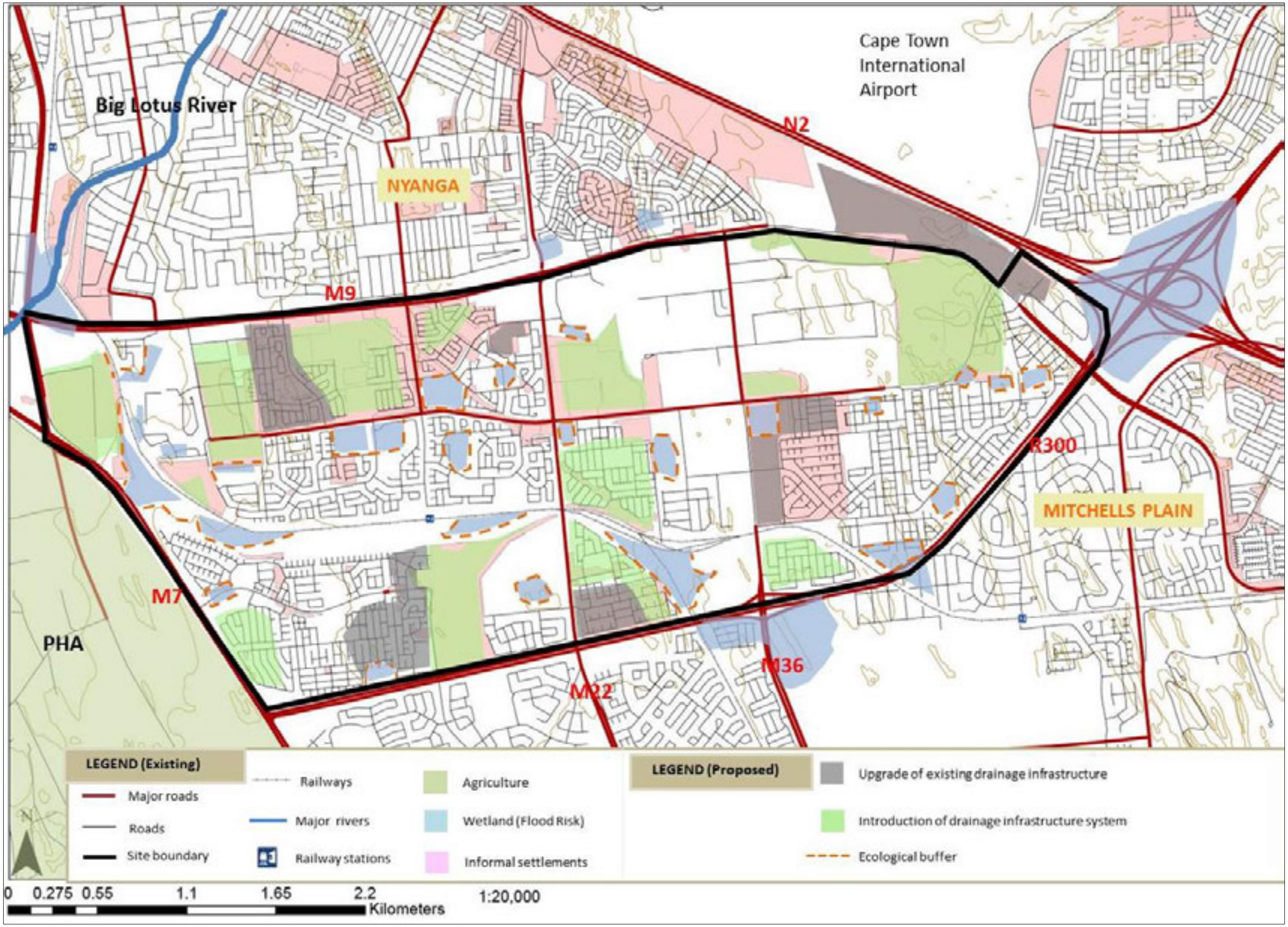

Figure 30, Map showing the third spatial layer of the SFRF: a conceptual representation of flood risk reduction through enhancement of water-related infrastructure systems in Philippi (Author, GIS Technical Library, University of Cape Town, 2016)

4.5.1 Precedents for enhancing flood resilience through sustainable water infrastructure and stormwater management systems

Ecological buffers

Ecological buffers are vegetated strips positioned adjacent to watercourses and systems (see Figure 31). They can be used to preserve and enhance water quality by trapping sediments and filtering pollutants such as nitrogen phosphorous, through biological and physical-chemical processes (Enanga, et al., 2010). During flooding the vegetation reduces peak flow and pollutants by absorbing excess water and excess nutrients, respectively. The wetland buffers also protect the aquatic environment and its natural habitats from impacts of activities in surrounding areas. Ecological buffer strips around wetlands and surface water bodies may be effective in enhancing water quality in Philippi and contributing to the control of stormwater systems to reduce the risk of flooding in Philippi.

