An urban environmental history of Melbourne's watercourses

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Abstract

This thesis interrogates and develops an urban environmental history of a network of urban watercourses. It achieves this by using the main rivers and tributaries of the city and suburban regions of Melbourne, Australia as a case study. Much literature exists detailing a range of subjects focused around the continual history of change caused by urbanisation to watercourses. However, examining this history of change within a city's greater network of urban watercourses has not received the same level of attention. The thesis contributes to this gap in the knowledge.

Urban watercourses constitute an important urban system providing vital resources and functions used in sustaining many urban populations. A complex history of use, abuse, and modification of watercourses has developed as they are transformed by the continuing processes of urbanisation into a range of structures and forms to suit evolving needs of urban populations. Author Roy Mann, writing in 1973, reflects this history of change when he declares urban rivers the most used and abused natural resources on Earth. Despite being an important urban system, examination of urban watercourses as complex urban networks is minimally featured in historical and contemporary urban studies literature. Commonly, literature concerned with urban studies, planning, design, and history neglect to treat watercourses as complex interconnected urban systems. Instead, watercourses are commonly referred to as components of other urban systems and histories. Frequently featured as individual reaches, in isolation, or without complex, multi-layered histories, urban watercourses are rarely considered as part of a larger individual urban-wide system. Consequently, throughout urban history, watercourse networks enclosed within urban fabrics have been hidden within plain sight.

This thesis was developed focussing on two main aims. The first was to develop and reveal the hidden and little known urban environmental history of urban watercourses as distinct complex networks. This branch of history examines the effects of urbanisation on the natural environment over time; how the environment affected urban form, and the surrounding countryside; and societies' responses to these effects. The thesis departs from the above listed common approaches to treating watercourses by identifying them as a separate system. It also uses the environmental history premise that rivers and tributaries consist of both natural and designed elements. Utilising urban environmental history method, the

research assembled historical and contemporary data not before collected or used, for the exclusive examination of Melbourne’s urban watercourses. The resulting urban environmental history, although using Melbourne as a case study is relevant for many industrialised cities globally, developed during the late 18^{th} and 19^{th} centuries, along watercourses. As these cities grew, the watercourses were treated in similar ways, based upon the engineering approaches to urban water developed in Britain during the industrial revolution of the 18^{th} and 19^{th} centuries. The urban environmental history also contributes to filling gaps within urban studies literature and gives a guide for future examinations of urban watercourses within cities globally.

The second aim was to document, interrogate, and develop an urban environmental history of Melbourne’s watercourse network, which is otherwise absent from literature. It is also envisaged the history will aid in explaining the reasons for the contemporary typologies of Melbourne’s watercourses, as urban water systems in general undergo revision concerning climate change, increasing urban population densities and issues surrounding water scarcity.

This is to certify that

I. the thesis comprises only of my original work towards the PhD except where indicated in the preface,

II. due acknowledgement has been made in the text to all other materials used,

III. the thesis is less than 100,000 words in length, exclusive of tables, maps, bibliographies and appendices

Marcus Leslie Lancaster

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Although this thesis is a first in-depth examination of Melbourne's watercourses, it has been done with the assistance of many interested, passionate and caring people. For this, I wish to extent my sincere thanks to the following people for their interest and passion. It has been greatly appreciated and was a driving force to complete this work on a topic at times was of an overwhelming scale.

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Abbreviations

CRB – Country Roads Board

DELWP – Department Environment, Land, Water and Planning (State Government)

EPA Victoria – Environmental Protection Authority

GIS - Geographic Information Systems

MMBW – Melbourne Metropolitan Board of Works

MTPC – Metropolitan Town Planning Commission

Melbourne Water – (corporatised form of MMBW, excluding water retail and parks sections)

NGA – National Gallery of Australia

PROV – Public Records Office Victoria

SECV – State Electricity Commission of Victoria

SLV – State Library of Victoria

SRWC – State Rivers and Water Supply Commission (Victoria)

VicRoads – Roads and Traffic Authority of the state of Victoria, Australia (previously CRB)

Definitions

Billabong A term of Australian Aboriginal origin used to describe a permanent or semipermanent body of water on riverine floodplains. The most common body formed in a cut-off meander or oxbow lake.[1] (See meander and oxbow lake).

Canal Artificial watercourses of uniform dimensions cut through inland areas and designed for navigation, drainage, or irrigation.[2]

Creek A term generally applied in Australia, Canada and most parts of the United States to any natural stream of water, smaller than a river and larger than a brook. A creek can be a tributary of a main river; medium sized low land watercourse or a flowing rivulet. In Australia, the term is also used for long shallow streams of intermittent flows.[3]

Lagoon Commonly a shallow stretch of sea water, for example, a bay, channel, or salt-water lake located near or connecting with the sea. Lagoons maybe partially or completely separated from the sea by a sandbank or spit.[4]

Marsh Poorly drained, waterlogged land either intermittently or permanently covered with water. Vegetated with aquatic and grass like plants, without development of peat.[5]

Meander Broad looping bends in watercourses.[6]

Oxbow Lake A lake formed in an abandoned meander channel, or cut-off loop at the neck of a bend.[7]

Peat Deposit of semi-carbonised plant remains in a waterlogged environment.[8] The marshes, swamps and wetlands of the Melbourne region have not been recorded as having accumulation of peat.

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[1] Hillman T.J., "Billabongs," in *Limnology in Australia. Monographiae Biologicae,* ed. P. De Deckker and W.D. Williams (Dordrecht: Springer, 1986), 457.
[2] Robert L. Bates, Julia A. Jackson, and Margaret Gary, *Glossary of Geology*, 2d ed. (Falls Church, Va.: American Geological Institute, 1980), 91.
[3] Ibid, 145.
[4] Ibid, 346.
[5] Ibid, 382.
[6] W. Kenneth Hamblin and Eric H. Christiansen, *Earth's Dynamic Systems*, 10th ed. (Upper Saddle River, NJ: Prentice Hall, Pearson Education, 2004), G12.
[7] Ibid, G13.
[8] Bates, Jackson, and Gary, *Glossary of Geology*, 459.

River A term used generally for a natural fresh-water surface stream of substantial capacity of a permanent or seasonal flow, moving within a definite channel toward a lake, sea or another river; also used to define any large stream.[9]

Snagg An Australian term for large woody debris including tree trunks and large branches that have fallen, or been swept by flood flows, into a watercourse.[10]

Desnagging Australian term for removing snags from watercourses. Also referred to as snagging.[11] Desnagging may also include removal of live riparian vegetation.[12] The practice was based on the premise that any objects obstructing flow velocities of watercourses worsen flooding, caused erosion, and created hazards for boating and swimming.

Stream A flow of running water transported under gravity towards progressively lower levels in comparatively narrow, clearly defined channels along the ground surface. Streams contain a mixture of water and dissolved, suspended, or entrained matter.[13]

Swamp Areas with intermittent or permanent water cover, with trees and shrubs, without peat formation. [14]

Watercourse Natural, well defined channels produced by a definite flow of either continuous or intermittent water. The term is also used to define a ditch, canal, aqueduct, or other artificial channel used for the conveyance of water. In legal terms, a watercourse is a natural stream rising in a particular drainage basin. It is not completely dependent for its flows on the surface drainage of the immediate area. Rather it flows between visible banks, in a well-defined channel within a definite depression in the landscape. Watercourses have a known and permanent, or periodic, source of water.[15]

Waterway A channel or course that is either natural (such as a stream or river) or artificial (a canal), that conducts water flows. The term is also used for navigable bodies or stretches of water available for passage by watercraft; a watercourse.[16] In Melbourne, the term is used interchangeably with watercourse.

Wetland An area of land that is commonly wet or inundated with a water table at or above ground level for at least part of the year during plant growing season. [17]

[9] Ibid, 541.
[10] Wayne D. Erskine and Ashley A. Webb, "Desnagging to Resnagging: New Directions in River Rehabilitation in Southeastern Australia," *River Research and Applications* 19, no. 3 (2003): 233-34.
[11] Ibid, 233.
[12] Ibid.
[13] Bates, Jackson, and Gary, *Glossary of Geology*, 616.
[14] Ibid, 631.
[15] Ibid, 694.
[16] Ibid, 696.
[17] Aber, James, Susan Aber, and Firooza Pavri, *Wetland Environments: A Global Perspective* (West Sussex: Wiley, 2012), 371.

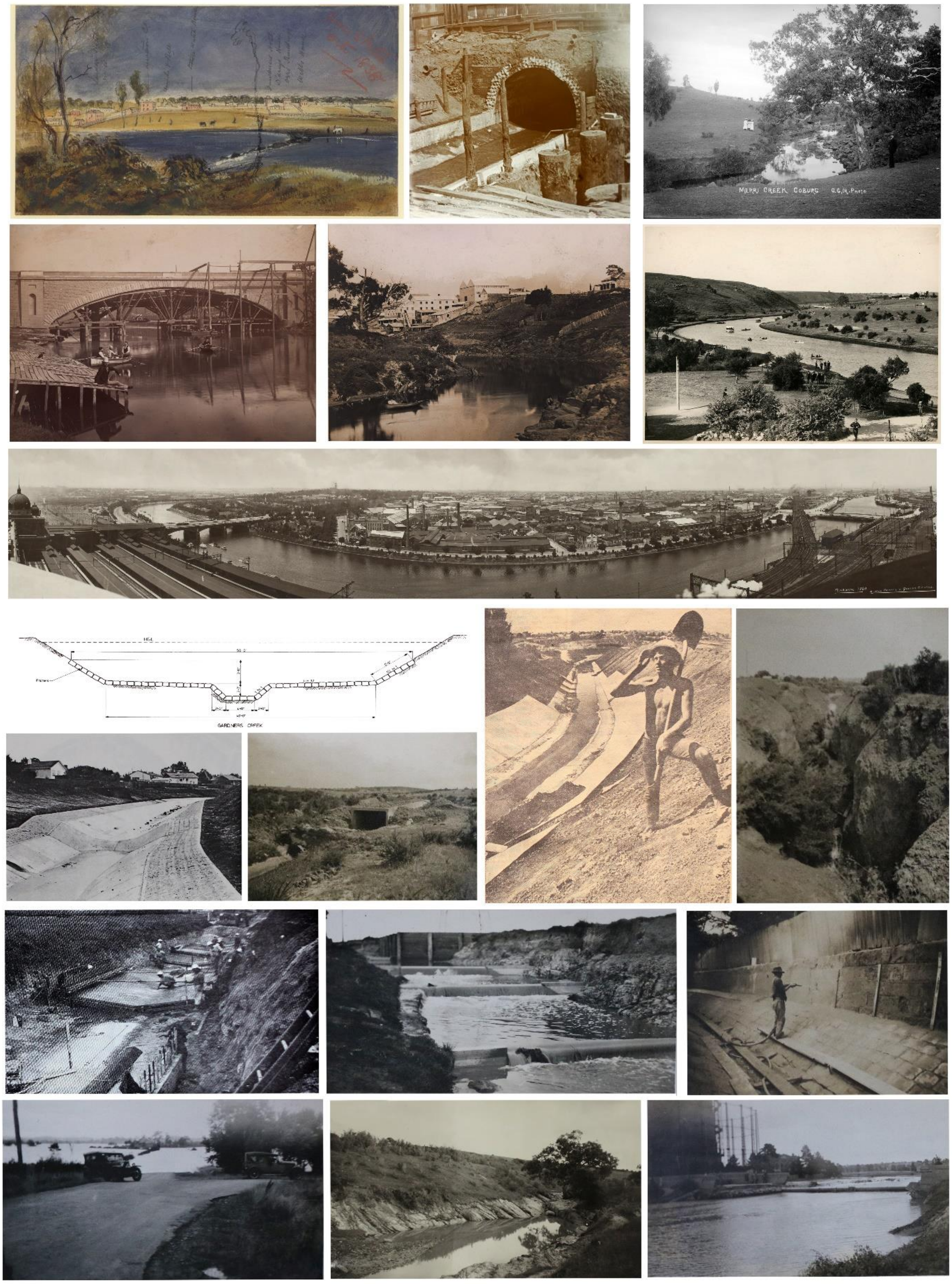

Figure 1. A selection of Melbourne's watercourses during the 19th and 20th centuries.

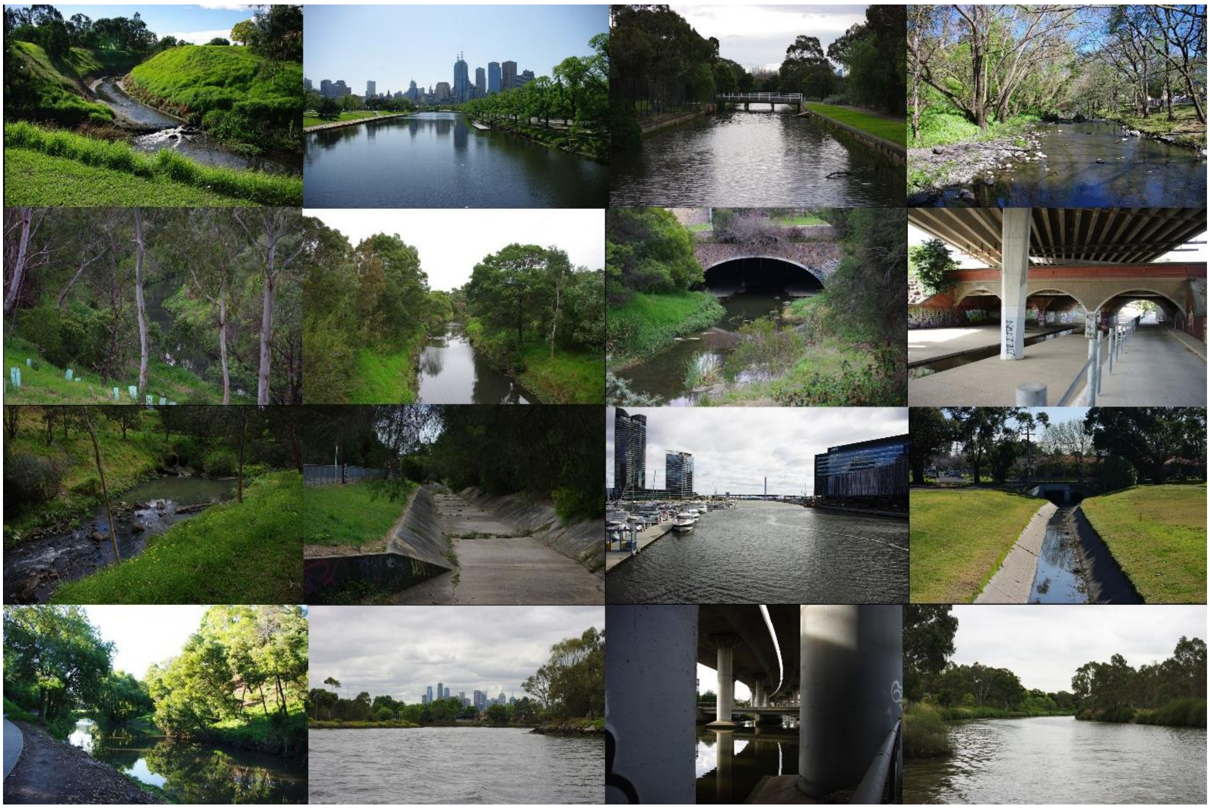

Figure 2. A range of Melbourne's contemporary watercourse typologies. The results of 183 years of urbanisation. Source: Author photos (2015-2017).

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Chapter One: Introduction – Urban rivers, streams and tributaries – hiding in plain sight

> …the most intensively used and most often abused resource on earth – the river of the urban region.[1]

This thesis examines the urban environmental history of an important urban network hitherto little considered as a separate and interconnected system. Unlike similar urban systems, it is a combination of both the natural and the designed. Urban watercourse networks – rivers, streams and tributaries have been frequently overlooked within much historical and contemporary urban studies literature, which tends to concentrate primarily on individual rivers, streams or waterscapes.

As many urban areas, most increasing in population, are experiencing water scarcity and other impacts of climate change, the sustainability of urban water is increasingly vital. In addressing these issues, many cities are reviewing their history of water use and the engineering of watercourses. However, these efforts are frequently hampered by a lack of specific historical and contemporary information detailing the changes caused by urbanisation to watercourse networks. In providing sustainable solutions for urban water, Ferguson, Brown and Deletic report many scholars argue solutions need to be developed based on systematic, network-wide diagnosis involving the type, cause or source of a problem.[2] This would involve the recognition of cities being composed of interrelated, dynamic and complex ecosystems functioning at local, regional and global scales. A major premise of this type of approach is viewing urban water systems, and watercourses, as interconnected networks. Hence, this thesis examines Melbourne's urban watercourses as a connected, dynamic and complex network.

This thesis addresses this gap in an urban environmental history of watercourses using Melbourne, Australia, as a case study. The thesis identifies the city's rivers, streams and

[1] Roy Mann, *Rivers in the City* (Newton Abbot: David and Charles, 1973), 13.
[2] Briony Ferguson, Rebekah Brown and Ana Deletic. "Diagnosing transformative change in urban water systems: Theories and frameworks," *Global Environmental Change*, 23 (2013): 265.

tributaries as a discrete, highly complex urban system, and details its history of change through urbanisation.

The author's interest in this subject is based upon a background in landscape architecture construction, and urban horticulture, and the noticeable absence of research and education about urban watercourses within these disciplines. Further interest developed from exposure to, and teaching in, urban history and finding a similar lack of examination of urban watercourses as individual, ecological and designed systems.

Since development of the first urban settlements in the Near and Middle East, 5000 – 7000 years ago, rivers, streams and tributaries have been significant components of cities. They have provided populations with key resources and ecological services, the most important being a source of fresh-water. Combined, these elements are essential for human survival and the ongoing sustainability of countless urban centres worldwide.[3] Water's availability has been a determining factor in evolution of the structure, function and services of cities and urban regions.[4] Many cities often claim rivers as defining or founding features, synonymous with the city's identity and growth.[5] Yet at the same time urban watercourses hide in plain sight, receiving little consideration as complex urban systems and scant attention is paid to human-initiated changes. The history of water within the establishment and evolution of urbanisation has been widely examined and documented within a range of separate histories; for example, histories of public sanitation or urban water supply systems. Yet few holistic historical narratives of change to a city's watercourse network wrought by urbanisation have been written.

This thesis details how and why Melbourne's rivers and streams have changed since European settlement. The majority covers the period 1835-1985 of Melbourne's urban history when watercourses underwent the most dramatic changes. The subsequent three decades, while important, are covered in lesser detail. Future research and work is required on this period. The first 150 years dictated the way many watercourses are still used and perceived within sections of the public and government agencies.

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[3] Stephen Myers, *Walking on Water: London's Hidden Rivers Revealed* (Gloucestershire: Amberely, 2011), 87-90.
[4] Sujay Kaushal, William McDowell, and Wilfred Wollheim, "Tracking Evolution of Urban Biogeochemical Cycles: Past, Present, and Future," *Biogeochemistry* 121, no. 1 (2014): 4064.
[5] Mark Everard and Helen L. Moggridge, "Rediscovering the Value of Urban Rivers," *Urban Ecosystems* 15, no. 2 (2011): 293.