Figure 31, Ecological wetland buffer strips in Saskatoon, Canada. Source: http://www.ecofriendlysask.ca/2014_05_01_archive.html

Permeable Paving

Permeable paving is usually made from coarse particle materials that enhance permeability and allow for filtration, infiltration and groundwater recharge (UNEP, 2014). It helps in reducing stormwater runoff by approximately 70% to 90%, as well as decreasing groundwater and soil contamination (Foster, et al., 2011). Using permeable paving to pave public open spaces in Philippi may contribute to water quality enhancement, and facilitate stormwater management through surface flow control.

Figure 32, Permeable pavement at Busamed Paardevlei Private Hospital parking area, Strand, Cape Town

Source: https://www.linkedin.com/pulse/greening-hospital-grounds-permeable-pavers-karin-johns

Runoff Storage

Runoff storage tanks are a source control method for stormwater harvesting (Figure 33). Storage of runoff from roofs or other elevated impervious surfaces can be done by barrels, rainwater tanks and other storage structure to store stormwater until the water is required (Armitage, et al., 2013). With little to no treatment, runoff storage could be used for non-potable water uses such as household garden irrigation, toilet flushing and industrial cooling, to supplement the potable water supply in Philippi. Facilities for stormwater storage may also be connected to other stormwater drainage systems to help protect receiving watercourses by reducing initial runoff volumes.

Figure 33, Roof runoff storage tanks (Armitage et al, 2013)

Green roofs

Green roofing is a building method that fully or partially covers building roofs with vegetation (UNEP, 2014). Green roofs can be essential in water retention and water quantity regulation by reducing stormwater runoff and sewer overload. Green roofing requires a selection of plants which are hardy, resilient and will thrive in a wide range of soil depths and climatic conditions. The plants absorb runoff from building roofs and later release it via evapotranspiration (Foster, et al., 2011). Green roofing may be useful and effective in control of runoff in the Philippi industrial area, where building roofs have large surface areas.

Figure 34, eThekwini Green Roof Pilot Project, Durban CBD (Armitage et al, 2013)