Urbanisation has resulted in modification of watercourses as urbanising societies seek to access and exploit a watercourse's resources, sustain communities and maintain the urban fabric. Myers believes a symbiotic, yet paradoxical relationship exists between urbanising societies and the watercourses within their urban boundaries.[6] As urbanising societies develop along watercourses, expansion places increasing needs upon watercourses while simultaneously devaluing them. Many rivers of industrialised cities now placed underground – in most cases, to hide their polluted conditions – were once valued as water sources.[7] The most common modifications to urban watercourses include: provision of reliable potable water; drainage systems for sewage, stormwater, urban runoff, and depositories for all types of refuse; shipping channels, routes and port facilities; power generation; engineering for flood control; and use as boundaries of demarcation between countries, states, cities, municipalities, and public and private land.[8] In addition to direct use and changes to the streambed and banks, riparian zones and floodplains have also been heavily modified or obliterated to accommodate a range of urban uses. Some have included siting of land-based transport systems along watercourse valleys and streambeds; use as service corridors for various urban supply and waste removal infrastructure; sites for park systems and recreational facilities; use for agriculture, market gardens and orchards.[9] The application of these multifaceted and frequently conflicting uses and roles has resulted in continual alteration and redesign of urban watercourses to fit within, beneath or above the urban fabric. Urban watercourses left open to the surface are commonly observed confined within well-defined channels, designed to flow with a certain degree of passive certainty. As mentioned above many others, having become polluted, were converted into sewers or drains, then piped and buried. Smaller headwater and ephemeral streams were similarly buried or erased entirely with the land they had occupied reclaimed. This diverse range of roles and requirements have ensured the development of long, complex and continually evolving historical narratives. They often include periods when urban rivers and their tributaries were at times valued, feared, celebrated, held in contempt, and ignored. These changes in attitudes, beliefs, and

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[6] Myers, 89.
[7] Ibid.
[8] J.G. Senior, "Melbourne's Waterways Enhancement," in *Inernational [sic] Symposium on Urban Stormwater Management: Sydney, 4-7 February 1992: preprints of papers*, ed. Institute of Engineers, Australia (Sydney, N.S.W: Institution of Engineers, Australia, 1992), 413-14; J. R. Karr and E. W. Chu, "Sustaining Living Rivers," *Hydrobiologia* 422/423 (2000): 1; Sujay S., Kaushal et al., "Urban Evolution: The Role of Water," *Water* 7, no. 8 (2015): 4064; Myers, 87, 90.
[9] Kaushal et al., 4064; Karr and Chu, 1; Senior, 413-14; Myers, 87, 90.

management were dependent upon the period, prevailing uses, environmental views and politics, levels of technology and knowledge and various stages of development or renewal an urban region may undergo.

In their natural state, rivers, tributaries and their floodplains form highly complex and ever-changing ecological systems, comprising different hydrological, geomorphological and ecological features.[10] Riparian zones, the interface between land and a watercourse, are just as complex, acting as buffer zones between up lands and a stream, forming ecologically unique interaction areas hosting plants, soil, water, and microbes.[11] Watercourses also function as components of the earth's hydrological cycle, sediment transportation and surface drainage systems.[12] Functioning collectively, watercourses form components of larger river systems. These consist of networks of connected channels that collect water precipitated onto the earth's surface and transport it back to the ocean or a lake.[13] Urban development and construction of impervious surfaces dramatically altered these hydrological and ecological functions. Hard urban surfaces reduced rainfall infiltrating the surface, resulting in increased runoff entering a watercourse.[14] This caused an increase in the occurrence of flash flooding and erosion of stream beds and banks.[15] Additionally, a range of problems came to be associated with the presence of urban watercourses, including flooding; erosion and undermining of property; pollution; disease; and drowning.

After mills and factories developed in Britain in the 18th century, populations moved from rural to industrial areas.[16] The use of watercourses as sewers resulted in ground-water contamination, and severe urban disease epidemics.[17] Squalid living conditions and rising disease mortality rates across Britain's industrialised urban regions led to action on improving urban environments.[18] The publication of Chadwick's *Report on the Sanitary*

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[10] Angela Gurnell, May Lee, and Catherine Souch, "Urban Rivers: Hydrology, Geomorphology, Ecology and Opportunities for Change," *Geography Compass* 1, no. 5 (2007): 1749.
[11] Peter M. Groffman et al., "Down by the Riverside: Urban Riparian Ecology," *Frontiers in Ecology and the Environment* 1, no. 6 (2003): 315.
[12] W. Kenneth Hamblin and Eric H. Christiansen, *Earth's Dynamic Systems*, 10th ed. (Upper Saddle River, NJ: Prentice Hall, Pearson Education, 2004), 296-301.
[13] Ibid.
[14] Michael J. Paul and J. L. Meyer, "Streams in the Urban Landscape," *Annu. Rev. Ecol. Syst* 32 (2001): 335.
[15] Ibid, 335, 39-40.
[16] Phyllis Deane, *The First Industrial Revolution*, 2d ed. (Cambridge Eng.: Cambridge University Press, 1979), 4; Myers, 78-84.
[17] Geoffrey F. Read, "The Development of Public Health Engineering," in *Sewers rehabilitation and new construction: repair and renovation*, ed. Geoffrey F. Read and Ian G. Vickridge (Amsterdam Elsevier, 1997), 13-15, http://www.knovel.com.ezp.lib.unimelb.edu.au/knovel2/Toc.jsp?BookID=3687
[18] Giusy Loforano, and Brown, Jeanette, "Wastewater Management through the Ages: A History of Mankind," *Science of the Total Environment* 408 (2010): 5259.

Condition of the Labouring Population of Great Britain (1842) initiated the 'English sanitary idea' arguing the physical environment significantly influenced an individual's welfare and that sanitation was paramount to health.[19] Filth was linked with disease and thence to water.[20] The solution to urban water problems became scientific control of the physical environment.[21] The emerging engineering profession was deemed most suited to provide solutions.[22] Following the introduction of water and sewerage networks, engineering became perceived as able to control nature and solve problems plaguing industrialised cities.[23] The combined work of sanitarians and engineers provided a reform model based upon engineered water systems, standard practice adopted globally by industrialised cities.[24] This included engineered sanitary sewerage systems removing (or, at least, hiding) water from the urban fabric.[25] Gandy suggests that water, 'like other facets of urban nature, was incorporated into an increasingly rationalised and scientifically managed form.'[26] Nature became something to be feared and controlled; the solution was the modern city and a disconnection Lewis Mumford described as encouraging 'an illusion of complete independence from nature.'[27]

It was not until early 20th century studies of flowing waters and watercourses that they were conceptualised as complex ecosystems.[28] By the early 21st century, effects caused by urbanisation on stream ecology and water quality had been documented.[29] The term 'urban stream syndrome' was developed by ecologists to describe the ecological and geomorphological degradation observed in watercourses draining urban fabrics (see chapter

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[19] Martin V. Melosi, *The Sanitary City: Urban Infrastructure in America from Colonial Times to the Present*, Creating the North American Landscape (Baltimore: Johns Hopkins University Press, 2000), 43.
[20] Kelly Shannon and Bruno De Meulder, "Water and the City: The 'Great Stink' and Clean Urbanism," in *Water Urbanisms*, ed. Bruno De Meulder and Kelly Shannon (Amsterdam: Park Books 2008), 5; Martin V. Melosi, "How Bad Theory Can Lead to Good Technology: Water Supply and Sewerage in the Age of Miasmas," in *Inventing for the Environment*, ed. Arthur P. Molella and Joyce Bedi (Cambridge, Mass.: MIT Press, 2003), 232.
[21] *The Sanitary City: Urban Infrastructure in America from Colonial Times to the Present*, 43.
[22] Andrew Karvonen, *Politics of Urban Runoff: Nature, Technology, and the Sustainable City*, Urban and Industrial Environments (Cambridge, Mass.: MIT Press, 2011), 3-4.
[23] Ibid, 2-3; Melosi, "How Bad Theory Can Lead to Good Technology: Water Supply and Sewerage in the Age of Miasmas," 232.
[24] "How Bad Theory Can Lead to Good Technology: Water Supply and Sewerage in the Age of Miasmas," 232.
[25] Shannon and De Meulder, 5; Myers, 112-14.
[26] Matthew Gandy, "The Bacteriological City and Its Discontents," *Historical Geography* (2006): 14.
[27] Karvonen, 1-3; L Mumford, "The Natural History of Urbanisation" in *Man's Role in Changing the Face of the Earth*, ed. William L. Thomas (Chicago: University of Chicago Press, 1956), 386; Gandy, 366.
[28] Colbert Cushing, and Kenneth Cummings, "Introduction: An overview of stream ecosystems," in *River and Stream Ecosystems of the World*, ed. Colbert Cushing, Kenneth Cummings, and G. Minshall (Berkeley: University of California Press, 2006), 1.
[29] Robert A. Francis, "Positioning Urban Rivers within Urban Ecology," *Urban Ecosystems* 15, no. 2 (2012): 285.

two, page 30).[30] Once land within a watercourse's catchment undergoes urban development, its water quality and quantity are dramatically altered.[31] Although urban watercourses remain major components of urban ecosystems, their combined use, abuse, and consequential modification has resulted in their evolution into complex urban systems. They exist both as degraded natural ecological systems and as components of highly engineered drainage and flood mitigation systems. An example is the many sections along urban watercourses that have been engineered, concrete or rock-lined to control erosion efficiently remove flood flows and prohibit large-scale meandering of stream courses. These modifications occurred while adjacent remnant patches of indigenous vegetation have been retained, rehabilitated or re-established. Engineering designed the watercourse to flow within a set easement, while the vegetation maintains habitat for urban wildlife, and ecosystem services. Figure three illustrates a section of the engineered concrete trapezoid channel along Gardiners Creek flowing through Melbourne's south-east suburbs. The concrete channel and portal of a freeway crossing are contrasted against the revegetation plantings of indigenous species and rock lining designed to imitate a natural in stream rock formation.

Figure 3. Gardiners Creek, Melbourne. An engineered channel and culvert revegetated with indigenous plants and interspersed with exotic weed species. Source: Author photo (2015).

Strang asserts hydrology of place in urban centres has been largely ignored by designers and engineers. They have transformed natural systems into urban infrastructure, to exist as

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[30] Christopher J. Walsh et al., "The Urban Stream Syndrome: Current Knowledge and the Search for a Cure," *Journal of the North American Benthological Society* 24, no. 3 (2005): 1119.
[31] Ibid, 707; Kaushal et al., 4075.

landscape.[32] Gandy further expands this idea: 'Water lies at the intersection of landscape and infrastructure crossing between visible and invisible domains of urban space.'[33] The consideration of urban watercourses as a hybrid between natural ecology and designed systems, directs research into the history of change caused by urbanisation to consider both aspects. Cronon argues that traditional history treats urban rivers as static, history-less, without reference to the natural world.[34] Additionally, the continuum of change urban watercourses undergo also requires consideration. Therefore, situating urban watercourses at the intersection of natural ecological and the designed aligns this research with the field of urban environmental history, a contemporary branch of environmental history. The approach describing the hybridisation of the natural and designed aspects of watercourses has featured widely within environmental history literature. For example, authors Richard White (1996) *The Organic Machine: The remaking of the Columbia River*, and Sarah Prichard (2011) *Confluence*: *The Nature of Technology and the Remaking of the Rhône* both identify and discuss the respective rivers as hybridised products of nature, design and technology. Environmental history examines how the wider natural environment and human cultures have affected each other and places the natural environment within broader historic narrative.[35] Urban environmental history includes connections between the city and the natural environment, and similarly places nature within wider history.[36] Based on these tenets, urban environmental history focuses upon a range of approaches. It examines urbanisation's effect on the natural environment over time; the natural environment's impact on structure, development, and expansion of urban regions; the examination of society's responses to these impacts and efforts to improve environmental problems; and urbanisation's impact upon the surrounding countryside and the effects on the wider environment.[37]

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[32] Gary Strang, "Infrastructure as Landscape" *Places* 10, no. 3 (1996): 13.
[33] Matthew Gandy, *The Fabric of Space: Water, Modernity, and the Urban Imagination*, (Cambridge: MIT Press, 2014),1, https://ezp.lib.unimelb.edu.au/login?url=http://www.jstor.org/stable/10.2307/j.ctt9qf9xf 1.
[34] William Cronon, "Time and the River Flowing " in *The Rhine an Eco-Biography, 1815-2000* (Seattle: University of Washington Press,, 2009), IX.
[35] D Worster, "Doing Environmental History," in *The Ends of the Earth: Perspectives on Modern Environmental History*, ed. D Worster (Cambridge, England: Cambridge University Press, 1988), 289-90.
[36]Joel A. Tarr, "The Material Basis of Urban Environmental History," 2005, 744.
[37] Christine Meisner Rosen and Joel Arthur Tarr, "The Importance of an Urban Perspective in Environmental History," *Journal of Urban History* 20, no. 3 (1994): 301; Samuel P. Hays and Joel A. Tarr, *Explorations in Environmental History: Essays* (Pittsburgh, Pa.: University of Pittsburgh Press, 1998), 70.

This thesis also uses specific terms when describing or referring to watercourses. A list of terms and definitions is featured following the abstract and acknowledgments. However, the two most commonly used herein are 'watercourse' and 'creek'. The term 'watercourse' is defined as a natural well-defined channel created partially or by a flow of either intermittent or continuous water. It is also used to refer to a canal or other artificial channel used for conveying water.[38] The term 'creek' is common in Melbourne, and Australia. It is applied to any natural stream larger than a brook yet smaller than a river.[39] Most of the creeks flowing through the Greater Melbourne region were tributaries of rivers, or discharged into wetland systems, rarely directly into a bay.

The identified gaps within the literature provide motivation for this thesis. The use of Melbourne's network of watercourses is typical of industrialised, developed cities globally.

This thesis sets out to unravel the urban environmental history of Melbourne's rivers, streams and tributaries, beginning in 1835 when European settlers established a permanent colony in the Port Phillip region. Placing nature within historical narrative allows for the development of specific site histories to include examination of changing interactions between natural and human scenarios. This research makes a significant contribution to current knowledge by combining the morphology of Melbourne's watercourses with its broader history. It also brings together information regarding the city's environmental history, and further archival data, previously unexamined. These provide explanation for modifications to, and evolution of, Melbourne's watercourse typologies. Detailed knowledge of history may aid with current and future management practices, restoration, and reduce replication of mistakes. This thesis also uses urban environmental history to illustrate the timeline of approaches to urban watercourse design made by engineers, designers, and policy makers. As discussed on page one, this reflects contemporary trends towards treatment of urban watercourses by governments, companies involved with urban water management, and the public. The reimagining of urban watercourses as valuable resources is being driven by increasing urban population densities and expanding urban fabrics, changes to climate, engineered water infrastructures reaching the end of design life, and increasing water scarcity. Such revision has recently included 'daylighting' – the redesign and recovery or uncovering of degraded watercourses to make them more visible across the urban fabric, as

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[38] Robert L. Bates, Julia A. Jackson, and Margaret Gary, *Glossary of Geology*, 2d ed. (Falls Church, Va.: American Geological Institute, 1980), 695.
[39] Ibid, 145.

well as water sensitive urban design (WSUD) and the introduction of catchment-wide planning and management of watercourses.[40] These require extensive historical data and mapping to establish routes, reasons for engineering modifications and use history to determine reasons for current stream structure.[41] An example of a revision project, specific to Melbourne and in process at the time of writing, is the Moonee Ponds Creek Collaboration Project. This seeks to bring all agencies and stakeholders together to form a group responsible for management, restoration, and future progression of projects on this significant and highly visible 41 km-long (25.44 miles) urban waterway on a catchment-wide scale. A major lack identified by the group is of data regarding the history of human-initiated change to the creek and its catchment.[42] Moonee Ponds Creek is one of Melbourne’s most urbanised and modified watercourses. It originally entered a significant wetland system feeding into a large lagoon but now flows directly into one of Melbourne’s main rivers, the Yarra (see chapter six, page 244).[43]

The Melbourne region

Melbourne is the capital city of the state of Victoria, located on the southern coast of mainland Australia. Victoria is found southeast of the continent, as illustrated by the map in figure four.

[40] Rebekah Brown and Jodi Clarke, *Transition to Water Sensitive Urban Design: The Story of Melbourne, Australia*, (Clayton, Vic.: Facility for Advancing Water Biofiltration, Monash University, 2007), II.
[41] Myers, 117-18.
[42] J. Francis, L. Poland, and G. Downey, “Moonee Ponds Creek Catchment Collaboration Workshop 4,” (Melbourne: Melbourne Water 2017), 1-4.
[43] Gary Presland, *The Place for a Village: How Nature Has Shaped the City of Melbourne*, 1st ed. (Melbourne: Museum Victoria Publishing, 2008), 66; C. Leigh and Melbourne Metropolitan Board of Works, *Development of the Moonee Ponds Creek Drainage System* (Melbourne: Melbourne Metropolitan Board of Works, 1981), 11-12.

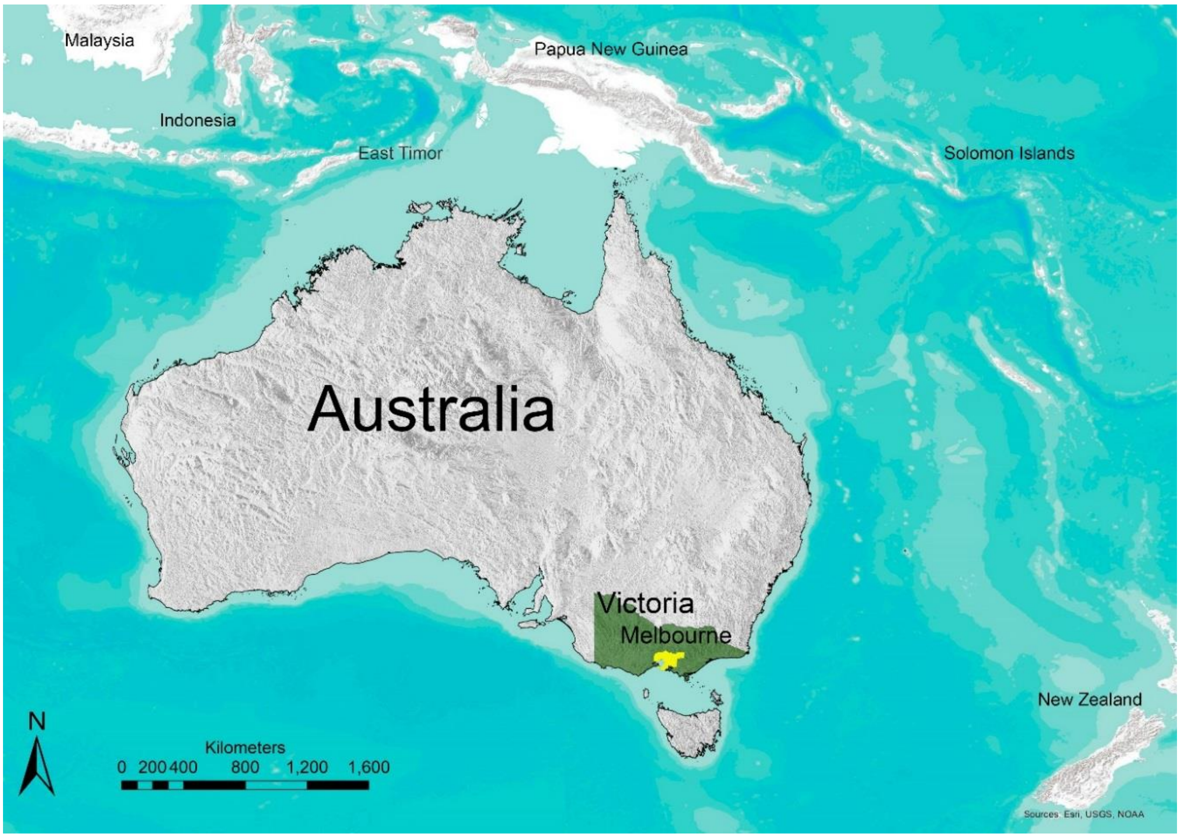

Figure 4. Melbourne within mainland Australia and immediate region.