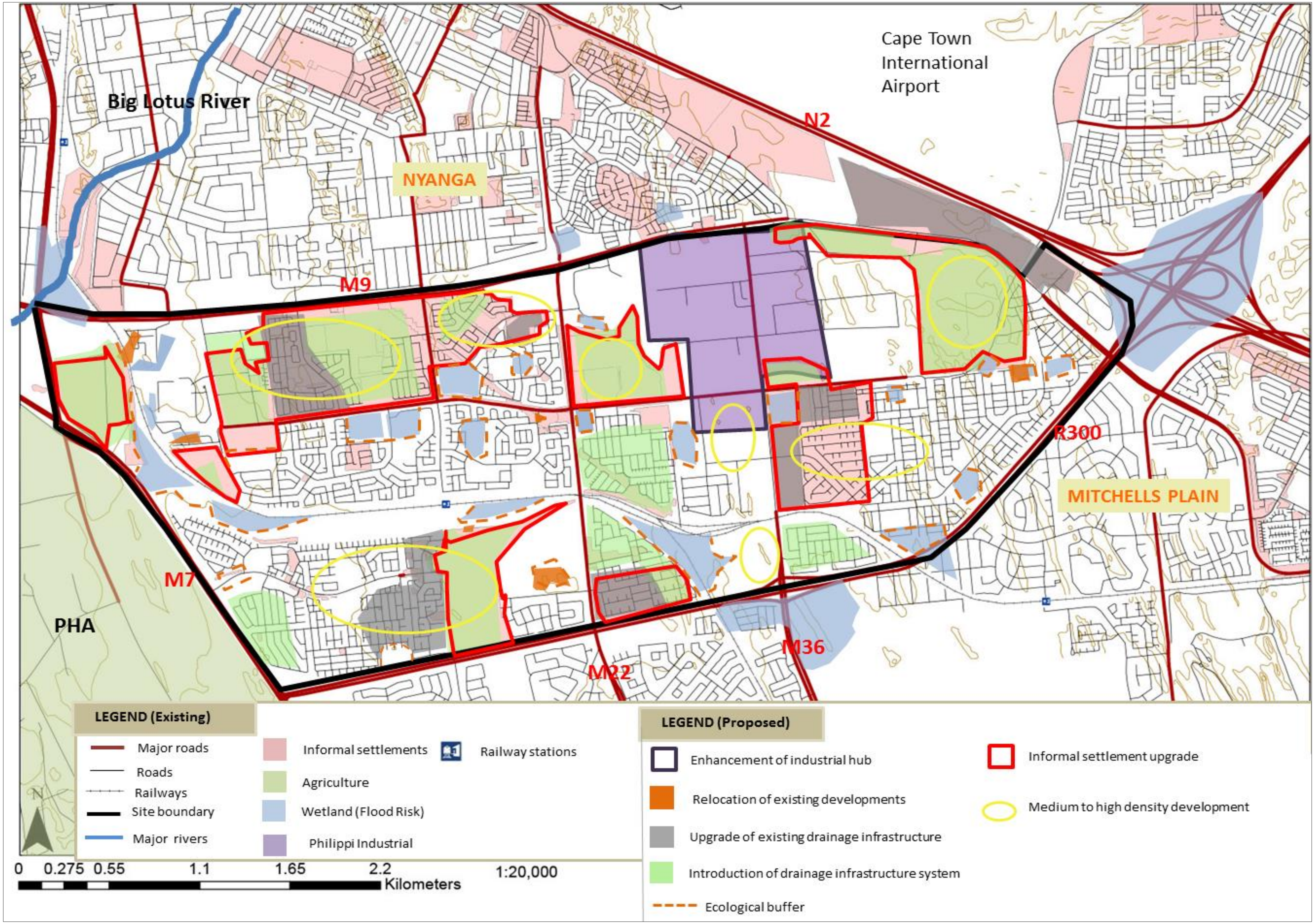

Figure 35, the Spatial Flood Resilience Framework for Philippi (Author, GIS Technical Library, University of Cape Town, 2016**)**

CHAPTER FIVE

5. IMPLEMENTATION OF THE SPATIAL FLOOD RESILIENCE FRAMWEWORK

5.1 Introduction

In seeking to achieve long term flood resilience and unlocking opportunities for development and investment that enhances well-being and socio-spatial justice in Philippi, the key strategies of flood risk reduction through land use planning, flood-aware residential development and water infrastructure systems enhancement have informed the identification of five key projects for implementation of the SFRF outlined in Chapter 4. This chapter is a continuation of the SFRF (Chapter 4), and focuses on the key projects, and is concerned with the implementation process of the projects over the next 25 years (2017-2041). The key projects include enhancement of drainage infrastructure capacity, land use parameters, improvement of water quality, flood-aware residential development and industrial development. This implementation process considers the necessary legislative requirements and governance parameters, responsible actors, timeframes and funding. This chapter also outlines recommendations for institutional frameworks and policies guiding the implementation of the SFRF in Philippi

Firstly, this chapter outlines the key projects to be implemented in Philippi. Secondly, the chapter focuses on the necessary phasing of the key projects to ensure that the implementation process is strategic and prioritises the timeframe of projects according to urgency of issues involved in projects. Thirdly, the chapter outlines the relevant legislation and the actors responsible for the implementation and the funding of the projects. Finally, the chapter outlines recommendations for the policy and institutional framework guiding flood risk reduction. The policy and institutional framework recommendations are mainly intended to enhance existing policy and institutional arrangements and to inform and guide the implementation of the SFRF for Philippi through efforts to facilitate flood risk management, adaptive capacity building and planning interventions for Philippi.

5.2 Key Projects

This section is a summary of the five key projects identified from the key strategies of the SFRF as key to enhancing adaptive capacity to flood risk in Philippi (Table 4). The key projects are vital in working towards long term flood resilience and unlocking opportunities for development and growth in Philippi. These projects are valued as supplementary to existing projects on flood risk reduction, and an initial step towards implementing the key strategies identified by the SFRF. These projects may also be identified as schemes to open

Philippi up to opportunities for future projects and innovation inputs beyond the anticipated scope of involvements.

Table 4, Key projects from the SFRF Key Strategies for Philippi (Author, 2016)

Project	Description of Project
Enhancement of drainage infrastructure capacity	This project aims at increasing Philippi's adaptive capacity to flood risk through enhanced management of local stormwater and sewer drainage systems. It involves: • Improvement of damaged, blocked and all inadequate existing drainage infrastructure • Introduction of new infrastructure in areas lacking stormwater and sewer drainage infrastructure • Use of SUDS measures to prevent heavily engineered water infrastructure, facilitate adaptability in accommodating future changes in the physical environment, and promote multifunctional use of stormwater drainage infrastructure; • Promoting storage of excess stormwater for household and industrial use
Land use parameters	This projects aims at limiting access to flood sensitive areas in Philippi for residential development, to reduce the impacts of flooding on the residents of Philippi. It involves: • Flood zoning of wetland areas to prevent residential development on high flood risk areas • Identifying alternative land uses for some wetland sites to enhance stormwater infrastructure capacity and create multi-use public spaces
Improvement of Water Quality	This project involves: • Rehabilitation and restoration of wetlands in a state of low water quality • Ecological buffering of wetlands • Improvement of surface and groundwater quality • Improvement of sanitation, wastewater and solid waste services in Philippi
Flood-aware residential development	This project aims at reducing the impacts of flood risk in Philippi through flood resilient residential developments and informal settlement upgrades. It involves: • Upgrade of informal settlements • Relocation of Philippi residents residing on wetland sites • Development of Flood-aware housing designs, particularly near wetland sites • Densification of residential developments to accommodate the growing population
Industrial development	This project aims at growing the industry sector in Philippi to provide job opportunities for the residents and attract investment in development of Philippi. It involves: • Intensification of industrial activity through capturing local innovation for industrial development • Promoting growth of Industrial hub to attract further economic, infrastructural and social investment in Philippi • Providing employment opportunities for local communities to promote sustainable livelihoods

5.3 Phasing of Key Projects

Phasing of projects is an important part of the implementation process to indicate the order of implementation over the next 25 years, as it may not be possible for the projects to be implemented simultaneously. Although the timeframes of the projects vary (see Table 5), the projects are interrelated and share a common objective of achieving flood resilience in Philippi. Therefore, each project should be mindful of the operation of the other projects to ensure that the outcome of one does not negatively affect other projects. Ongoing maintenance and upgrade will be required for each project after implementation to enable that there is continuous support for adaptive capacity building and flood resilience, and ensure that future development acknowledges the importance of existing flood risk reduction measures in Philippi.

Implementation of projects may come with great uncertainty regarding population growth, resources availability, ecological health, climate, food security, economic status, and the capacity of institutions and local communities to facilitate the implementation process. Therefore, the process has been structured into five 5-year phases to facilitate the structuring and prioritisation of the projects and the monitoring of the process.

Table 5, Phasing of the Implementation of Projects put forward in the SFRF for Philippi (Author, 2016)

PROJECT	Phase 1 2017-2021	Phase 2 2022-2026	Phase 3 2027-2031	Phase 4 2032-2036	Phase 5 2037-2041
Enhancement of drainage infrastructure capacity	Drainage infrastructure + Sanitation	Flood storage			
Land use parameters	Flood zoning	Alternative uses for wetland sites	Alternative uses for wetland sites		
Improvement of Water Quality	Waste service delivery	Wetland restoration + buffering	Groundwater quality	Groundwater Quality	Groundwater Quality
Flood-aware residential development	Relocation	Informal settlement upgrade + flood resilient housing	Informal settlement upgrade + flood resilient housing	Informal settlement upgrade	Informal settlement upgrade
Industrial development		Expansion of industrial hub	Expansion of industrial hub		

The first phase of the implementation process involves flood zoning of the wetland areas and relocation of Philippi residents currently settled on wetland sites to low risk areas. This phase also involves the commencing of the drainage infrastructure enhancement project to provide areas that are lacking drainage and sanitation or having inadequate drainage infrastructure with adequate sanitation, and stormwater and sewer drainage systems. During this phase household and community waste removal services will also be improved in order to reduce stormwater and groundwater pollution and enhance environmental health.

The second phase of the implementation process involves implementation of initiatives for storage of excess stormwater at community and household level, and for industrial purposes. This phase also involves the restoration and rehabilitation of polluted wetlands, which includes buffering of the wetlands, and implementation of alternative land uses for wetland sites suitable for multiple uses. The expansion of Philippi industrial and upgrading of informal settlements also begin in this phase to boost local economic activity and provide flood-resilient housing for the residents living in close proximity to wetland sites.

By the third phase of the SFRF implementation, the drainage infrastructure enhancement project would be complete and Philippi would be expected to have sufficient, efficient and adequate stormwater and sewer drainage systems and flood storage capacity that reduce flooding impacts and contribute to sustainable water infrastructure networks. Phase three involves preservation and enhancement of groundwater quality to increase the potential of the CFA as a source of future water supply. Phase 3 is also a continuation phase for the implementation of alternative land uses for wetland sites, informal settlement upgrade and industrial development projects.