Australia has three main climate types: arid/semi-arid, temperate and tropical.[44] Melbourne's climate is 'temperate oceanic' under the Köppen climate classification system, the climate characterised by warm summers, mild winters and rainfall spread consistently across seasons.[45] The climate classifications for Australia are illustrated with the map in figure five. The temperate climate zone, including Melbourne, covers only 13.9 percent of the continent when compared with the climates of other capital cities to the north and west. These are located either within the dominant climates of arid/semi-arid, covering 77.8 percent of the land area or within a tropical climate covering 8.3 percent.[46] The scale of the arid/semi-arid climate zone makes Australia's climate very dry compared to other continents'. Rainfall patterns are highly seasonal: 80% of the landmass receives rainfall of less than 600

[44] M. C. Peel, B. L. Finlayson, and T. A. McMahon, "Updated World Map of the Köppen-Geiger Climate Classification," *Hydrology and Earth System Sciences* 11, no. 5 (2007): 1642.
[45] Ibid.; Frederic P. Miller, Agnes F. Vandome, and John McBrewster, *Climate of Australia: Climate of Australia. Bushfire, Effects of Global Warming on Australia, Climate Change in Australia, Drought in Australia, Wet Season, Tropical Cyclone, List of Wettest Tropical* (Mauritius: Alphascript, 2009), 2.
[46] Peel, Finlayson, and McMahon, 1642.

millimetres (23.6 inches) annually, while parts of the tropical coast receive over 4000 millimetres (157 inches) annually.[47] Across the Melbourne region, rainfall is also highly variable ranging east to west from 500 to 1200 millimetres (20 to 47inches).[48]

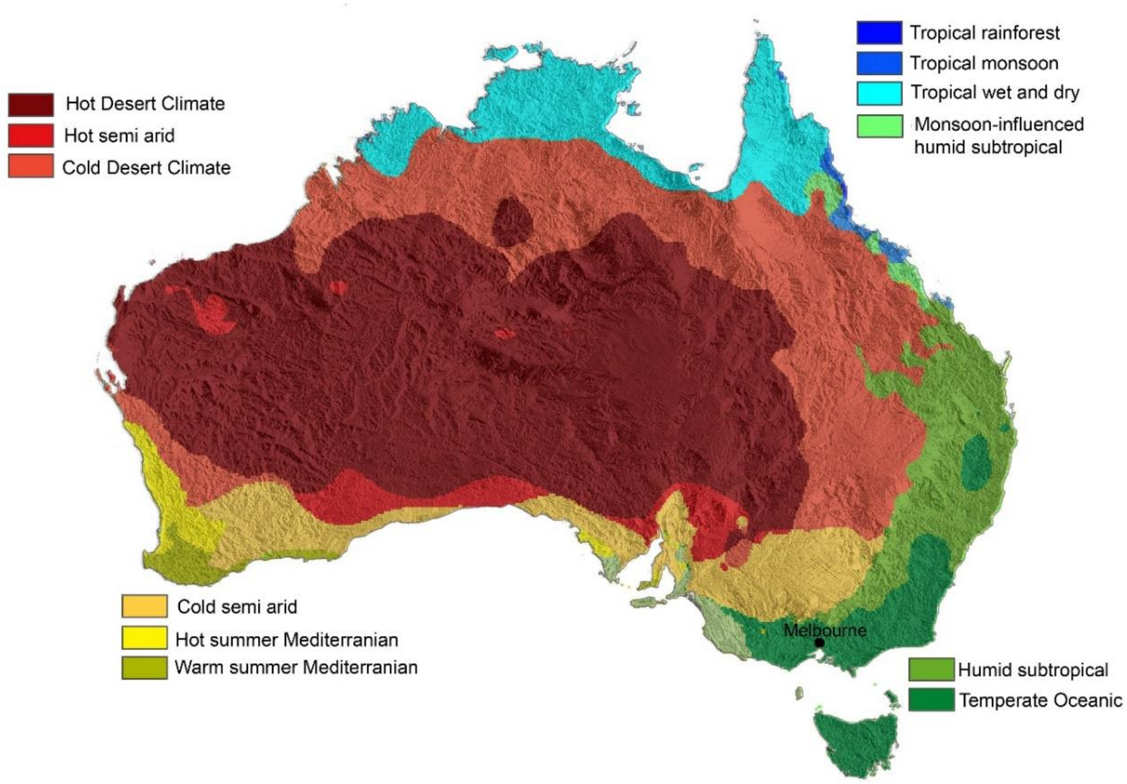

Figure 5. Australia's climate zone according to the Köppen climate classification system. Source: Peel, Finlayson and McMahon (2007).

Melbourne's rivers, streams and tributaries

The distribution and flow of the Earth's river systems has resulted from influencing factors including terrain, climate, precipitation, topography, and geology.[49] They have also influenced Melbourne's development, the region's physical geography dictating patterns of

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[47] Miller, Vandome, and McBrewster, 1.
[48] Amy K. Hahs and Mark J. McDonnell, "Selecting Independent Measures to Quantify Melbourne's Urban–Rural Gradient," *Landscape and Urban Planning* 78, no. 4 (2006): 436.
[49] John P. Rafferty, *Rivers and Streams*, (Chicago: Britannica Educational Publishing, 2011), xi-xii, http://UNIMELB.eblib.com.au/patron/FullRecord.aspx?p=624307

urban growth, and are the largest city of the state of Victoria.[50] Figures six and seven illustrate the position of Victoria within the Australian mainland and the location of the Port Phillip and Western Port catchment area within the state.

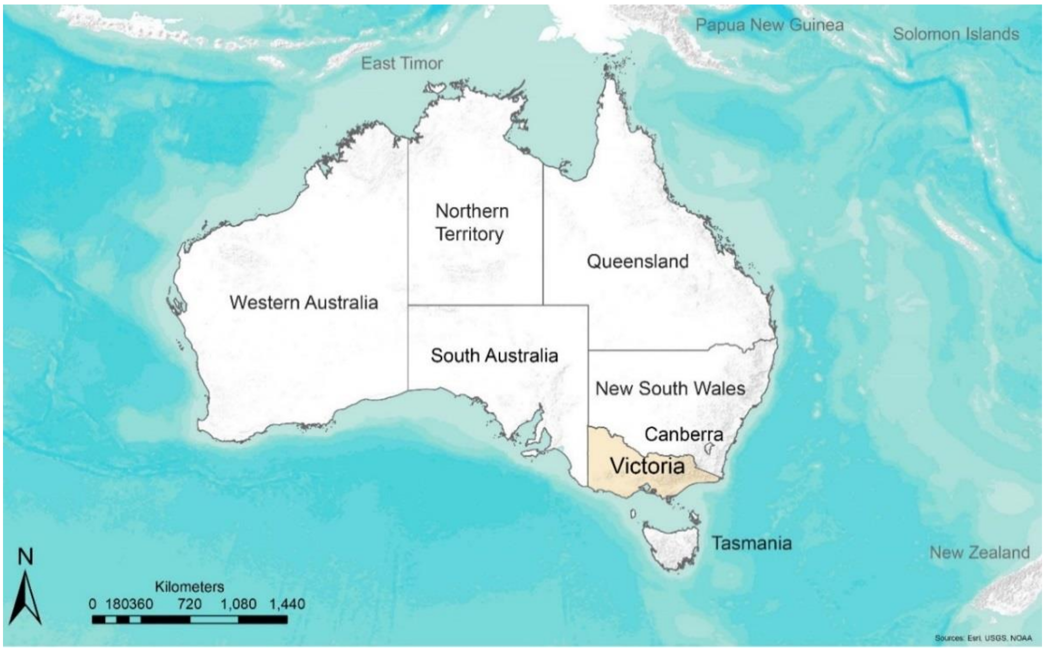

Figure 6. Victoria within the Australian mainland.

The city and metropolitan area is within the Port Phillip and Western Port catchment.[51]

[50] Presland, *The Place for a Village: How Nature Has Shaped the City of Melbourne*, 222-23.; Hahs and McDonnell, 436.
[51] "Our Region" Port Phillip & Western Port Catchment Managment Authority, accessed July 10, 2015, http://www.ppwcma.vic.gov.au/our-region.aspx.

Figure 7. Port Phillip and Western Port catchment region.

As of July 2017, Melbourne's population is approximately 4.7 million people.[52] The total land area of the catchment is 11,723 square kilometres (4526 square miles).[53] Land use across the catchment consists of 13% urban, 45% rural farming land and 42% forest cover.[54] The Melbourne urban region located within the catchment comprises the Yarra, Maribyrnong, Plenty, Werribee and southern section of the Bunyip River catchments.[55] The catchments, including the city and suburban regions drain into either Port Phillip Bay or the smaller Western Port Bay, as illustrated in figure eight.[56]

[52] "Regional Population Growth, Australia, 2016," Australian Bureau of Statistics, updated July 28, 2017, http://www.abs.gov.au/ausstats%5Cabs@.nsf/mediareleasesbyCatalogue/28F51C010D29BFC9CA2575A0002126CC?Opendocument.
[53] "National Water Account 2014," Australian Government Bureau of Meteorology, accessed October 14, 2015, http://www.bom.gov.au/water/nwa/2014/melbourne/contextual/physicalinformation.shtml#general_description;
[54] Port Phillip & Western Port Catchment Managment Authority.
[55] Australian Government Bureau of Meteorology.
[56] Port Phillip & Western Port Catchment Managment Authority.

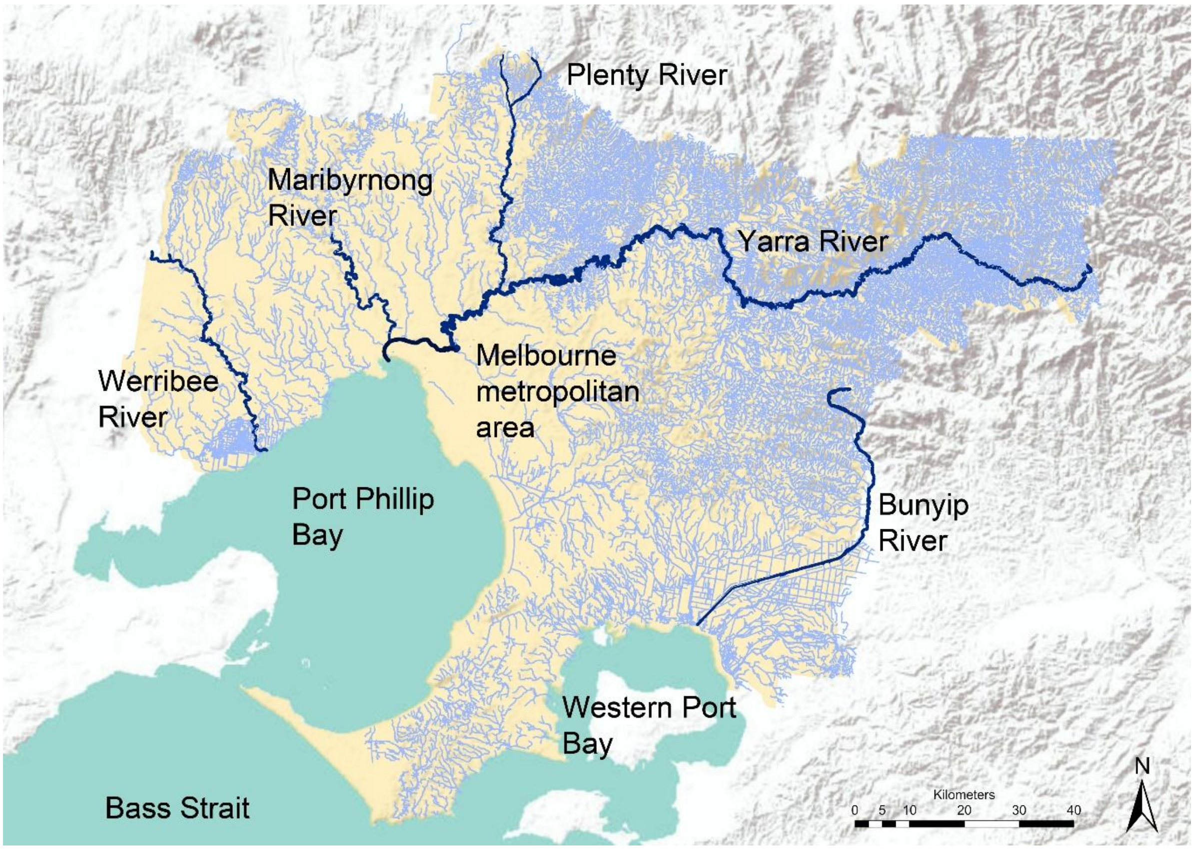

Figure 8. Main rivers of the Greater Melbourne region draining into the bays.

Urban Melbourne includes the city's central business district and surrounding suburbs, covering an area of 9985 square kilometres (3855 square miles) as of June 2015.[57] The city and suburban area contain the lower reaches of three river systems; the Yarra, Maribyrnong and Plenty. Melbourne's central business district – the first area in the region to be developed as urban fabric by European settlers – is located at the northern end of Port Phillip Bay.[58] Two major rivers located in Melbourne's metropolitan region flow into the largest local river, the Yarra. The Plenty enters the Yarra 40 kilometres (25 miles) upstream from the city, while the Maribyrnong enters the Yarra three kilometres (two miles) from the Yarra's mouth at Hobsons Bay.[59] Figure 13 is a map of the watercourses of the network examined by this thesis in relation to Melbourne's central business district – CBD - on the map.

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[57] Nenad Petrovic to I.D. Consulting (blog), March 17, 2016, http://blog.id.com.au/2015/population/australian-demographic-trends/population-densities-of-australian-capital-cities-melbourne-and-sydney/.
[58] Hahs and McDonnell, 436.
[59] "Formation of the Werribee River Catchmant," Werribee River Association, accessed 23 October, 2017, http://werribeeriver.org.au/history/formation-of-the-werribee-river-catchment.

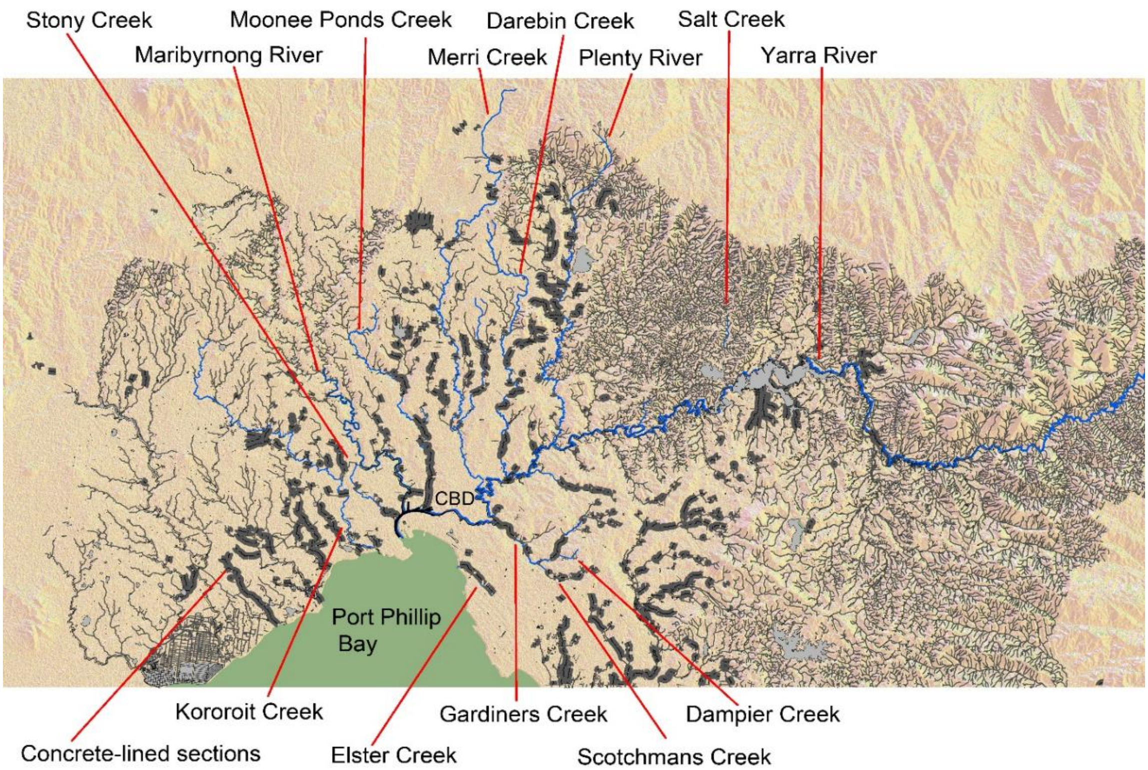

Figure 9.Watercourses featured with this thesis.

The topography of the Melbourne region consists of flat basalt rock plains in the west, stretching northeast, dissected by the river valleys of the Werribee, Maribyrnong, and Plenty.[60] The plains meet the foothills of the Great Dividing Range, creating the Yarra Valley, shaped by the Yarra River. A broad flat coastal plain extends southeast from the foothills to the shores of Port Phillip and Western Port Bays, containing the lower reach of the Bunyip River.[61] This case study of Melbourne's river systems includes the Yarra, Maribyrnong and Plenty, as the lower reaches of these rivers and many of their tributaries are located within urban, suburban or peri-urban regions. While the Bunyip and Werribee Rivers are part of the catchment and currently located within the Victorian Government's boundaries of Melbourne's urban area, they are not crucial to this research as they flow within rural or peri-urban outer regions and are not as extensively surrounded by urban fabric. Figure ten illustrates a three-dimensional model of the Melbourne region's topography.