Phase 4 and 5 involve the continuation of informal settlement upgrade and groundwater quality preservation, which are the only project activities expected to take place in the last 10 years of the SFRF implementation.

5.4 Implementation Actors, Responsibilities and Funding

This section identifies the relevant policy and legislative actions, actors and sources of funding responsible for the implementation of the projects in Philippi. As seen in Table 6, there are a number of relevant actors existing. Many of these actors are government institutions at municipal level. While provincial and national government play a role in regulating and guiding the implementation process, the City of Cape Town is expected to play a major role in the facilitation of partnerships and implementation of the projects. Table 6 also illustrates that there are some new institutions proposed for the implementation of the projects. The proposed institutions are mainly at community level and are intended to promote public participation and community involvement in project implementation, to ensure that there is transparency and continuous exchange of information from project implementation to the relevant actors involved. These community programmes also aim at developing skills of the local residents of Philippi to enable employment through local maintenance of infrastructure and to sustain adaptation measures and flood risk awareness at local level. A district level body (The Khayelitsha-Mitchells Plain District Floods and

Storms Planning Task Team) is also proposed, to cooperate in new projects and developments and provide contextualised flood risk analyses within the district. This team comprises actors from different municipal departments, NGOs, academics, private sector, businesses and representatives from settlements within the district. The list of institutions and actors presented in Table 6 is not exhaustive of the possible actors that may contribute to the implementation of the SFRF.

Table 6, Relevant legislation, Actors and Funding for Implementation of Key Projects

PROJECT	Guiding policy/Legislation	Institutions/ Actors Responsible (Existing)	Institutions/ Actors Responsible (Proposed)	Funding
ENHANCEMENT OF DRAINAGE INFRASTRUCTURE CAPACITY	-Disaster Management Act (Act 57 of 2002) -The National Water Act (36 of 1998) -Infrastructure Development Act, 2014 (Act No. 23 of 2014) -By-Law Relating to Stormwater Management -City Of Cape Town Municipal Disaster Risk Management Plan -City of Cape Town Management of Urban Stormwater Impacts Policy -Water Services Departmental Sector Plan for City of Cape Town -CTSDF -City of Cape Town IDP -SUDS: Landscape and Indigenous Plant Species Guideline (2011) -Management of Urban Stormwater Impacts Policy (2009) -The Khayelitsha-Mitchells Plain District Plan	- CCT Catchment, Stormwater and River Management branch - CCT Disaster Risk Management Centre - CCT Water and Sanitation dept. - CCT Department of Spatial Planning and Urban Design - FSEPTT -Philippi Community -Private Sector -Academic institutions	-Local skills development programme for local monitoring and maintenance of drainage infrastructure -The Khayelitsha-Mitchells Plain District Flooding and Storms Planning Task Team	*National:* - Municipal Infrastructure Grant: Category 1: Households *Provincial:* -The Expanded Public Works Programme (EPWP): Infrastructure -Public-private partnerships - CCT
LAND USE PARAMETERS	-Disaster Management Act (Act 57 of 2002) -The National Water Act (36 of 1998) -NEMA (107 of 1998) -SPLUMA (16 of 2013) -Infrastructure Development Act, 2014 (Act No. 23 of 2014) -City Of Cape Town Municipal Disaster Risk Management Plan -City of Cape Town Management of Urban Stormwater Impacts Policy -Floodplain and River Corridor Management Policy -CTSDF -City of Cape Town IDP	- CCT Disaster Risk Management Centre - CCT Department of Spatial Planning and Urban Design - FSEPTT -Non-Governmental Organisations -Philippi Community	-The Khayelitsha-Mitchells Plain District Flooding and Storms Planning Task Team	*National:* - Municipal Infrastructure Grant: Category 2: Public municipal facilities -Public-private partnerships - CCT
IMPROVEMENT OF WATER QUALITY	-Disaster Management Act (Act 57 of 2002) -The National Water Act (36 of 1998) -The National Environmental Management Act (NEMA) (107 of 1998) -National Environmental Management: Waste Act (59 of 2008) -The Integrated Waste Management By-law -National Policy for the provision of basic refuse removal services to indigent households -Municipal waste sector plan -Floodplain and River Corridor Management Policy -Water Services Departmental Sector Plan for City of Cape Town -CTSDF	-National Water Affairs -Water Research Commission - CCT Water and Sanitation dept. - CCT Catchment, Stormwater and River Management dept. - CCT Solid Waste Management dept. - CCT Dept. of Spatial Planning and Urban Design - CCT Biodiversity Management Branch - FSEPTT -South African National Biodiversity Institute (SANBI) -Working for Water -Philippi Community -Private sector	Community level water quality monitoring programme -The Khayelitsha-Mitchells Plain District Flooding and Storms Planning Task Team	*Provincial:* - Expanded Public Works Programme: Environment and Culture -Public-private partnerships - CCT

	-City of Cape Town IDP -The Khayelitsha-Mitchells Plain District Plan			
FLOOD-AWARE RESIDENTIAL DEVELOPMENT	-Disaster Management Act (Act 57 of 2002) -The National Water Act (36 of 1998) -National Building Regulations and Standards Act No. 103 of 1977 -City Of Cape Town Municipal Disaster Risk Management Plan -Framework for Adaptation to Climate Change in the City of Cape Town -CTSDF -City of Cape Town IDP	- CCT dept. of Safety and Security: Disaster Risk Management - CCT Water and Sanitation dept. - CCT Social Development dept. - CCT Dept. of Spatial Planning and Urban Design - FSEPTT - CCT Human Settlements dept. -The National Upgrading Support Programme (NUSP) -Non-Governmental Organisations -Philippi Community -Private Sector	-Local skills development programme for adaptation to climate change -The Khayelitsha-Mitchells Plain District Flooding and Storms Planning Task Team	*National:* - Municipal Infrastructure Grant: Category 1: Households -The National Upgrading Support Programme (NUSP) *Provincial:* -The Expanded Public Works Programme (EPWP): Infrastructure -Public-private partnerships - CCT
INDUSTRIAL DEVELOPMENT	-SPLUMA (16 of 2013) -Manufacturing Development Act. (187 of 1993) -Industrial Development Amendment Act (49 of 2001) -CTSDF -City of Cape Town IDP -The Khayelitsha-Mitchells Plain District Plan	-National dept. of Trade and Industry -Western Cape Government Dept. of Economic Development and Tourism - CCT Economic Development dept. -CCT Dept. of Spatial Planning and Urban Design - FSEPTT -The Philippi Economic Development Initiative (PEDI) -Local small scale business/industry owners -Non-Governmental Organisations -Philippi Community -Private Sector	-Organisation: Opportunities for local, national and international investment in industrial growth and surrounding residential development	- CCT -Private Sector -Public-private partnerships

5.5 Recommendations for Policy and Institutional Arrangements

Local planning

Although the issue of flood risk in Philippi is increasingly impacting a rapidly growing part of Cape Town's population, it is hardly identifiable on city-wide or district spatial plans. This shows that there has not been enough priority dedicated to Philippi as a flood risk area. To promote effective planning in areas of disaster risk such as Philippi, it is important to encourage local area plans that focus on a scale that facilitates the identification of, not only risk, but other neighbourhood and community scale issues and priorities such as fire risk or food security. Local spatial plans such as this SFRF for Philippi can empower and enable local government to identify flood risk, and thereafter, develop relevant adaptation measures. Local plans can also contribute to widening and enriching the perceptions and awareness of informality and help in accommodating the diversity of a township like Philippi in approaching interventions. It is important that local planning is generally informed by the existing hierarchy of plans such as the SDF, IDP, and District plans, and in turn have the capacity to inform the higher tier policies, to ensure that local government and higher-tier government policies are corresponding and well-matched for coherent city-wide developmental policies.

Risk-informed planning

When approaching interventions for development at different scales within the city, it is important to ensure that disaster risk is one of the major informants for policies that guide planning and design. When disaster risk is a consideration in higher-tier planning policies other than disaster risk management policy,such as the national and provincial SDFs, it is easier to prioritise risk reduction at local level. The existence of different types of disaster risks and hazards within the city should be strongly acknowledged in city-wide and district plans, which helps in informing and supporting local level plans and action, intended to enhance resilience of local communities to risk. The proposed establishment of a Flooding and Storms Planning Task Team for the Khayelitsha-Mitchells Plain District is aimed at facilitating the identification of flood risk and all its relevant aspects at district and neighbourhood scales. One of the duties of such a body at local scale is to directly inform the district plan of existing risk and ensure that flood risk is not undermined in higher-tier planning policies such as the CTSDF and the IDP.

This recommendation for risk-informed planning essentially calls for the designing of planning processes which produce local plans that focus on disaster risk as a common agenda, and acknowledge the significance of disaster risk at different scales. This recommendation applies to other disaster risks beyond flood risk experienced in Cape Town (e.g. fires). When disaster risk is identified and prioritized, together with other local interests and priorities such as employment, food security and housing, it helps create awareness of the extent and severity of risk and encourages the creation of more dynamic and robust plans for development and disaster risk reduction in Cape Town.