[60] Melbourne Metropolitan Board of Works, *Planning Policies for the Melbourne Metropolitan Region* (Melbourne: Melbourne Metropolitan Board of Works, 1971), 18.
[61] Ibid.

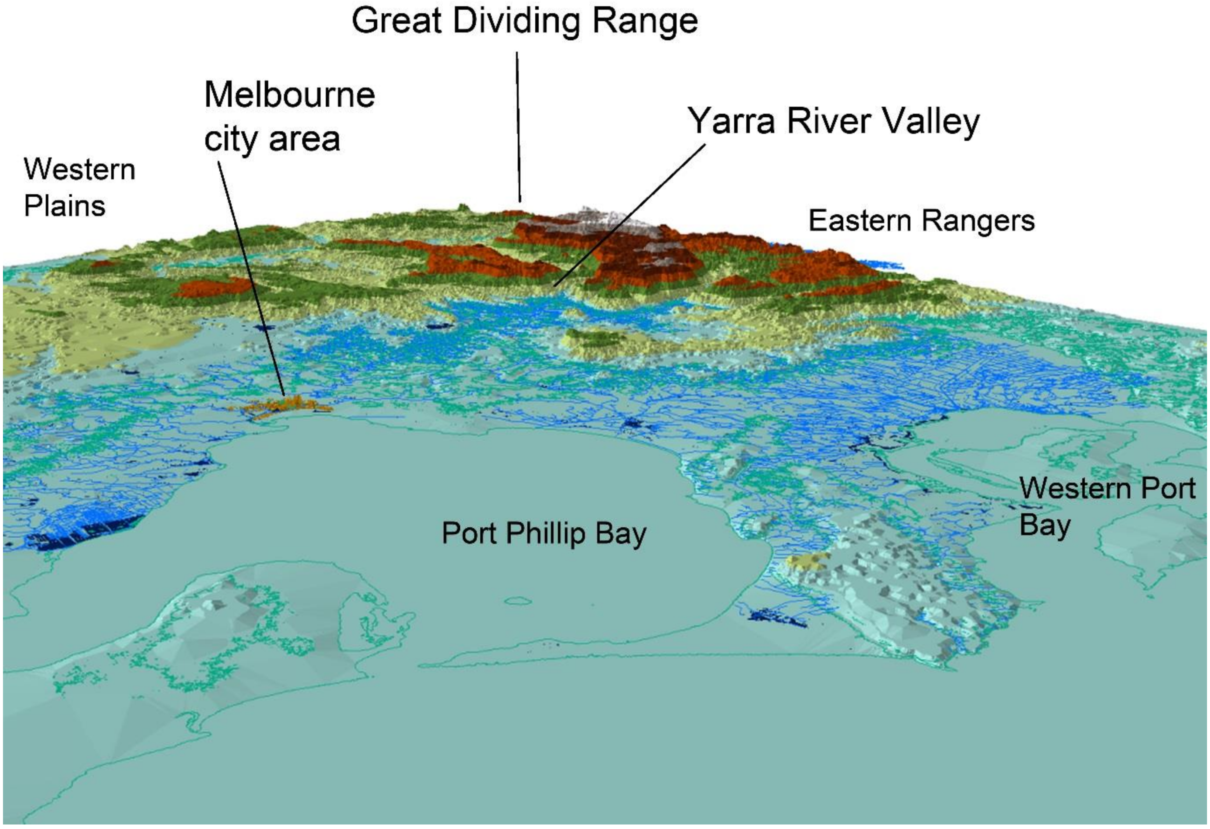

Figure 10. The topography of the Melbourne region in relation to watercourse network.

The climate of the Melbourne region is described as a temperate oceanic climate consisting of cool, wet winters and warm, dry summers (see chapter one, page 9-10).[62] Across the Melbourne region, rainfall may vary from between 500 to 1200 millimetres (19.6 to 47.2 inches) over an 80-kilometre (50 miles) distance, west to east.[63]

Melbourne’s urban watercourses are an ideal case study for this thesis as many of the watercourses’ prescribed uses and authorities’ management practices are compatible with similar western cities. However, there is one significant difference – arguably advantageous for this study’s global relevance – between Melbourne and most contemporary cities, attributed to ‘best practice’ in early development. At a time when Melbourne was growing rapidly, during the mid-to-late 19th century, London developed its combined sewerage

[62] Andrew Sturman and Nigel Tapper, *The Weather and Climate of Australia and New Zealand*, 2nd ed. (Melbourne: Oxford University Press, 2006), 344-46; Victoria Land Conservation Council, *Melbourne Area, District 2 Review: Descriptive Report* (Melbourne: Victorian Land Conservation Council, 1991), 57.
[63] Hahs and McDonnell, 436.

system. Cited as an engineering marvel, this system developed into the conventional approach for managing urban liquid waste and stormwater runoff, and the favoured solution for public sanitation and health. Combined sewers collect and transport all effluent and surface drainage.[64] In London, the rivers and streams had become so polluted many were converted into combined sewers and culverted or piped.[65] Authorities in Melbourne, however, constructed a separate sewerage system, removing effluent outside the city for treatment.[66] Therefore, the city's watercourses collect only stormwater and urban runoff.[67] This left the city with the question of managing local watercourses that were *not* combined sewers.[68] Although many of Melbourne's streams were buried as stormwater drains, or erased with their land reclaimed for development, Melbourne Water – the city's water management authority since 1991 - currently manages 8400 kilometres (5220 miles) of surface rivers, streams and other tributaries.[69]

Another advantage in studying Melbourne is its brief history. Compared with other similarly developed cities Melbourne provides a condensed version of urbanisation. Unlike the watercourses of London altered over centuries, Melbourne's rapid and dramatic changes have transpired in only 180 years. Obtaining relevant historical data within such a narrow period provides positive advantages regarding the material quality and accuracy of data types. Melbourne is also contemporaneous with the development of photography.[70] This provides a rich resource for examining changes to watercourses, urban fabrics and landscapes not captured in textual descriptions alone. Improvements in printing in the 19th century mean high quality maps and documents, now archived; provide greater legibility than earlier materials.

No extensive study of Melbourne's 8400 kilometres (5220 miles) of surface watercourses has hitherto been attempted, and the present work is naturally only a

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64 Myers, 21.

65 Ibid, 114.

66 George A. Gibbs and Melbourne and Metropolitan Board of Works., *Water Supply and Sewerage Systems of the Melbourne and Metropolitan Board of Works: Compiled from Official Documents* (Melbourne: Engineering Publishing, 1925), 80.

67 Ibid, 55.

68 A. E. Dingle and Carolyn Rasmussen, *Vital Connections: Melbourne and Its Board of Works, 1891-1991* (Ringwood, Vic.: McPhee Gribble, 1991), 154.

69 "Drainage System " Melbourne Water Corporation, updated October 11, 2017, http://www.melbournewater.com.au/whatwedo/manageflooding/pages/drainage-system.aspx.

70 Penny Tinkler, *Using Photographs in Social and Historical Research*, (London: SAGE, 2013), xi, SAGE research methods https://ezp.lib.unimelb.edu.au/login?url=http://methods.sagepub.com/book/using-photographs-in-social-and-historical-research.

preliminary foray into such a study.[71] Authors interested in related topics typically concentrate on the city's main river, the Yarra, or it's second largest, the Maribyrnong; or water bodies or agencies. One exception is Presland's (2009) *The Place for a Village,* which looks at Melbourne's watercourses from a natural history perspective, detailing formation of land and waterscapes before urbanisation. This work highlights problems associated with the study of Melbourne's former land and waterscapes. As with any historical research, the outcome is dependent on data quality. The lack of data on Melbourne's watercourses has been identified as a significant management issue by the Moonee Ponds Creek collaboration project, as discussed on pages nine and ten. Presland suggests Melbourne's 'instant city statuses resulted in much of the land and waterscapes being modified or erased before detailed maps were made.[72] There are many gaps in records of Melbourne's watercourses and data in this thesis has consequently been derived from a wide range of sources. Figure 11 illustrates the entire network of watercourses within Melbourne's urban boundary as of March 2018.

[71] Melbourne Water.
[72] Gary Presland, "The Natural History of Melbourne – a Reconstruction" (PhD diss., University of Melbourne, 2005), 30.

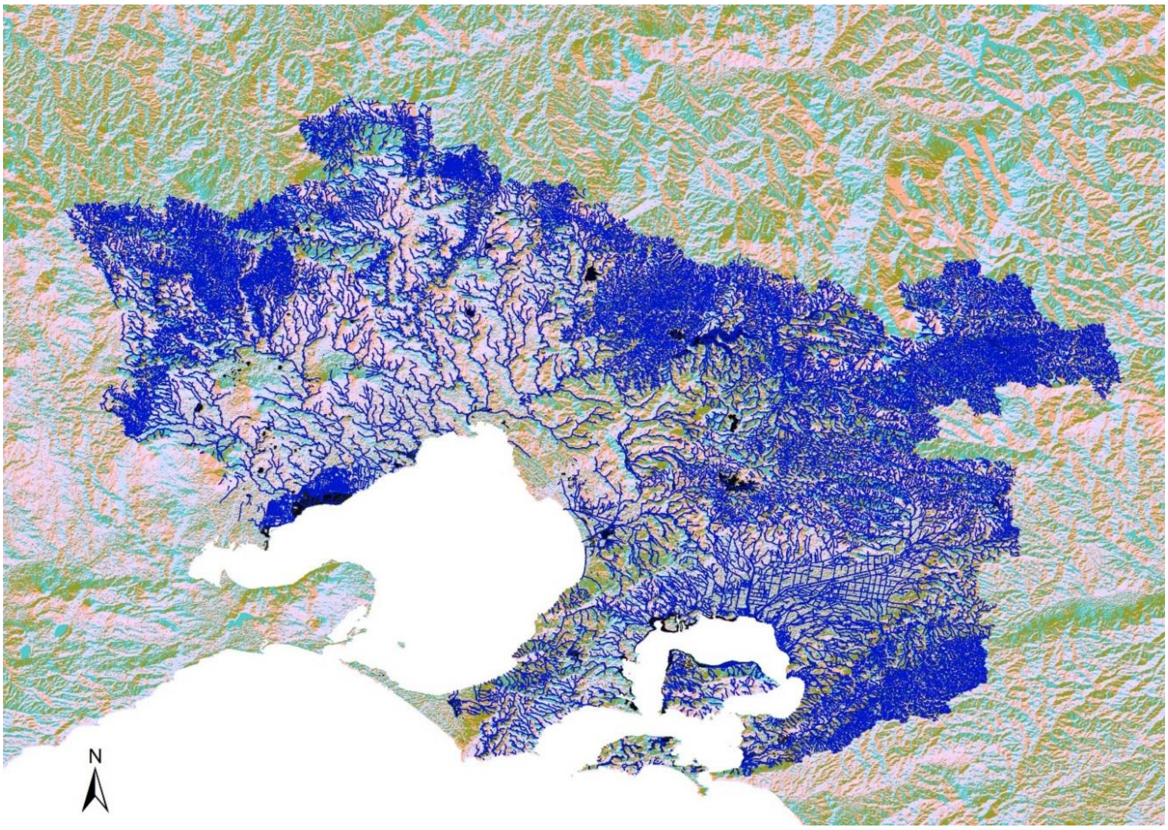

Figure 11. Watercourses within Melbourne’s urban boundary as of March 2018.

Only two main rivers and a selection of significant tributaries are discussed herein on route to understanding an overall urban environmental history of Melbourne. The history details how urbanisation modified and designed Melbourne’s watercourses. It highlights changes in technology and knowledge; perceptions and socio-political values; and the re-emergence of problems once thought solved.

In developing an urban environmental history, this work begins with a literature review (see Chapter Two) detailing, the history of changing roles and requirements placed on urban watercourses by cities globally. This includes changing management approaches over time, increasing pressures for more sustainable, and conservation practices. The literature review also examines the *absence* of watercourses within urban history, design, engineering and planning literature. Chapter Three explains the methodology used in this research.

The examination of Melbourne’s watercourses has been divided into three specific periods. Chapter four covers the first period from 1835 until 1900. This period has been chosen as it covers the establishment of Melbourne, includes the initial impacts urbanisation had upon the area’s watercourses. One of the most significant features of the period was creation of the Melbourne Metropolitan Board of Works (MMBW) in 1891. This was in response to the city's conflicting use of its watercourses for potable water, drainage and unsanctioned sewage disposal. As the city rapidly developed its watercourses underwent dramatic and swift changes for provision of a reliable source of potable water, creation of an international shipping route, and flood mitigation and protection works for control of frequently large-scale flooding. These changes occurred simultaneously as Melbourne developed without proper drainage or sewerage systems, resulting in watercourses becoming open sewers. The MMBW was responsible for construction and management of the first metropolitan-wide sewerage system, management of the potable water supply and responsible for all rivers and creeks (streams) within the urban area (excluding the ports). By 1900, many areas of the city were sewered and the MMBW was beginning to contemplate how to manage the surface watercourses.

The second period, examined in Chapter Five, covers the first half of the 20thcentury, from 1900 until 1950. This period signifies the period when legislation from 1923-1926 was developed to enable the MMBW to manage the city's drainage and flood management problems. So significant was the legislation it continues to direct management of Melbourne's watercourses. The period is also significant as in 1929 Melbourne's first metropolitan-wide plan of development was published that included a section specifically focussing on watercourses and their value. To this day, the 1929 plan remains both unusual for its inclusion of watercourses, and influential. By 1950, however it was becoming evident the ongoing development of Melbourne required a new plan, while the watercourses required significant engineering modifications to cope with increasing drainage flowing from expanding and new suburbs.

Chapter Six examines the third period, from 1950 until the present. This period is significant as it includes; the impacts of Melbourne's second comprehensive (1954) planning scheme on the watercourses; the main freeway era commencing in 1958 through 1985 that proved a major driver of change towards watercourses; public environmental awareness and the development of protest groups from the late 1960s through to 2017; and the evolving use of watercourses as main drains across the entire period. This involved a change of direction from purely an engineering perspective to include ecological hydrology. Under this regime, natural water cycles of floodplain storage for flood flows saw development of retarding basins, and reservation of land from development to allow for floodwater storage and slowing of flows.

Chapter Seven examines the little-known history of using watercourses and riparian land for locating parkland, recreational facilities, and trail networks. This also included development of watercourse valleys as habitat corridors and landscape reserves, preserving remnant areas of indigenous vegetation and topographic features.

The concluding chapter (Eight) is a summary of the urban environmental history of Melbourne's watercourses, highlighting changes over the past 183 years. It also examines a section of the Lower Yarra River using a rare graphic description of an 1881 tour conducted by the City of Melbourne's Health Committee along the river. The committee were seeking to establish the causes of pollution effecting the river. One hundred years to the day the same route was walked, enabling a powerful method for comparison. The chapter also includes overlapping events and drivers established during the last three decades of the 20th century shaping contemporary responses, management and treatment approaches to ensure the ongoing sustainable existence of these dynamic urban systems. Figure 12 illustrates contrasting views of two of Melbourne's main creeks. The above image is a section of the Merri Creek that has undergone revegetation work and modification to the stream bed and banks for erosion control and mitigation of flood flows. The lower image shows a section of the urbanised Moonee ponds Creek, heavily engineered for flood mitigation and erosion control for protection of the surrounding freeway structures.

Figure 12. Engineered waterscapes of the naturalised Merri and entirely constructed Moonee Ponds Creeks. Source: Author photo (2017).

Chapter Two: Literature Review – Urban watercourses as an individual entity within the literature: A notable absence

> Rivers have always been at the heart of city life; the control of their waters was a key to the building of human societies.[1]

Introduction

Urbanisation's impacts on watercourses are discussed across an array of literature within diverse disciplines. Changes created by urbanisation affect all aspects of a watercourse's natural functioning and the eco-services (for example fresh-water, cooling, habitat, breakdown of pollution) utilised by urban populations.[2] Urbanisation also leads to changes in stream geomorphology, physical structure and water quality.[3] Much research and literature exists on the effects of urbanisation on these natural systems and structures of watercourses.[4] However, the literature tends to concentrate on individual rivers, or tributaries, focussing minimally on a river's or urban area's network of watercourses. In addition, much of the literature focusses on a specific theme or main use of an urban watercourse. For example, an urban river in the context of being an industrial river, a transport route or part of a cities' combined sewer system. Since the first urban settlements were established 5000-7000 years ago in the Near and Middle East, the process of urbanisation and urban populations have developed a long, complex history involving the modification and exploitation of watercourses and their stream networks, flowing across the earth's surface.

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[1] Dave Martin, Geffory Petts, and John Healthcote, eds., *Urban Rivers Our Inheritance and Future* (London, UK: IWA Publising, 2002), 1.
[2] Robert A. Francis and Michael A. Chadwick, *Urban Ecosystems: Understanding the Human Environment*, 1st ed. (London ; New York: Earthscan from Routledge, 2013), 55; Dagmar Haase, "How Is Urban Land Use Unique?," in *Rethinking Global Land Use in an Urban Era*, ed. K. Seto and A. Reenberg. (Cambridge MIT Press, 2014), 309.
[3] Angela Gurnell, May Lee, and Catherine Souch, "Urban Rivers: Hydrology, Geomorphology, Ecology and Opportunities for Change," *Geography Compass* 11, no.5 (2007): 1118-19.
[4] Francis and Chadwick, 285.

However, despite this long association, photographer Mustafah Abdulaziz suggests humans have developed an overwhelming misunderstanding of water and a disconnection with the natural environment.[5] This literature review demonstrates how human relationships with water evolved within the urban context, while also highlighting the gradual disconnection of urban populations away from natural waterscapes towards highly engineered networks and systems, hidden within the urban fabric.

This review begins by examining water management practices of communities living in non- or pre-urban environments. The literature refers to these groups as indigenous peoples. However, as discussed by Jiménez, Cortobius and Kjellén (2014) a single, universally acceptable definition for indigenous peoples within the literature remains absent.[6] Within the context of managing water resources, and living in non-or pre-urban environments, the definition for indigenous peoples selected for this thesis is from Taiaiake and Corntassel describing such people as 'in contrast to and in contention with the colonial societies and states that have spread out from Europe and other centres of empire.'[7] Looking at the water management practices of these groups provides context demonstrating how perceptions towards water have been changed by urbanisation through centralisation of urban water supplies, effluent removal, and drainage systems operating outside environmental and climate factors. Within this water scenario, urban watercourses are simply drains. The literature regarding urban watercourses within design, planning, urbanism and history literature is then reviewed. Similar to traditional history approaches, literature from these disciplines commonly considers urban watercourses and water as separate unconnected features or components of other urban infrastructure and processes.[8] The main landmarks in urban watercourse use, abuse and modification are examined, drawn from a range of related histories. In addition to reviewing the literature, a narrative is developed that illustrates how urban watercourses, globally, evolved into their contemporary forms and structures, commonly situated between the natural and designed. This includes the main problems and

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[5] "Photographer Turns Lens on Our 'Complex, Disconnected' Relationship' with Water," *Australian Broadcasting Commission, News* , accessed 24 August, 2017, http://www.abc.net.au/news/2017-08-24/photographer-documents-water-crisis-across-the-globe/8834964.
[6] Alejandro Jiménez, Moa Cortobius, and Marianne Kjellén, "Water, Sanitation and Hygiene and Indigenous Peoples: A Review of the Literature," *Water International* 39, no. 3 (2014): 277.
[7] Taiaiake Alfred and Jeff Corntassel, "Being Indigenous: Resurgences against Contemporary Colonialism," *Government and Opposition* 40, no. 4 (2005): 597.
[8] Shannon and De Meulder, 5-6.

solutions developed by societies for the use and management of watercourses as cities evolved throughout urban history.