Long term planning and implications

When considering flooding impacts, policies and plans such as this SFRF should consider the relationships between different sectors and how each sector contributes to and is affected by flood risk at a local scale, and the city scale. Multi-sector considerations of flooding impacts facilitate the prediction of short (± 5 years) and longer term (20 years +) consequences of the plans and interventions to prevent exacerbation of the flooding impacts, or transferring of impacts elsewhere. Implementation processes such as phasing, as prepared for this SFRF, are important in facilitating the implementation of projects and monitoring of outcomes and impacts for long term plans. Long term planning should have great considerations for the potential of future growth, change and uncertainties associated with natural systems, climate change, and social and economic development patterns. Planning that is aware of the existing uncertainties facilitates flexible and adaptable policymaking and encourages stewardship and responsibility from different stakeholders in building adaptive capacity to flood risk. It is also important that, in planning for flood risk reduction, any conflicts between short term prospects and longer term implications of chosen interventions are highlighted and addressed in policymaking.

Sustainable water and infrastructure management

Water and infrastructure management policies need to direct some focus on finding sustainable solutions to neglected and inadequate stormwater and sewer systems. Local plans that encourage the implementation of SUDS, such as this SFRF, are important in prioritising areas of urgent infrastructure needs, ensuring that adequate water and waste infrastructure systems are in place and to encourage ongoing monitoring and maintenance of stormwater and sewer drainage infrastructure systems in Philippi. Drainage infrastructure plays an important role in reducing impacts of flooding in Philippi and should be considered an urgent key project. Water and infrastructure management should also collaborate with waste management to work towards the reduction of surface and groundwater pollution, and in so doing, promote the potential of flood storage and groundwater recharge. The need for adequate solid waste management in Philippi could be addressed through provision of sufficient solid waste skips with frequent municipal waste collection services to prevent blockage of stormwater systems, which leads to flooding.

Collaborative governance

The institutional frameworks behind flood risk management, adaptive capacity building and development are part of a highly complex system, which consists of various government departments, NGOs, private sector, businesses and local communities. To create a system that shifts away from fragmented institutional arrangements towards more integrated frameworks and approaches, it is important that flood risk and all its aspects are well understood and to ensure that institutional arrangements for approaching flood risk value input from a relatively rich and strong network of actors because a large part of the effectiveness of planning for flood resilience is determined by the administrative system supporting it.

This recommendation suggests that adjustments should be made to the existing Flooding and Storms Emergency Planning Task Team in its approach to the response to flood risk in Cape Town. More collaborative efforts should be encouraged to make the Flooding and Storms Emergency Planning Task Team more effective in its approach to flood risk. A further recommendation has been made for more partnerships like the Flooding and Storms Emergency Planning Task Team be formed at district and neighbourhood levels, to raise awareness of local flood management issues at local level. The proposed Khayelitsha-Mitchells Plain District Flooding and Storms Planning Task Team is one example of such a partnership at district level. This task team needs to be made up of multidisciplinary bodies, which involve institutions, academia, companies and local communities as actors and participants implicated in the process. Different actors have access to different resources, and their individual capacities are critical in addressing the multifaceted and interconnected issues related to flood risk management.

Planning for flood resilience requires a strong institutional framework, which can be built through collaborative governance, allowing for input from a variety and network of actors contributing to financial resources, expertise and knowledge, policy development and social capital (Waddell, 2016). A strong institutional framework enhances relationships between the state and individuals affected by risk, and makes communities and individuals who are part of a network with various external actors more resilient. The diverse institutional networks would facilitate implementation process, and allow Philippi communities to access resources that enable them to build adaptive capacity to flood risk.

5.6 Conclusion

This chapter has explored the process of implementation for the key projects of the SFRF which include enhancement of drainage infrastructure capacity, land use parameters, improvement of water quality, flood-aware residential development and industrial development. The chapter has demonstrated that the process of implementing the SFRF is an important part of the anticipated product of the plan, which envisions a flood resilient Philippi. The implementation process outlined in this chapter has considered legislative requirements, responsible actors, timeframes and funding. The chapter has presented a phasing structure which summaries the project timeframes and highlights implementation priorities. It is evident from the phasing, that drainage infrastructure, water quality and flood zoning are the most urgent initial steps to flood risk reduction in Philippi. This chapter has also identified the need to establish more community-based programmes for skills development in facilitating the monitoring and maintenance of infrastructure in Philippi. The establishment of a district Flooding and Storms Planning Task Team is also proposed to essentially ensure that flood is not undermined in development priorities at local level. As the chapter continues with recommendations for policy and institutional frameworks, the need for more risk-informed local plans with long term objectives is identified, and most importantly for implementation of the SFRF for Philippi, collaborative governance to strengthen institutional capacity and sustainable water and infrastructure management.