Water management practices of indigenous peoples

Madhav and Berkes believe the human activity on natural systems has commonly been portrayed as destructive.[9] However, during the late 20th century this view changed with growing appreciation of indigenous communities' use and management of natural resources.[10] Human societies are claimed by Gadgil and Berkes to have developed diverse ways of using and working with natural environments.[11] The general approach to managing natural resources by indigenous societies largely depends upon perception and experience of a resource's response to use patterns. For example, if a resource's availability fluctuated widely regardless of human use, society would impose few limits on its usage. If a resource were perceived as finite and highly sensitive to human use, societies would practice restrained and sustainable patterns of usage, valuing and respecting the resource.[12] Marchand et al maintain fresh water is commonly placed in this category, widely recognised as being vital for human existence.[13]

Jiménez, Cortobius, and Kjellén note within indigenous societies the management and use of water was intimately related to cultural and religious practices, beliefs and traditional ceremonies.[14] Singh cites the example of rural villages in India where water is managed at two levels: within the local, physical environment; and the non-material spiritual world.[15] Water from certain bodies is perceived as eternally sacred and a medium to attain spiritual enlightenment. Water from non-sacred sources is perceived as secular and provided for everyday uses including drinking, cleaning, and production.[16] The inhabitants therefore perceived water as a renewable source, focussing management practices on sustaining the

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[9] Madhav Gadgil and Fikret Berkes, "Traditional Resource Management Systems," *Resource management and Optimization* 8, no. 3-4 (1991): 129.
[10] Ibid.
[11] Ibid.
[12] Ibid.
[13] Michael Marchand et al., *The River of Life Sustainable Practices of Native Americans and Indigenous Peoples*, (Berlin/Boston: De Gruyter, 2013), 13-14, http://UNIMELB.eblib.com.au/patron/FullRecord.aspx?p=1113312
[14] Jiménez, Cortobius, and Kjellén, 280.
[15] Nandita Singh, "Indigenous Water Management Systems: Interpreting Symbolic Dimensions in Common Property Resource Regimes," *Society & Natural Resources* 19, no. 4 (2006): 360.
[16] Ibid.

village physically and spiritually, while also ensuring the supply does not become degraded or polluted.[17] Sardarli contends that indigenous peoples have evolved unique ways of representing the importance and sacred values of water by developing intimate and vital connections for use and protection.[18]

With the global rise of urbanisation, Marchand et al assert many management practices, beliefs and cultural customs related to water developed by indigenous communities have been lost.[19] King believes many urbanisation patterns have been influenced by colonial rule since 1500 as core powers based in Europe colonised numerous regions, globally.[20] In 1914, half of Earth's land surface and one-third of the world's population were under direct colonial rule.[21] Taiaiake and Corntassel claim colonising settler states sought to eradicate many indigenous groups.[22] This included changing water from common property to contested commodity.[23] Nash cites changes to the social organisation of water systems in Central America transformed over the pre-conquest to modern period.[24] Spanish rule disrupted or destroyed indigenous water rights and sustainable management, resulting in water scarcity. The introduction of crops used to produce alcohol led to water being replaced by alcohol in indigenous community ceremonies.[25] Concerns relating to rising alcohol consumption during the 1960s prompted the switch to soft drinks, produced by large multi-national manufacturers. By the early 21st century, these manufacturers were major extractors of the region's ground water, bottling and selling it to global and local markets.[26] Local populations are paying for what was once common property.[27]

Research by Prober, O'Connor, and Walsh (2011) shows indigenous communities also managed water from a natural resource approach using multifaceted knowledge bases

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[17] Ibid, 361.
[18] Arzu Sardarli, "Use of Indigenous Knowledge in Modeling the Water Quality Dynamics in Peepeekisis and Kahkewistahaw First Nations Communities," *Pimatisiwin: A Journal of Aboriginal & Indigenous Community Health* 11, no. 1 (2013): 55.
[19] Marchand et al. 11-18.
[20] Anthony D. King, "Colonialism, Urbanism and the Capitalist World Economy," *International Journal of Urban and Regional Research* 13, no. 1 (1989): 1; W. Reinhard, "Colonization and Colonialism, History of A2 - Baltes, Neil J. Smelserpaul B," in *International Encyclopedia of the Social & Behavioral Sciences* (Oxford: Pergamon, 2001), 2241.
[21] Ibid.
[22] Alfred and Corntassel, 597.
[23] June Nash, "Consuming Interests: Water, Rum, and Coca-Cola from Ritual Propitiation to Corporate Expropriation in Highland Chiapas," *Cultural Anthropology* 22, no. 4 (2007): 621-22.
[24] Ibid.
[25] Ibid, 621.
[26] Ibid, 621-22.
[27] Ibid, 622.

involving the behaviour of complex ecological systems within their region of habitation in combination with cultural practices and spiritual beliefs.[28] This includes indigenous season knowledge of weather, flora and fauna cycles and their links to land use and culture.[29] According to Gadgil, Berkes and Folke, knowledge accumulated through observation and cross-generational transmission to ensure continued conservation, and in some cases enhancement, of biodiversity and natural resources critical for community existence.[30] As many indigenous societies are dependent on limited, catchment sizes for provision of resources there are strong incentives to manage, conserve and manipulate the landscape to increase biodiversity, thus increasing diversity in their resources.[31]

Water management practices of Indigenous peoples of Australia and the Melbourne region

A review of indigenous inhabitants' management of water is relevant to an overview of Melbourne's watercourse network and water resources management before European settlement. Finn and Jackson show the use of river valleys by indigenous Australia has a history spanning tens of thousands of years, with examples of connections to riparian environments including evidence from fossil records, midden finds and fish traps, the more complex of these built from rocks.[32] Accounts from early European explorers noted indigenous groups' proximity to rivers and other water sources.[33] Langton suggests Australia's indigenous people view the landscape as comprising hundreds of countries and named sites including watercourses, wetlands, and lagoons.[34] Many country names frequently labelled significant sites and their surrounding areas, with water bodies viewed as more than

[28] Suzanne M. Prober, Michael H. O'Connor, and Fiona J. Walsh, "Australian Aboriginal Peoples' Seasonal Knowledge: A Potential Basis for Shared Understanding in Environmental Management," *Ecology & Society* 16, no. 2 (2011): 1-2.
[29] Ibid, 2.
[30] Madhav Gadgil, Fikret Berkes, and Carl Folke, "Indigenous Knowledge for Biodiversity Conservation," *Ambio* 22, no. 2/3 (1993): 151.
[31] Ibid, 151-52.
[32] Marcus Finn and Sue Jackson, "Protecting Indigenous Values in Water Management: A Challenge to Conventional Environmental Flow Assessments," *Ecosystems* 14, no. 8 (2011): 1233.
[33] Ibid, 1233-34.
[34] Marcia Langton, "The Social Archaeology of Australian Indigenous Societies," ed. Bryce Barker, Ian McNiven, and Bruno David, *The Social archaeology of Australian indigenous societies* (Canberra, A.C.T.: Aboriginal Studies Press, 2006), http://search.informit.com.au.ezp.lib.unimelb.edu.au/browsePublication;res=IELIND;isbn=0855754990. 142.

mere physical features of the landscape.[35] The distinctions between land and water are perceived as not absolute; instead, they are cultural space. Resource use is guided by water availability based upon the type of waterscape, its location, ownership, its bounty, hazards, and other characteristics considered predetermined by the sacred past.[36] Relationships with water places are multi-layered, consisting of social and religious traditions and their connections to power, knowledge, well-being, good fortune or alternatively misfortune, which is viewed as the wrath from an ancestral being distressed by human misconduct.[37] The complexity of these relationships amongst Australian indigenous peoples and water places are examined by Goodall and Cadzow (2009) *Rivers and Resilience Aboriginal People on Sydney's Georges River*. The river flows through urban Sydney, capital city of New South Wales. Goodall and Cadzow traced the continual presence of Aboriginal people in the region from before European colonisation to the present, focussing on the role the Georges played in allowing mobility across the area regardless of property boundaries, Aboriginal reserves, or National Parks.[38] This research emphasized relationships between sites and places and how the watercourses formed land shapes and the surrounding fertile environments. These environments provided Aboriginal people, before and after colonisation, with important harvestable resources, while the river provided rapid transport, a communication system, and was an important source of cultural narrative and symbol.[39] However, it is the focus on how the river allowed continual movement that demonstrates the importance of watercourses to Aboriginal people and how in the study region this use continued despite post-colonial urbanisation. [40]

The eel and fish traps, and associated marshland management located in western Victoria, according to Langton, are an example of indigenous people's water resource management.[41] Archaeological evidence has been found of artificial large-scale drainage systems consisting of large excavated channels, and complex traps.[42] A series of channels had

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[35] Ibid, 144.
[36] Ibid.
[37] Ibid.
[38] Heather Goodall and Allison Cadzow, *Rivers and Resilience Aboriginal People on Sydney's Georges River* (Sydney: University of New South Wales Press, 2009): 8-9.
[39] Ibid, 8.
[40] Ibid.
[41] Ibid, 141.
[42] Harry Lourandos, *Continent of Hunter-Gatherers: New Perspectives in Australian Prehistory* (Cambridge ; Melbourne: Cambridge University Press, 1997), 218-20.

been excavated to drain a broad area of boggy ground sited between two natural marshes.[43] The channels utilised the natural hydraulic system to create a swift current by draining run-off and seepage water, discharging into the marshes.[44]

Presland stresses changes to the watercourses of Melbourne were rapid following European settlement.[45] Broome affirms indigenous peoples occupied and managed the region for at least 40,000 years, with archaeological evidence of habitation uncovered at the confluence of the Maribyrnong River and its tributary Deep Creek.[46] The site revealed human remains and an indigenous midden containing various artefacts carbon dated to reveal human occupation for at least 40,000 years, one of the most important such sites on the Australian continent. However, information concerning the indigenous peoples of the Melbourne region’s water management is minimal. Some local histories, such as Broome’s, briefly discuss indigenous people’s links to rivers and creeks typified by alternating periods of camping and food gathering, largely dependent upon the season.[47] The European colonisation and following urban development eliminated food supplies, disrupted Aboriginal movement patterns, changed natural hydrological systems, and erased many landscapes.[48] Presland provides an illustration of the physical development of the town combined with grazing of introduced sheep and cattle, which destroyed locations containing traditional sources of food and water.[49]

Melbourne Region

Following the European settlement of the Melbourne area, Presland contends, urban development occurred at such a swift rate much of the land and waterscapes were modified or totally erased before being properly plotted.[50] Consequently, little is known about the indigenous people’s river farming practices around the Melbourne region. A fish-trap,

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[43] Ibid, 219.
[44] Ibid.
[45] Presland, *The Place for a Village: How Nature Has Shaped the City of Melbourne*, 5-6.
[46] Richard Broome, *Coburg, between Two Creeks* (Melbourne: Lothian, 1987), 4-5.
[47] Ibid, 5-12.
[48] Ibid, 27; Presland, *The Place for a Village: How Nature Has Shaped the City of Melbourne*, 4-5.
[49] Gary Presland and Victoria Archaeological Survey, *An Archaeological Survey of the Melbourne Metropolitan Area*, Occasional Reports Series / Victoria Archaeological Survey, (Albert Park, Vic.: Victoria Archaeological Survey, Ministry for Planning & Environment, Victoria, 1983), 13; James Dredge, *Brief Notices of the Aborigines of New South Wales, Including Port Phillip, in Reference to Their Past History and Present Condition* (Geelong: printed by James Harrison, 1845), 12-14.
[50] Presland, “The Natural History of Melbourne – a Reconstruction,” 30.

constructed rocks placed across the river that was discovered along one of the region's main rivers, the Maribyrnong, as discussed by Jones, is one of the few-recorded river-related artefacts pre-dating European settlement.[51] Finnigan contends further evidence of indigenous people's occupation of the region either has been built over, or was not recognised by European colonisers.[52] According to Presland and the Victorian Archaeological Survey, this is because until the early 1980s archaeological research in Victoria was commonly restricted to rural, non-urban areas.[53] Consequently, many indigenous artefacts and sites of the Melbourne area have been lost or destroyed by continuing urban development and the modification of rivers, streams, riparian zones and wetlands. Many of the sites and artefacts discovered within Melbourne's area have resulted largely from the work of amateur groups.[54] Overall, pre-European indigenous habitation and culture within the area has been clearly documented, despite the loss of much visible evidence.[55] It is clear, however, that the watercourses of the area were valued and respected as key to indigenous population's lives and survival within the region. Finnigan suggests this is evident in other forms such the stories of the descendants of the indigenous population of the region.[56]

There were various sources of water spread unevenly across the region where Melbourne is now located.[57] The rivers and streams flowing from the north provided an abundance of permanent fresh water and important sources of flora and fauna for food supply.[58] In addition, watercourse valleys were utilised as routes for traveling inland from Port Phillip Bay to further resources.[59] When water and food was most abundant, reliable and easily accessible the populations were largest and tended to stay longer.[60]

The first European colonisers arrived in the region during the 1830s. According to Woiwod, they sought pastures for sheep and were immediately impressed by the large areas of open landscape with high, lush grasses, the result of extensive indigenous fire-stick

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[51] Valantyne J. Jones, *Solomon's Ford : Which Ford? Which Solomon?* (Fitzroy Vic.: Globe Press, 1983), 5.
[52] G Finnigan, *City of Port Phillip Aboriginal Resource Primer*, (Melbourne March, 2001), 7.
[53] Presland and Victoria Archaeological Survey, 1.
[54] Ibid, 7.
[55] Presland, *The Place for a Village: How Nature Has Shaped the City of Melbourne*, 205.
[56] Finnigan, 7.
[57] Presland and Victoria Archaeological Survey, 12.
[58] Ibid.
[59] Ibid, 13; Mick Woiwod, *Once around the Sugarloaf: The Transformation of a Victorian Landscape and the Story of Its People* (Kangaroo Ground, Vic.: Bend of Islands Press, 1992), 30.
[60] Lourandos, 64.

farming.[61] As the pastoralists settled the land, they followed Aboriginal tracks, established their main settlements near important well-watered Aboriginal campsites, and developed other settlements on less important campsites close to permanent water.[62] The relative ease and speed the colonisers developed farming land was largely due to prior management carried out by indigenous peoples.[63] Canning, Thiele, and Mitchell report the many sections of the river and stream valleys across Melbourne, deeply incised into the underlying geology, provided indigenous communities with essential resources.[64] These included an accessible source of perennial fresh-water, an array of food sources and stone for tool manufacture.[65] Valley environments also provided shelter from seasonal elements, places for housing, timber for fires and tools.[66] The value of rivers and creeks to the indigenous people is discussed by Lester and Dussart in their highlighting of a report to the Chief Protector of Aboriginals in 1840.[67] The report claimed locations of greatest value to indigenous peoples for their productiveness, the rivers, creeks and watercourses were being rapidly occupied by European settlers with squatters' licences, legally entitling them to occupy the land without intrusion from indigenous groups. The report also discussed the rivers and creeks as the normal places of habitation for indigenous groups, providing them with their most abundant food sources.[68] River and stream banks were also used for providing materials for ceremonial purposes such as kaolin (white clay) for body paint.[69] The patterns of movement of the indigenous populations of Melbourne were largely influenced by geology. Lourandos affirms overall fresh-water was managed as part of the larger natural resource management of the Melbourne region by the indigenous population.[70] Described as hunter-gatherers, their management practices were influenced on seasonal variations, and accumulated, passed down knowledge about local water and food supplies.[71]

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[61] Mick Woiwod, *Once around the Sugarloaf: The Transformation of a Victorian Landscape and the Story of Its People*, 25.
[62] Ibid.
[63] Ibid, 25-27.
[64] Shaun Canning, Frances Thiele, and Mel Mitchell, *Indigenous Cultural Heritage and History within the Metropolitan Melbourne Investigation Area* (Melbourne: Australian Cultural Heritage Management, 2010), 7.
[65] Ibid.
[66] Ibid.
[67] Alan Lester and Fae Dussart, "Trajectories of Protection: Protectorates of Aborigines in Early 19th Century Australia and Aotearoa New Zealand," *New Zealand Geographer* 64, no. 3 (2008): 217.
[68] I. W. Symonds, *Bulla Bulla, an Illustrated History of the Shire of Bulla* (Melbourne: Spectrum, 1985), 18.
[69] Margaret Bride, Graham Bride, and Port Melbourne Historical and Preservation Society, *The Borough and Its People: Port Melbourne 1839 - 1939* (Port Melbourne: Port Melbourne Historical and Preservation Society, 2013), 2.
[70] Lourandos, 62-69.
[71] Ibid, 1.