CHAPTER SIX

6. CONCLUSION

This dissertation has used literature review (Chapter 2) to explore the themes of 'Flood Risk and Urban Informality', 'Flood Resilience and Adaptation' and 'Infrastructure Planning for Flood Risk'. The literature review presented a theoretical framework of relevant literature, which opened new perspectives that guided the approach to the contextual analysis (Chapter 3) of Philippi as a case study and the SFRF for Philippi (Chapter 5) as an intervention. The study has sought to answer and explore the following questions:

- How might an infrastructure-led approach to planning interventions build adaptive capacity to reduce the impact of flooding in Philippi?
- What are the planning related limitations to implementation of infrastructure interventions for building adaptive capacity to flood risk in Philippi?
- How can an infrastructure-led planning approach be effectively incorporated in flood risk management systems to provide solutions for adaptation to flood risk?
- What is the role of planning in moving towards flood resilient neighbourhoods in Cape Town?

As one of the largest townships in Cape Town, Philippi has a rapidly growing population and increasing number of inhabitants residing in informal settlements, and exposed to flooding impacts. Many inhabitants of Philippi live in poverty and lack the means to protect their dwellings and belongings from flooding. The township has inadequate stormwater and sewer drainage networks, which leads to flooding of the settlements during heavy rainfall periods. Flooding in Philippi is also exacerbated by the inundation of wetland areas, which affects resident located on wetland sites or in close proximity to the wetlands. This study has identified the lack of adequate drainage infrastructure as a major contributor to flood risk in Philippi, and has identified that infrastructure is a key approach to planning for flood resilience for the context of Philippi.

For Philippi, an infrastructure-led approach to planning for flood resilience comes with some challenges and limitations. The fundamental challenges to sustainable urban drainage in Philippi are associated with limited access to available land, and high settlement densities which make it difficult to retrofit and upgrade existing developments. The response to flood risk is predominantly short-term and reactive, and is undertaken by a relatively fragmented institutional framework. The existing policy and spatial plan framework related to Philippi has a lack of risk-informed local plans aimed at reducing risk impacts and building adaptive capacity to risk. However, the location of Philippi within Cape Town has also presented the township with opportunities for future infrastructure developments, such as proximity to agricultural and industrial hubs, major transport networks and an aquifer.

This study has proposed a spatial planning tool; the SFRF for Philippi, to ensure that future development in Philippi avoids or at least mitigates flood risk and enhances flood resilience. The SFRF is guided by principles of socio-spatial justice and environmental sustainability, and is outlined through the strategies that aim to reduce flood risk through, land use planning, adequate drainage infrastructure and flood-aware residential development. The SFRF is supplemented by an implementation plan and recommendations for the policy and institutional framework guiding the implementation process (Chapter 5). The study has highlighted the need for risk-informed local plans to reduce disaster risk in Cape Town. Collaborative governance is a significant aspect of the planning and implementation processes for flood risk reduction, as it integrates different actors in working towards a common agenda. Planning constitutes parallel processes and notions to those of flood risk management and sustainable infrastructure development. Therefore, cooperative relationships between planning, flood risk management and sustainable water and infrastructure development should be put at the forefront of development in flood risk areas such as Philippi, in order to enhance clarity and thoroughness, and encourage efficiency in the planning process through an integrated approach to building adaptive capacity to flood risk.

Recommendations for future research

Due to the limited scope of this dissertation, an extension of adaptive capacity building studies to other areas of disaster risk in Cape Town should be done through further research. Disaster risk related research should be done at local scale to detail all necessary aspects and ultimately create a city-wide comprehensive disaster risk research base to inform development in the CCT.

It is also recommended that research on sustainable water networks and stormwater reclamation should be advanced. This also includes further research on the feasibility and capacity of the CFA as a water source for the city, and local SUDS innovation to create contextually viable measures for water and infrastructure management.

This study also recommends further research on possible approaches to planning that seeks to reduce flood risk and enhance resilience in informal settlements. This recommendation calls for a more Global South perspective on urban flood risk to widen planning field perceptions on urban informality and provide more precedents relevant for future studies in the global south context to draw on and enhance.

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APPENDIX A

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APPENDIX B

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