Review of literature: Human initiated change to watercourses

Human initiated changes to watercourses in urban and rural areas have been widely documented on numerous individual rivers and tributaries globally. Schönach asserts throughout human history, rivers have been of vital importance to humans in material and mental terms.[72] As a result, this importance has been acknowledged in the literature, and in particular, the special genre of river histories that focusses on a river as an historical subject.[73] Although a range of disciplines publish research and literature regarding changes accredited to urbanisation on watercourses, this thesis is largely aligned with the river history genre. In her review of river history literature, Paula Schönach defines river histories as investigations of numerous ways people have perceived, lived along, and modified rivers to suit their culture, economy, politics and lifestyle preferences. She also discusses the genre's relationship to the field of environmental history and argues the study of river histories is developing increasingly sophisticated methodologies in both interdisciplinary range and approaches.[74] Schönach has divided her review of river history literature into three main themes. The first covers spatial dimensions and scales of river histories; the second is human-river interactions over time within riverine environments. These include social-economic, technology, political, current knowledge, and decision making, and how they intertwine and may conflict with one another. The third theme covers a broad range of cultural themes that includes history of ideas, conceptions, institutions, and values involving rivers.[75] Schönach states given the amount of literature published on river histories, her review has been restricted to a 20-year period and the geographical region of Western Europe and North America.[76] The majority of the literature reviewed by Schönach involves either entire or sections of individual rivers flowing through urban, rural, or both locations, while other histories focused on a particular topic. For example, Erik Swyngedouw's (2015) *Liquid power: Contested hydro-modernities in twentieth-century Spain 1898-2010*. Swyngedouw provides an examination of the political-ecological relationships between social and political power and the hydro-social aspects of water, across the country. While Prichard's (2011) *Confluence: The nature of technology and the remaking of the Rhône* is an examination of the

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[72] Paula Schönach, "River Histories: a thematic review," *Water Histories* 9, (2017): 234.
[73] Ibid.
[74] Ibid.
[75] Ibid, 237-238.
[76] Ibid, 234.

continual remaking of the entire Rhône as primarily an industrial river. However, despite this large and significant range of topics and rivers, literature focussing on an urban region's wider network of watercourses as an interconnected system, has not received similar levels of attention. In acknowledging this deficit, Francis asserts the study of major urban watercourse systems is problematic due to the levels of degradation, engineered modifications, and scale of many urban regions.[77] As discussed on page one, Chapter One, many cities globally are experiencing threats to the sustainability of their urban water systems. The main threats include: increasing urban populations; impacts of climate change on rainfall and magnitude of severe weather events; end of design-life for engineered water infrastructure; environmental degradation and pollution; and limits in resources and their allocation.[78] In developing solutions for these issues, Ferguson, Brown and Deletic propose a fundamental system-wide change is required.[79] This would involve viewing cities as dynamic and complex, interrelated and adaptive ecosystem services functioning at local, regional and global scales. Hence the need to view urban water systems, including watercourses, at a system or network level.[80] Ferguson, Brown and Deletic argue, contemporary strategic planning for urban water does not commonly follow the system-wide approach when developing solutions or managing problems.[81] They further report many scholars argue for the need to develop diagnostic approaches that aim to identify the type, cause or source of a problem taking into account the complexity of the entire system in a universal manner.[82] This type of approach is evident in the recent work of the Moonee Ponds Creek Collaboration project in Melbourne (see pages 8-9). In examining the entire catchment of the creek and its network of tributaries, the group has identified a major problem is the lack of historical data on the changes caused by urbanisation to the entire watercourse network.[83] As such the study of urban watercourse networks, rather than a single river or reach, may assist in future planning and developing solutions for sustainable urban water systems. Examination of an urban region's watercourse network may reveal: tributaries that were historically filled or

[77] Robert Francis, "Positioning urban rivers within urban ecology," *Urban Ecosystems* 15 (2012): 288.
[78] Briony Ferguson, Rebekah Brown and Ana Deletic, "Diagnosing transformative change in urban water systems: Theories and frameworks," *Global Environmental Change*, 23 (2013): 264.
[79] Ibid.
[80] Ibid.
[81] Ibid.
[82] Ibid, 265.
[83] [83] J. Francis, L. Poland, and G. Downey, "Moonee Ponds Creek Catchment Collaboration Workshop 4," (Melbourne: Melbourne Water 2017), 1-4.

piped underground; disconnection of watercourses with floodplains; reasons for engineering modifications to larger downstream connecting watercourses; and revealing of former lost associated waterscapes of rivers and streams. According to Shannon and De Meulder (2013) since the rise of engineered urban water systems since at least the 19th century, water, within many cities and urban fabrics globally, has been either engineered out of site or modified into an aesthetically pleasing form. In expanding the theory of water being removed from the urban fabric, De Meulder and Shannon further note, water in general, and its relationship to urbanism, is also absent from much classical and contemporary urbanist literature.[84] Foundation 'classics', such as Unwin's *Town Planning in Practice*, (1909) and Lewis' *Planning the Modern City,* (1949) make no reference to urban water. Later dated works – Lynch's *Good City Form* (1984), Kostof's *The City Shaped: Urban patterns and meanings through history*, (1999), and Jellico and Jellico's *The Landscape of Man: Shaping the environment from prehistory to the present day* (1995) – similarly fail to include significant detail of the history of urban watercourses, their relationship to urbanism and the evolution of their current form**.** Although Kostof, Jellico, and Jellico discuss riverside cities, it is as visual, aesthetic, and defining features of urban fabrics, with little discussion of their histories or changing roles. The subject of urban rivers and their tributaries is not, however, new, with narratives such as Childe's, dating back to the earliest urban civilisations of southern Mesopotamia established along the Tigris and Nile rivers.[85] However, as Cronon maintains, the morphology of roles and requirements placed on watercourses are rarely, acknowledged by conventionally written histories.[86] Instead, rivers and streams are commonly used as background to other narratives. Two Melbourne examples are Newman's *Melbourne: The biography of a city*, in which the city's main river is featured secondarily to discussion of bridges, ships, and development of the port and Otto's *Yarra: The History of Melbourne's Murky River*.[87] Otto's book, although containing a range of topics on the Yarra including morphology, geology and geography, the focus is the social history of people and events occurring along the river. This approach results in the river frequently featured as background to other social histories.

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[84] Shannon and De Meulder, 5.
[85] V. Gordon Childe, "The Urban Revolution," *The Town Planning Review* 21, no. 1 (1950): 5,8-12.
[86] Cronon, ix.
[87] W. H. Newnham, *Melbourne, Biography of a City*, Rev. ed. (Melbourne: Hill of Content, 1985), 114-23; Kristin Otto, *Yarra the History of Melbourne's Murky River*, (Melbourne: The Text Publishing Company, 2011), http://UNIMELB.eblib.com.au/patron/FullRecord.aspx?p=794958

As discussed on page 31, Schönach reports river histories are researched and written using a wide range of methodologies, under an increasingly wide scope of topics. Due to this significant range and scope, only a few river histories have been reviewed here, commencing with Australian rivers. At the time of writing, Otto's history of the Yarra is one of more widely known works on the Yarra. Helen Gregory's *History of the Brisbane River* is an environmental history that analysed historical and contemporary observations to determine the river's capacity for providing the expanding City of Brisbane and towns located along the river. [88] Gregory's research achieved this by focussing on people who observed natural and human-induced changes to the river and how they, and the river, were affected. This included using personal observations from a range of historical and contemporary sources, and interviews.[89] A second approach to the Brisbane River, also focussing on human responses, and the language used towards the river and its environment, that involved flooding on the river and its floodplains is Margaret Cook's 'A River with a City Problem': Brisbane and its Flood-Prone River. Cook's examination of the relationship between the river and people residing on its floodplains, how they responded to the environment, and how the river shaped their lived experiences.[90] The research covered the period 1824 – 1900 and was based on four distinct narratives. The first involved admiration for the river as a source of economic and functional potential that were promoted until severe flooding in 1839. This incited a second response of astonishment that led to a third narrative of people demanding the taming of the river's nature through engineering solutions to prevent flooding. The fourth narrative appeared as a secondary argument to controlling nature; the realisation that human action had created the flooding threat.[91] Cook argued that despite the accumulation of flood and climate knowledge since 1824, when the initial British settlement was established, current responses and future actions towards flooding on the Brisbane River have evolved very little.[92] A different approach to the environmental history of the Moorabool River, in the central highlands of Victoria, Australia, is Erica Nathan's *Lost Waters: A History of a Troubled Catchment*. [93] Her research recorded the history, since European settlement, of what she

[88] Helen Gregory, *History of the Brisbane River* (Yeronga: Australia Marine Conservation Society, 1996), vi.
[89] Ibid.
[90] Margaret Cook, "A River with a City Problem," not a City with a River Problem: Brisbane River and its Flood-Prone River,' *Environment and History* 24, (2018): 469.
[91] Ibid.
[92] Ibid, 495.
[93] Erica Nathan, *Lost Water's: A History of a Troubled Catchment* (Carlton: Melbourne University Publishing, 2007), 1-7.

terms the waterscape of the central highlands reach of the river.[94] Nathan's approach developed a historical perspective to the politics of water allocation and reallocation, and what water meant to the people of the waterscape and how the river connected them to place.[95] From her examination of historical and contemporary data, Nathan demonstrates issues surrounding water and its management is more than just debates over resource allocations; it must also include the experience of people intimately connected to the waterscape.[96]

The above Australian river histories focused on one particular river, with the exception of Nathan's history of the Moorabool River, as she included the wider waterscape. All authors focused on human-initiated changes to the rivers with Gregory, Cook and Nathan developing histories based on personal observations, events and experiences of people closely associated with the particular river. While Cook focusses primarily on the theme of flooding, Otto tends to focus more towards social history. Gregory's environmental history is based on human observation of changes to the river, with Nathan focussing on how the politics of water resource allocation affected people in the catchment and environmental change to the river and its region. The authors have concentrated on either entire rivers, or a particular region a river flows through, regardless of adjacent land use.

According to Cronon, although the major uses given to watercourses allowed the evolution of many urban settlements, within traditional histories, the watercourse's own history remains conspicuously obscure, being the only landscape feature portrayed as unchanged.[97] Traditional histories also feature watercourses as linking devices for places, people and events that otherwise appear separate, the river itself seemingly static.[98] Rivers are nonetheless frequently presented as foundational features for many cities.[99] The authors of World Facts, in 2016, listed one hundred and forty of the world's most commonly known capital cities and the rivers on which they are located.[100]

Le Corbusier's *The City of Tomorrow and its Planning* suggest a contrary position: that rivers should not flow through cities, but instead serve as a liquid railway, warehouse and

[94] Ibid, 2.
[95] Ibid, 2-3.
[96] Ibid, 5-6.
[97] Cronon, ix.
[98] Ibid.
[99] Everard and Moggridge, 293.
[100] "River's of the World's Capital Cities " World's Facts Inc, accessed February 16, 2016, https://sites.google.com/site/worldfactsinc/rivers-of-the-world-s-capital-cities.

distribution centre.[101] Rivers are likened to servants who should not be observed in a home's main rooms.[102] Mumford one of the few urban historians to discuss rivers, considers them the most resilient urban utilities, for both water supply and transport.[103] He refers to rivers as the *roadbed* of many civilisations.[104] Although both Le Corbusier and Mumford recognise rivers as important transport routes for servicing cities, Mumford also values watercourses' provision of fresh-water for drinking and irrigation.[105] These vital uses are notably absent in Le Corbusier's work.

The narrative of this evolution within the context of urban watercourses' continual change within the development of urbanisation has been confined to literature about specific cities, rivers or tributaries, or specific topics and themes. The lost rivers of London, for instance, have been widely documented, in studies by Barton (1962), Myers (2011), and Talling (2011). These books provide accounts of the history and current forms of rivers flowing above, beneath and across London's urban fabric. Gumprecht's environmental history of the Los Angeles River comprehensively details its placement within a 51-mile (82 kilometre) long concrete flood channel, and plans for future restoration.[106] Tilly Hinton's *A Field Guide to Love and the Los Angeles River* is based on the universal principals of the naturalist field guide to critique how people relate to nature within urban environments, using the contemporary history of the Los Angeles River.[107] Focussing on three aspects of the river – water, paint and weeds – Hinton uses interviews with a range of stakeholders intimately connected with the river to discover their emotion affinities that tie them to the river and its immediate environs. Utilising historical and contemporary data Hinton develops an environmental history of the river based on the participant's sense of place and emotions towards the river and its future.[108] Another river history that examined human affinities tying people to a river is Stephen Dobbs' *An Ecological History of The Singapore River: With particular reference to the Lighterage Industry*. Dobbs used a combination of archival and

[101] Le Corbusier, "The City of Tomorrow and Its Planning " in *The Blackwell City Reader*, ed. Sophie Watson and Gary Bridge (Oxford: Blackwell, 2002), 21.
[102] Ibid.
[103] Lewis Mumford, *The Culture of Cities* (London: Secker & Warburg, 1938), 316.
[104] Ibid, 316-17.
[105] Ibid, 316.
[106] Blake Gumprecht, *The Los Angeles River: Its Life, Death, and Possible Rebirth* (Baltimore: Johns Hopkins University Press, 1999), 174-227.
[107] Tilly Marie Hinton, "A Field Guide to Love and the Los Angeles River" (PhD diss., University of Technology Sydney, 2017), vi.
[108] Ibid.

oral history sources to examine, and reconstruct, the ecological history of the river and the Lighterage industry (lighterage is the transfer of cargo from large ships to smaller barges, lighters, for short trips in waters too shallow for larger vessels).[109] His examination of the Singapore River is a combination of social, ecological and economic histories with urban studies and geography to illustrate how the river functioned as the centre of the city and main trade route for the colony.[110] The result situates the river within both an ecological context and the historical development of Singapore, while highlighting the lighterage industry's role. Dobbs also establishes a social history of the industry and how the lightermen interacted with, and worked and lived along river, viewed its ongoing changes, and changes to the shipping and lighterage industries.[111] *The Environmental History of the Hudson River: human uses that changed the ecology, ecology that changed human uses*, edited by Henshaw, also focuses on the ecological history of an entire and significant river.[112] The book is divided into four sections, the first examining the Hudson's history and biology. The second concentrates on the premise of the river as a source of resources exploited by indigenous peoples and the colonists. Part three examines the river from the perspective of European colonists as a river of commerce and how they exploited the river and its environs with no regard to impacts on its ecology. In the final section, authors discuss the spiritual impacts of the river on people, highlighting the beginning of the world's environmental movement in the Hudson Valley in seeking to protect the river and its environs.[113] In a departure from the general examinations of rivers, *The Biopolitics of the Danube Delta: Nature, History, Politics* edited by Constantin Iordachi and Kristof van Assche, focused on the delta or river–mouth region of the Danube.[114] Written as a case study, the contributing authors bring together insights from the natural and social sciences, and humanities to illustrate the interconnected relationships existing between nature, culture and politics.[115] Based on the aspects of the delta's history and future directions, presented and discussed within the book, the

[109] Stephen Dobbs, "An Ecological History of the Singapore River: With Particular Reference to the Lighterage Industry" (PhD diss., Murdoch University, 1999), ii.
[110] Ibid, 247-249.
[111] Ibid, 247-253.
[112] Robert Henshaw. "Introduction." In *Environmental History of the Hudson River: Human uses that changed the Ecology, Ecology that changed Human Uses,* ed. Robert Henshaw (Albany: State University of New York Press, 2011), xv-xx.
[113] Ibid, xix.
[114] Constantin Iordachi and Kristof van Assche, "Introduction," in *The Biopolitics of the Danube Delta: Nature, History, Politics,* eds. Constantin Iordachi and Kristof van Assche (Lanham: Lexington Books, 2015), xiii.
[115] Ibid, xvi.

contributors also argue developmental plans and policies for the delta require a more sophisticated and complex images of places and communities.[116] Another examination of the Danube, focused on its management, is Winiwarter, Schmid and Dressel, 'Looking at half a millennium of co-existence: the Danube in Vienna as a socio-natural site'.[117] The authors argue actions undertaken during the 19th century retain influence over the layout of Vienna and its annual city budget. In offering an explanation, the authors developed an overview of the significant events in the interconnected histories of Vienna and the Danube using an interdisciplinary team of researchers.[118] The results included an examination of the history of settlement, sewage disposal and flooding and reconstruction of the floodplains evolution. The results from the histories and river morphology were used to produce a long-term perspective for the river's management.[119] Further research on the Danube by Winiwarter et al, examines the differences between pre-industrial and industrial society's relationship with nature.[120] The Danube is discussed as a long-term case study in an examination of the river as a socio-natural site hybrid. [121] The approach by Winiwarter et al, examines the connections between the arrangement of infrastructure such as ports, bridges, dams, and power plants located along the river, with practices involving the river that included transport, river regulation, food and energy production.[122] The authors conclude by arguing for current management decisions concerning the river should be firmly based on historical knowledge. Similarly, Martin, Petts, and Heathcote focus on urbanisation's long-term effects on London's aquatic environment. The authors illustrate the pollution history of London's watercourses and explore community engagement projects for the restoration of streams, their corridors and the adjacent urban fabric.[123]

Other books include examinations of a number of rivers focussing on a particular theme. For example, *Urban rivers: remaking rivers, cities, and space in Europe and North*

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[116] Ibid, xxvi.
[117] Verena Winiwarter, Martin Schmid, and Gert Dressel, "Looking at half a millennium of co-existence: the Danube in Vienna as a socio-natural site," *Water History* 5, (2013): 101.
[118] Ibid, 101-102.
[119] Ibid, 114-115.
[120] Verena Winiwarter, Martin Schmid, Severin Hohensinner, and Gertrude Haidvogl, "The Environmental History of the Danube River Basin as an Issue of Long-Term Socio-ecological Research," in *Long Term Socio-Ecological Research Studies in Society-Nature Interactions Across Spatial and Temporal Scales,* eds. Simon Singh, Helmut Haberl, Marian Chetow, Michael Mirtl, and Martin Schmid (New York: Dordrecht, 2013), 103.
[121] Ibid.
[122] Ibid.
[123] Dave Martin, Geoffrey Petts, and John Healthcote, eds., *Urban Rivers* (London: IWA Publishing, 2002).

America edited by Castonguay and Evenden regards the industrialisation of a selection of large rivers in Europe and North America.[124] Douglas' *Cities: An Environmental History* provides one of the few overviews of urban watercourses (albeit briefly and generally), from a global perspective, including examples of changes created by urbanisation.[125] Similarly, though focussing specifically on one city, *HTO Toronto's Water from Lake Iroquois to Lost Rivers to Low-flow Toilets* edited by Reeves and Palassio examines Toronto's rivers through a lens of social, technical, environmental and contemporary histories.[126] A similar book focussing on the overall theme of urban water by Maria Kaika *City of Flows Modernity, Nature, and the City*. Kaika asserts nature and the modern city are frequently perceived as being independent of each other, or opposites.[127] Through her development of a history of the role of water in the modern city, she illustrates how nature has been fully integrated into urban life and is entwined in all aspects of urban social life.[128] Michèle Dagenais, *Montreal City of Water: An environmental history* also examined the wider topic of water, and water-related infrastructure, and their central roles in the development of Montreal's new urban forms since the early 19th century.[129] Dagenais focused on both how water shaped and was shaped by development of the urban form and as an important sociocultural component of city life to Montreal's inhabitants across the history of the city's process of urbanisation.[130] Swyngedouw, *Liquid Power: Contested Hydro-Modernities in Twentieth Century Spain* along similar lines to Dagenais, (though on a country-wide scale) examined the relationship of water with the unregulated process of the country's development and modernisation.[131] His research on water politics and engineering illustrates how political, economic and social processes entwined with the qualities and powers of water in the quest of immense social dreams and visions.[132] Swyngedouw documented the transformation of Spain's waterscapes

[124] Stéphane Castonguay and Matthew D. Evenden, eds., *Urban Rivers: Remaking Rivers, Cities, and Space in Europe and North America* (Pittsburgh: University of Pittsburgh Press, 2012).
[125] Ian Douglas, *Cities: An Environmental History*, Environmental History and Global Change Series (London: I.B. Tauris & Co. Ltd., 2013).
[126] Wayne Reeves and Christina Palassio, eds., *Hto Toronto's Water from Lake Iroquois to Lost Rivers to Low-Flow Toilets* (Toronto: Coach House Books, 2008).
[127] Maria Kaika, *City of Flows Modernity, Nature, and the City* (New York: Routledge, 2005), 4.
[128] Ibid, 5.
[129] Michèle Dagenais, *Montreal City of Water: An environmental history*, trans. Peter Feldstein (Vancouver: University of British Columbia Press, 2017), 4.
[130] Ibid, 4-9.
[131] Erik Swyngedouw, *Liquid Power: Contested Hydro-Modernities in Twentieth Century Spain* (Cambridge, Massachusetts: The MIT Press, 2015), 1.
[132] Ibid.

with the construction of large-scale engineering projects shaped by political-ecological processes.[133]

Kibel, *Rivertown: Rethinking Urban* Rivers, and Shannon and De Meulder, *Water Urbanisms: east*, write about urban watercourses from a landscape architectural, urban design focus.[134] These books concentrate on the reimagining and redevelopment of urban watercourses considering post-industrial and heavily degraded rivers, and their management to improve water quality and flood management. The projects are site-specific and heavily design-focussed.[135] This approach, focusing on redesign of small individual sections of watercourse banks and manipulation of adjacent parkland, neglects urban water in general and largely fails to consider the watercourse's wider catchment area. Backhaus, Dam and Jenson note that despite the development of WSUD, many in the design profession continue to use outmoded approaches to urban watercourses.[136] Hoyer, Kronawitter, and Dickhaut reason that the slow acceptance of WSUD lies in outcomes.[137] They suggest many WSUD projects are designed to prevent local flooding and thus focus on quantitative design aspects. This results in heavily engineered projects with no consideration of ecological, social, or aesthetic qualities. Designs lacking these qualities are perceived by the public as visually unattractive, unusual, or messy, and if poorly maintained, lack benefit due to higher design and construction costs than conventional drainage approaches.[138]

This lack of catchment-wide design approaches and reluctance to adopt WSUD ignores landscape architecture's rich heritage in urban watercourse research-design-management. Searns cites the widely renowned Fredrick Law Olmstead Sr.'s (1822-1903) designs for watercourses, green and parkways.[139] Eisenman suggests that Olmstead's best-known works, providing a significant turning point for urban watercourse design, were the Emerald

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133 Ibid, 223-230.
134 Paul Stanton Kibel, ed., *Rivertown: Rethinking Urban Rivers* (Cambridge, Mass.: MIT Press, 2007); Kelly Shannon and Bruno De Meulder, eds., *Water Urbanisms: East* (Zurich: Switzerland Park Books, 2013).
135 Shannon and De Meulder; Kibel.
136 Antje Backhaus, Torben Dam, and Marina Bergen Jensen, "Stormwater Management Challenges as Revealed through a Design Experiment with Professional Landscape Architects," *Urban Water Journal* 9, no. 1 (2012): 29; Peter J. Morison and Rebekah R. Brown, "Understanding the Nature of Publics and Local Policy Commitment to Water Sensitive Urban Design," *Landscape and Urban Planning* 99, no. 2 (2011): 83.
137 J. Hoyer, L. Kronawitter, and W. Dickhaut, "Envisioning a Water Sensitive City – Case Studies from Europe and the USA," in *WSUD 2012: Water sensitive urban design; Building the water sensiitve community; 7th international conference on water sensitive urban design,* ed. Engineers Australia (Barton, A.C.T.: Engineers Australia, 2012), 88.
138 Ibid.
139 Robert M. Searns, "The Evolution of Greenways as an Adaptive Urban Landscape Form," *Landscape and Urban Planning* 33, no. 1–3 (1995): 68.

Necklace and Back Bay Fens projects (1879-1895).[140] Using comprehensive planning considering the wider urban area, environmental restoration and ecological engineering to manage sewage and control flooding provided a large-scale park system on Boston's Charles River basin.[141] For Searns, much of Olmstead's ecological design has been compromised by construction of traditional drainage approaches across Boston's urban fabric during the 20th century.[142] This included introduction of culverts and land reclamation and consequent sedimentation and aquatic weed invasion.[143] The failure of site-specific design and lack of catchment-wide approaches are highlighted by Dreiseitl who believes urban watercourses, parklands and green spaces are rigidly planned and therefore uninspiring and unattractive.[144] Dreiseitl suggests many such sites are designed as temporary spaces awaiting future development, or as mere gaps between buildings and roads, and are disconnected from the natural environment, other habitat spaces and the urban fabric.[145] He further suggests the long-term sustainability of urban rivers, tributaries, and adjacent green-space is at risk without appropriate management.[146]

The field of landscape urbanism emerged during the 1990s with the premise that a city's landscape, as opposed to its buildings, should be foundational to its design.[147] Its foremost publication, Waldheim's *The Landscape Urbanism Reader*, fails to consider rivers or tributaries as an individual urban system.[148] Water is treated as an aesthetic feature, incorporated into the overall visual aspects of a design. The featured projects neglect to identify design's role within water and catchment management.[149]

The absence of water from literature has been attributed by authors such as De Meulder and Shannon to the link between water and public health and sanitation in 19th century London[150] where polluted water supplies led to outbreaks of cholera.[151] De Meulder and Shannon claim

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140 Theodore Eisenman, "Frederick Law Olmsted," *Journal of Planning History* 12, no. 4 (2013): 292-93.
141 Ibid, 292-95.
142 Ibid, 294-95.
143 Ibid.
144 Herbert Dreiseitl, "Blue-Green Social Place-Making: Infrastructures for Sustainable Cities," *Journal of Urban Regeneration & Renewal* 8, no. 2 (2015): 161-62.
145 Ibid, 161.
146 Ibid.
147 Frederick Steiner, "Landscape Ecological Urbanism: Origins and Trajectories," *Landscape and Urban Planning* 100, no. 4 (2011): 333.
148 Charles Waldheim, *The Landscape Urbanism Reader*, 1st ed. (New York: Princeton Architectural Press, 2006).
149 Ibid, 165-72.
150 Shannon and De Meulder, 6.
151 Ibid.

urban water sanitation became a paramount concern with civil engineering providing the solution.[152] Water was identified and used as a mode of sanitation, to be removed as efficiently as possible.[153] Myers asserts urban water became an engineering responsibility, resulting in numerous watercourses becoming combined sewers or drains, accordingly covered and buried.[154] Contemporary engineering literature generally continues to treat urban watercourses as drainage system components, their designs based on quantitative hydrological formula: O'Loughlin and Robinson for example refer to watercourses as 'receiving waters', related to larger rivers or lakes.[155] They also classify watercourses as trunk drains, providing design criteria for the modification of stream banks and bed to ensure rapid and efficient removal of stormwater flows.[156] The engineering of natural watercourses into trunk drains includes widening and straightening of streambeds, lining of channels with concrete or rock, and construction of channel flow regulators including weirs and drop structures.[157] White and Howe report that urban surface water is managed with a drainage philosophy unchanged since the industrial revolution involving draining into the nearest river or tributary.[158] This sits with a proposal from Brown, Keath and Wong of a transitional framework illustrating a historical timeline of stages urban water management has followed.[159] Although writing specifically for Australian cities, the framework is applicable to cities globally. The proposed stages delineate changes in social, technological, and governance structures coinciding with the industrial revolution in Britain.[160] Urban water engineering developed in Britain modelled design and management of global urban water systems.[161] The first stage was the *water supply city*, with the development of secure potable water for cities. The *sewered city* followed, developed from the mid to late 1800s, with design and construction of reticulated sewerage systems disposing of effluent outside

[152] Ibid.
[153] Ibid.
[154] Myers, 112-14.
[155] Karvonen, 14-15; G O'Loughlin and D Robinson, "Urban Stormwater Drainage " in *Australian Rainfall and Runoff a Guide to Flood Estimation*, ed. Pilgrim D (Barton, ACT: Institution of Engineers, Australia, 1998), 291-92.
[156] D. H. Pilgrim and Institution of Engineers Australia., *Australian Rainfall and Runoff: A Guide to Flood Estimation* (Barton, ACT: Institution of Engineers, Australia, 1998), 291,336.
[157] Ibid, 336-39.
[158] Iain White and Joe Howe, "The Mismanagement of Surface Water," *Applied Geography* 24, no. 4 (2004): 263.
[159] R. Brown, N. Keath, and T. Wong, "Urban Water Management in Cities: Historical, Current and Future Regimes," *Water Science & Technology* 59, no. 5 (2009): 851-54.
[160] Ibid, 851.
[161] Ibid, 851-53.

cities.[162] Although combined sewers were used globally, Australia's rainfall intensities necessitated specific requirements. The costs associated with constructing combined systems large enough proved prohibitive and therefore only separate sewerage systems were used.[163] The next problem was stormwater and flooding, with the *Drained city* developing in the mid-20th century. This resulted in the engineering modification of urban watercourses for the rapid and efficient removal of stormwater from the urban fabric and the limiting of flooding and property damage.[164] The *Watercourses city* came after, focussing on the degraded conditions of watercourses and the management of stormwater quality. The *Water cycle city* and the *Water sensitive city* are the final stages, focussing on the recognition of limits to traditional water sources and provision of sustainable water futures respectively.[165] These last are yet unrealised, although current management practices consist of facets of all the city stages, engineering commonly retaining a prominent position for design, management, and frequently, contemporary restoration of urban watercourses.[166]

As discussed in Chapter One, page six, environmental history frequently defines rivers and urban watercourses as situated between the natural and designed. Richard White and his environmental history of the Columbia River, which flows through the Pacific North-West of North America, examines the river as an organic machine that maintains its unmade qualities despite being modified by human intervention; a hybrid consisting of natural and designed qualities.[167] White emphasises the river's role as an energy system that provides hydroelectricity from the dams constructed on the river and as a source of food for the salmon inhabiting its waters. He argues this as a new way to think about the relationship between nature and human interventions and history, and asserts human history is not understood without natural history and vice-versa.[168] White's examination of the Columbia develops a history of the relationship between the river's natural history and history of human intervention.[169] Prichard (see page 31) further expands the premise of watercourses as hybrids

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[162] Ibid, 852.
[163] Ibid.
[164] Ibid.
[165] Ibid, 853-54.
[166] S. Eden and S. Tunstall, "Ecological Versus Social Restoration? How Urban River Restoration Challenges but Also Fails to Challenge the Science ? Policy Nexus in the United Kingdom," *Environment and Planning C: Government and Policy* 24, no. 5 (2006): 675-77.
[167] Richard White, *The Organic Machine: The Remaking of the Columbia River* (New York: Hill and Wang, 1995), x-xi.
[168] Ibid.
[169] Ibid.

situated between the natural and designed with her definition of the Rhône River as an envirotechnical landscape.[170] She suggests through a combination of ecological and technological systems, human and nonhuman interaction, the river has been continually remade between the end of World War II and the late 20th century.[171] This remaking has resulted in creation of a complex and dynamic of nature, technology and society; an envirotechnical landscape.[172] Although only focussing on the Rhône, Pritchard also notes her work demonstrates how technological change, objectives, design, and negotiation shaped the appearance of river management in France since 1945.[173]

In addition to identifying urban watercourses as hybrids of natural ecology and the designed, the history of urban rivers and streams has also been analysed as components of a city's urban metabolism. Urban metabolism is defined by Kennedy, Cuddihy and Engel-Yan as the total of technical and socioeconomic processes occurring in cities that results in energy production, growth and removal of wastes.[174] Barles, *Urban metabolism and river systems: an historical perspective-Paris and the Seine, 1790-1970* uses the concept to analyse the metabolic interaction between the Sein and Paris during the industrial era.[175] Her research uses the concept of urban metabolism to focus on the exchanges of water and wastes, and the quantities, within the context of management strategies implemented by governing bodies and stakeholders.[176] Gandy also utilises the concept of urban metabolism, *Rethinking urban metabolism: Water, space and the modern city*, in his examination of the expansion of urban water systems since the 19th century industrial city. He asserts that with the development of the modern city, nature became the focus of contemplation as opposed to previously being perceived as a material necessity. As such, Gandy argues, with development of the contemporary city and the commodification of nature and natural resources, such as potable water, concepts of urban metabolism have become problematic for explaining the circulatory

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170 Sara Pritchard, *Confluence: The Nature of Technology and the Remaking of the Rhône* (Cambridge, Massachusetts: Harvard University Press, 2011), 1.
171 Ibid.
172 Ibid, 1-2.
173 Ibid, 6.
174 Christopher Kennedy, John Cuddihy and Joshua Engel-Yan, "The Changing Metabolism of Cities," *Journal of Industrial Ecology* 11, no.2 (2007): 44.
175 Sabine Barles, "Urban metabolism and river systems: an historical perspective – Paris and the Seine, 1790–1970," *Hydrology and Earth System Sciences* 11, (2007): 1769.
176 Ibid.

processes underpinning the transformation of nature into vital commodities.[177] Gandy suggests the idea of metabolism in this case is not derived function analogies, rather from an interconnecting of social and biophysical processers creating new forms of urban nature.[178]

In comparison to the Australian and international river histories, water histories, and associated literature examined above, this thesis differs to those studies as it focusses on Melbourne's network of main watercourses as opposed to just one river. The thesis also covers more than just a single theme or history involving the examined watercourses, although themes such as flooding and industrial use of watercourses are examined. The thesis is limited primarily to Greater Melbourne's urban area, resulting in only the urban reaches of the main rivers being included. It also illustrates the interconnectedness of the city's main rivers with each other and their tributaries, and seeks to generate the understanding that urban watercourses are part of a larger network that is impacted by changes to single or parts of other watercourses within the system. In comparing this research to that other authors such as authors Gandy, White, Kaika, and Swyngedouw, who concentrate on specific themes and topics, this thesis covers similar topics in considering Greater Melbourne's entire watercourse network. However, where the authors concentrate on one specific aspect of a river or topic, this thesis provides a larger overview of how the watercourse network was affected and shaped by ecological-political factors and how these led to produce Melbourne's network of hybrid natural and engineered watercourses.

The physical and biophysical effects of urbanisation on the natural systems of watercourses

As this thesis positions urban watercourses between the natural and designed, the literature on physical and biophysical effects of urbanisation is also relevant. According to Francis, urban watercourses became the focus of increased research commencing in the 1990s, as their importance as components of a range of urban systems were realised.[179] This was coupled with a need for clearer understanding of urban watercourse ecosystem structure and processes, improved natural resource management and the need for more appropriate

177 Mathew Gandy, "Rethinking urban metabolism: Water, space and the modern city," *City* 8, no.3 (December 2004), 373-374.
178 Ibid.
179 Francis, 285.

planning and management to control the continuing degradation and destruction of riverine systems globally.[180] For example, a simple web-based literature search using the term 'urban rivers' in any number of general online databases reveals a large amount of literature on changes created by urbanisation to the specific natural systems of urban watercourses. Much of this research focuses on issues surrounding water quality and its broader implications including effects on human health.[181] Other areas of recent research largely focusing on ecological and biological systems include; stream ecology and health, hydro-geomorphology, biochemical processes, community ecology, and river and stream restoration. Francis reports most of this research has been conducted on comparatively small watercourses within urban catchments as opposed to larger rivers and tributary systems of heavily urbanised cities.[182] Strang suggests the design of contemporary American cities has largely disregarded hydrology of place, routing watercourses into concrete lined channels or pipes, essentially erasing visual and spatial attributes of a region.[183] Holis builds on this by implying urbanisation disrupts and reconfigures the pathways and storages of water within the natural hydrological cycle. Changes also occur to hydrological cycles outside the city as reservoirs are built to artificially collect and hold water for urban consumption.[184]

The effects of urbanisation on the physical and biophysical characteristics of watercourses is summarised by Paul and Meyer.[185] Urbanisation changes stream hydrology; geomorphology; water temperature; water ecology and biology; ecosystem process; introduction of various chemicals and toxins to the water that disturbs or modifies normal chemical processes.[186] In addition, Wright reports water flowing through concrete drainage infrastructure, collected from the urban surface, has significantly modified pH and salinity levels due to concrete dissolution.[187] One of the more widely known and studied effects of urbanisation on watercourses is the increase in rainfall and runoff entering watercourses from impervious surfaces. Barnes, Morgan, and Roberge define impervious surfaces as constructed surfaces using impermeable materials that repel water and stop rainfall and meltwater from

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[180] Ibid, 286.
[181] Ibid, 287.
[182] Ibid, 285.
[183] Strang, 13.
[184] G. E. Hollis, "Rain, Roads, Roofs and Runoff: Hydrology in Cities," *Geography* 73, no. 1 (1988): 9.
[185] Paul and Meyer, 333.
[186] Ibid, 339-54.
[187] Ian. Wright, "Concrete Pushing Urban Water Quality over the Edge?", *Ecos* 168, no. 87 (2012): 1.

being absorbed into surfaces such as soils and sands.[188] Main impervious surfaces include rooftops, roads, footpaths, carparks, driveways, compacted soils and clays, and soils with high clay content.[189] Similar materials are used for building roofs that include, stone, concrete, terracotta, steel, and a range of other synthetic, waterproof materials. According to Barnes, Morgan, and Roberge, surfaces covered by impermeable materials are classified as being hydrologically active (general surface runoff). Within the urban fabric land uses involving industrial, transportation, commercial, and high to medium residential buildings, contain the highest areas of impervious surfaces that are commonly rated as being almost 100 percent hydrologically active.[190]

As discussed, the construction of impervious surfaces, such as buildings and roads, causes a reduction in the amount of rainwater and runoff infiltrating the surface.[191] This increases runoff flows entering a watercourse that leads to increased occurrences of flash flooding and erosion of stream banks and beds.[192] Thus, the amount and density of impervious surfaces constructed across a catchment area greatly impact the flow rates entering a watercourse. Schueler, Fraley-McNeal and Cappiella in a review of research examining the impervious cover model reported watercourses with less than ten percent impervious cover function as sensitive streams and display minimal disruption to hydrological function and aquatic ecosystems.[193] Watercourses within areas of ten to 25 percent impervious cover demonstrate distinct symptoms of declining health and geomorphological damage to stream banks and beds.[194] Rivers and tributaries within areas of 25-60 percent impervious cover are classified as non-supportive of hydrological processers, channel stability, habitat or water quality. Those within areas of greater than 60 percent as classified as urban drainage and have been heavily modified as conduits for flood flows.[195] These streams effectively become drains, displaying poor water quality, habitat, and

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[188] Kent B Barnes, J Morgan, and Martin Roberge, *Impervious Surfaces and the Quality of Natural and Built Environments* (Baltimore: Department of Geography and Environmental Planning, Towson University 2001), 3.
[189] Ibid; David B. Jennings and S. Taylor Jarnagin, "Changes in Anthropogenic Impervious Surfaces, Precipitation and Daily Streamflow Discharge: A Historical Perspective in a Mid-Atlantic Subwatershed," Landscape Ecology 17, no. 5 (2002): 471
[190] Barnes, Morgan, and Roberge, *Impervious surfaces*, 3.
[191] Michael J. Paul and J. L. Meyer, "Streams in the Urban Landscape," *Annu. Rev. Ecol. Syst* 32 (2001). 335.
[192] Ibid.
[193] T Schueler, L Fraley-McNeal, and K Cappiella, "Is Impervious Cover Still Important? Review of Recent Research," *Journal of Hydrologic Engineering* 14, no. 4 (2009). 309-10.
[194] Ibid.
[195] Ibid.

biodiversity, with extremely unstable channels, resulting in many being eradicated and modified into lined channels or underground drains.[196] In examining the history of coverage of impervious surfaces within an urban area, Jennings and Jarnagin looked at historical aerial photographs and compared daily streamflow and rainfall records of the same period.[197] Their research illustrated the historical relationship of engineered impervious surfaces and streamflow. Examining the impervious surface area of Upper Accotink Creek, in Virginia North America, Jennings and Jarnagin found artificial impervious surfaces expanded from three percent in 1949 to 33 percent in 1994.[198] Analysis of streamflow and rainfall data across the same period showed a steady increase in streamflow discharges associated with normal and extreme daily rainfall amounts. The researchers concluded historical changes in streamflow within the catchment appeared to be related increases in impervious surface cover.[199] In a similar study Miller et al., compared changes in stormwater runoff from two rural areas that were transformed into peri-urban areas located within the town of Swindon, United Kingdom.[200] Urbanisation and the spread of impervious surface coverage over the areas were studied using historical data for the period 1960s to 2010s.[201] Results illustrated impervious surface coverage within the peri-urban catchments increased from 11 percent during the 1960s to 44 percent in the 2010s.[202]

Walsh et al, in 2005, developed the term 'urban stream syndrome' to refer collectively to these effects and the severe ecological and geomorphological degradation caused, commonly observed in urban watercourses.[203] Symptoms include hydrological changes including a flashier hydrograph or higher frequency of larger flows caused by higher levels of runoff collected from impervious urban surfaces. Water containing elevated concentrations of contaminants and nutrients; changed channel morphology or enlarging of stream width and depth due to changes in sediment loads caused by increased runoff with changed sediment

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[196] Ibid.
[197] David B. Jennings and S. Taylor Jarnagin, "Changes in Anthropogenic Impervious Surfaces, Precipitation and Daily Streamflow Discharge: A Historical Perspective in a Mid-Atlantic Subwatershed*," Landscape Ecology* 17, no. 5 (2002): 471
[198] Ibid, 471-72.
[199] Ibid.
[200] James D. Miller, Kim Hyeonjun, Thomas R. Kjeldsen, John Packman, Stephen Grebby and Rachel Dearden, "Assessing the impact of urbanization on storm runoff in a peri-urban catchment using historical change in impervious cover," *Journal of Hydrology* 515, (2014): 59.
[201] Ibid.
[202] Ibid.
[203] Gurnell, Lee, and Souch, 1118-20.

supply; reductions in biotic (living organisms) abundance and increases in species that can successfully tolerate the range of changes (listed symptoms).[204] Although the causes of the syndrome are described as complex and interactive, most effects are attributed to several primary large-scale sources, largely urban stormwater runoff discharged into watercourses by hydraulically efficient drainage systems. In addition to this, Walsh et al consider the effects of urbanisation on watercourses so wide ranging, future research into urban stream ecology requires expansion to include economic, social and behavioural aspects of urbanisation.[205]

Stream covering and daylighting

A major consequence of urbanisation on watercourses has been covering or transformation into culverts and underground pipes. Pinkham discusses the covering of urban watercourses and builds upon Strang's proposition of urbanisation disregarding hydrology of place (page 30).[206] Pinkham summarises the modern era's use of streams, describing their modification into highly engineered structures, designed to serve the drainage requirements of urban centres. Myers (2011) claims covering of urban watercourses is pre-industrial. He cites the example of the River Walbrook in London, completely covered in the late 15th century to control the stench emitted from its polluted waters, and to provide space for housing construction.[207] Adding evidence to Pinkham's claim is the research by Elmore and Kaushal focussing on burial of headwater streams.[208] The research found 73 percent of headwater streams in catchments of less than one hectare (2.5 acres) within Baltimore, MD, had been buried.[209] They identify headwater streams as the smallest watercourses effected by urbanisation.[210] Trice reports headwater streams provide an array of functions including pollution and nutrient removal, ground-water recharge, and flood mitigation.[211] Elmore and Kaushal, additionally suggest they also provide aquatic habitat, clean drinking water, functions for nitrogen retainment and removal, and indicators of overall watershed health due

[204] Walsh et al., 706-07.
[205] Ibid, 706.
[206] R Pinkham, "Daylighting: New Life for Buried Streams," (Snowmass, Colorado: Rocky Mountain Institute, 2000), iv.
[207] Myers,79.
[208] Andrew J. Elmore and Sujay S. Kaushal, "Disappearing Headwaters: Patterns of Stream Burial Due to Urbanization," *Frontiers in Ecology and the Environment* 6, no. 6 (2008): 308.
[209] Ibid, 311.
[210] Ibid, 308.
[211] Amy Trice, "Daylighting Streams: Breathing Life into Urban Streams and Communities," (Washington American Rivers 2013), 3.

to heightened sensitivities to changes in land use.[212] Despite this, they report, the covering of headwater streams continues, as they constitute the major section of stream length and are the most economical to bury. The effects of stream removal from the surface have been identified as one of most extreme impacts of urbanisation.[213] The consequences identified by Trice include destruction of original stream channels and beds; contributing to downstream habitat and channel degradation; aquatic habitat fragmentation; heightened transportation of toxic contaminants; reduction of ecosystem services such as nutrient processing and sediment retention, and flooding.[214] Research on patterns of stream burial due to urbanisation, by Elmore and Kaushal, indicated urban regions contained disproportionally more buried streams than other areas. Within their study area, City of Baltimore, 66 percent of streams were buried compared with only 19 per cent outside the urban region.[215] The continued burial of smaller urban watercourses highlights another less documented problem created by the urban development process. Tice suggests headwater streams remain largely un-named and un-mapped due to their small scale within the overall stream network and catchment.[216] Presland makes specific mention of the difficulty tracing and plotting headwater and ephemeral streams, unmapped before erasure, or not flowing at the time of survey.[217] The consequences of this are evident in a 1992 project in Vancouver regarding the tracing of the city's buried stream courses.[218] Ninety percent of the city's streams are buried as combined sewers. Due to a lack of mapping, the landscape architect tracing their former courses was required to use extensive on-ground exploration.[219] Myers describes his five-stage process for tracing London's lost and buried rivers. The first two involve an initial literary search, followed by detailed cartographic research. The third involved walking the routes using historical maps and on-ground analysis of topography, contours, and talking with residents encountered on the streets. The next stage consisted of searching local libraries. The final stage involved consultation with London's water authority, Thames Water, for corporate

[212] Elmore and Kaushal, 308.
[213] Ibid.
[214] Ibid; Trice, 6.
[215] Elmore and Kaushal, 310.
[216] Trice, 3.
[217] Presland, *The Place for a Village: How Nature Has Shaped the City of Melbourne*, 61-67.
[218] R Sarti, "Navigating the Main Streams beneath Vancouver: Landscape Architect Discovers Beds Paved," *The Vancouver Sun*, February 11, 1992, B8.
[219] Ibid.

history and crosschecking to determined stream courses before final plotting and mapping occurred.[220]

Tice states the legacy of the decisions to cover urban watercourses during the industrial era remains today as streams continue to be largely absent from numerous urban areas.[221] Mann, writing in *River in the City*, believes urban rivers were the last open valleys on the urban terrain, the last continuing pathways where society may re-establish rights of access.[222] Their burial erases an urban area's final traces of connection to natural water ecosystems and the aesthetics of surface hydrology. However, the engineering approach of covering was challenged during the early 1970s, in North America, and the outcome has been evolving since.

'Daylighting' is the uncovering of previously culverted or piped watercourses, regarded by Broadhead and Lerner (2012) and Pinkham (2000) as one of the most dramatic challenges to conventional engineering approaches regarding surface waters and drainage of the urban fabric.[223] It emerged during the 1970s in North America when a headwater stream was exposed as part of a park development and a section of an urban creek in California was uncovered (see chapter eight, page 327).[224] Daylighting has since spread globally. The University of Sheffield's daylighting map in 2017 listed over 100 daylighting projects worldwide.[225] Broadhead and Lerner report a range of problems created by previously culverted or piped watercourses that includes insufficient capacities to manage increasingly violet flash floods, blockages and flooding and impacts on aquatic habitats.[226]

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[220] Myers, 117-25.
[221] Trice, 3.
[222] Mann, 20.
[223] Adam T. Broadhead and David N. Lerner, "Www.Daylighting.Org.Uk: Case Study Website Supporting Research into Daylighting Urban Rivers," *Hydrological Processes*, no. 12 (2013): 1840-41; Pinkham, iv-vi.
[224] Ibid, 17,28.
[225] "Daylighting.Org.Uk," A. Broadhead, University of Sheffield, accessed August 26, 2017, http://daylighting.org.uk/Daylighting/map.php.
[226] Broadhead and Lerner, 1840.

Table 1. Main engineering and environmental benefits of watercourse daylighting.

Engineering-hydrological	**Environmental**
Increased hydrological capacity over a culvert	Recreation of a floodplain
Reduction of runoff velocities	Helps reduce erosion
Relieve choke points of underground drainage systems	Prevents flooding
Cost effectiveness against replacement of underground drainage structures	Open channels viable options to reconstruction of underground engineered systems nearing end of design life
Diversion of runoff and stormwater from combined sewers	Reduction in amount of water entering treatment plants

Table 1. Main engineering and environmental benefits of stream daylighting. Source: Pinkham (2005), page iv-v

A range of other environmental, social and economic benefits have been cited by proponents, however as Wild et al report, evidence for these benefits is sparse, as the aims and outcomes of daylighting projects are rarely examined and published.[227]

At the time of writing one of the largest and best-known daylighting projects was the uncovering and reinstatement of Chenggyechon stream in Seoul, South Korea. Shin and Lee report the project spanned 2003-2005 and involved the demolition of 5.4 kilometres (3.4 miles) of concrete covering and elevated highway structures and construction of 5.7 kilometres (3.5 miles) of new streambed.[228] Neruda1, Tichonova, and Kramer reported daylighting the stream was only part of an overall urban revitalisation project, including creation of open space within an otherwise densely constructed urban fabric.[229] This involved construction of a separate water supply system to Chenggyechon, as the stream had been

[227] T. C. Wild et al., "Deculverting: Reviewing the Evidence on the 'Daylighting' and Restoration of Culverted Rivers," *Water and Environment Journal* 25, no. 3 (2011): 412; Broadhead and Lerner, 1840.
[228] Jong-Ho Shin and In-Kun Lee, "Cheong Gye Cheon Restoration in Seoul, Korea," *Proceedings of the ICE - Civil Engineering* 159 (2006), http://www.icevirtuallibrary.com/content/article/10.1680/cien.2006.159.4.162.
[229] Martin Neruda, Irina Tichonova, and Dmitry Kramer, "Theoretical and Practical Aspects of Rivers Revitalization," *Journal of Earth Science and Engineering* 2, no. 3 (2012): 152.

separated from its original source.[230] According to Trice, stream daylighting projects have been completed in several designed forms including natural, architectural and cultural restoration.[231]

Conclusion

As demonstrated by this literature review, the impacts of human initiated change, including processes of urbanisation, has been published across an array of literature produced by a diverse range of authors and interdisciplinary teams. These authors work from a large range of disciplines and methodologies. One of the most prominent genres within the literature is the river history, as evident in the selection reviewed. They range in complexity, scale and scope, and, for example, include social, ecological-political, environmental, socio-natural, and human-nature relationships. The review also demonstrates the majority of river histories focus on an entire individual river or section including both urban and rural regions, while some concentrate specifically the urban or rural. Another dominate form of literature is water histories that examine the history of human-water interaction within a particular period, theme, region, or water use.

Despite the varied and immense range of research, topics and publications, the literature reviewed illustrates watercourses are rarely perceived as large, complex, interconnected networks and systems. This is evident in the amount of literature focused on individual rivers, with minimal to no discussion of the larger network of tributaries. However, this is changing as evident by the article from Ferguson, Brown, and Deletic (2013). As discussed on page 32, these authors argue the ongoing management of watercourses requires a more systematic approach that starts with perceiving watercourses as networks or systems. In also addressing the management of watercourses Winwarter et al (2013), discussed on page 38, argue management decisions should be based firmly on historical knowledge. With these two premises in mind, this thesis differs from much of the reviewed literature with an examination of Melbourne's watercourses as an interconnected urban network and seeks to build a solid base of historical knowledge regarding major changes to the network caused by urbanisation and human intervention. The thesis also examines watercourses using the

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[230] Ibid.; Jong Youl Lee and Chad David Anderson, "The Restored Cheonggyecheon and the Quality of Life in Seoul," *Journal of Urban Technology* 20, no. 4 (2013): 156.
[231] Trice, 8.

premise developed by authors of environmental history, including Richard White and Sara Pritchard (see page 43-4), of being hybrids situated between the natural and designed. This view is illustrated in much of water history and stream ecology literature with watercourses being examined as either heavily degraded natural systems or components of engineered urban water systems.

Literature reviewed on indigenous peoples' water use provides a comparison of the values they placed upon watercourses and water, while illustrating how these values have evolved over urban history to those of contemporary societies. Finally, the reviewed literature highlights the way urbanisation has separated societies from watercourses and the environment, by transforming functioning watercourses into rational and manageable urban forms. This illustrates Abdulaziz's (2017) suggestion that humans have developed an immense misunderstanding of water and disconnection with the natural environment.[232]

[232] "Photographer Turns Lens on Our 'Complex, Disconnected' Relationship' with Water," *Australian Broadcasting Commission, News* , accessed 24 August, 2017, http://www.abc.net.au/news/2017-08-24/photographer-documents-water-crisis-across-the-globe/8834964.

Chapter Three: Methodology and Methods

> 'Urban environmental history…evolved out of the linking of urban history and environmental history.'[1]

The methodology for this thesis has been informed by the literature review and the portrayal and perception of urban watercourses. As evident from the literature review, a history of change caused by urbanisation to watercourse networks has received minimal attention. The literature instead focuses upon the history of individual watercourses, themes such as 'industrial' or 'lost' rivers or uses watercourses as components to other histories; for example, public sanitation, drainage or water-supply. Additionally, within traditional history watercourses are commonly featured as background elements to a range of human-centred narratives. Planning and design literature similarly neglects or features watercourses only superficially or as background components to other design projects or urban infrastructure. Another significant characteristic of urban watercourses missing from the literature is their identification as an individual, complex urban system. Unlike the entirely human-designed built environment, transport, and energy networks, watercourses are generally treated in isolation as single features of the urban fabric, failing to be perceived as part of larger interconnected or catchment-wide networks.

In chapter one, this thesis aligned the research with the field of urban environmental history, a field that evolved when environmental history was linked with urban history.[2]

Environmental history seeks to develop and expand understanding of the effect of the natural environment on human civilisations, while also seeking to establish humanity's effect on that environment and identifying the consequences.[3] While traditional branches of historical research primarily focus on human and societal topics, environmental history diverges from this by including natural historical narrative.[4] Although environmental history

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[1] Joel A. Tarr, "Urban Environmental History," ed. Frank Uekoetter, *The Turning Points of Environmental History* (Pittsburgh: University of Pittsburgh Press, 2014), 72, http://ebookcentral.proquest.com/lib/unimelb/detail.action?docID=2039336.
[2] Ibid, 2; Martin V. Melosi, "The Place of the City in Environmental History," *Environmental History Review* 17, no. 1 (1993): 2.
[3] Worster, 290-91.
[4] Timo Myllyntaus, *Thinking through the Environment: Green Approaches to Global History*, ed. Timo Myllyntaus (Cambridge, UK: White Horse Press, 2011), 2; P. H. Collin, *Dictionary of Environment & Ecology*, 5th ed. (London: Bloomsbury, 2004), 142; Melosi, "The Place of the City in Environmental History," 2.

research focuses on study of the past, the discipline developed due to contemporary concerns regarding the impact of human activity upon the natural environment in the present.[5] The field evolved during the 1960s and 70s, chiefly in North America, its rise linked to the environmentalist movements of the period.[6] However, its origins can be traced back to least the mid-19th century with such publications as Marsh (1864) *Man and Nature; or, Physical Geography as Modified by Human Action*.[7] Marsh identified changes to Earth's physical condition produced by human action and focussed on what he termed 'disturbed harmonies'.[8] Merchant claims the discipline is both one of the oldest and newest fields within human history, including a set of methodologies incorporating nature into the narrative.[9]

Urban environmental history, as distinguished from environmental history, seeks to examine the roles and position of nature and the natural environment within the history of cities and urbanisation.[10] This is achieved by examination and analysis of the effects of cities and urbanisation on the natural environment over time. It includes analysis on natural environment's impact on cities and urban regions; examination of societal responses to these impacts and efforts to solve or manage environmental problems; and study of the impacts of urbanisation upon the surrounding countryside and resulting effects on the wider environment.[11]

The other component to urban environmental history, urban history, seeks to examine the historical characteristics of cities and urban regions, and the history of the process of urbanisation.[12] Urban history's method is frequently multidisciplinary and involves urban geography and sociology; social, business and architectural histories; archaeology and economics.[13] The history of urbanisation similarly crosses different disciplinary boundaries to

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5 Ian Whyte, A dictionary of environmental history, (London: I.B.Tauris, 2013), 1, http://UNIMELB.eblib.com.au/patron/FullRecord.aspx?p=1213947
6 Ibid, 2.
7 Ibid, 501.
8 George Perkins Marsh, *Man and Nature, or, Physical Geography as Modified by Human Action* (London: Sampson Low, Son and Marston, 1864), iii.
9 Carolyn Merchant, *The Columbia Guide to American Environmental History* (New York: Columbia University Press, 2002), xiii.
10 Rosen and Tarr, 301.
11 Martin V. Melosi, *Effluent America: Cities, Industry, Energy, and the Environment* (Pittsburgh: University of Pittsburgh Press, 2001), 126; Rosen and Tarr, 70.
12 M Frisch, "American Urban History as an Example of Recent Historiography," *History and Theory* no. 3 (1979): 352-77.
13 Ibid.

focus on urban regions' development within cultural, social, political, and economical contexts.[14]

Research Questions

This research seeks to answer questions of: how urbanisation has affected upon Melbourne's watercourses; how the area's watercourses affected upon the structure, development and expansion of the city's urban fabric; societal responses to these impacts and efforts to improve arising environmental problems; and the impacts of Melbourne's development on the surrounding countryside. Essentially the thesis is an examination of how and why Melbourne's urban development and urbanisation processes changed the area's watercourses. It also strives throughout to identify elements of these processes that can be universalised.

Urban Environmental History Methodology

Over the history of urbanisation, watercourses enfolded into the urban fabric have been significantly modified for a range of reasons concerning human survival, societal, industrial, economical, and aesthetic reasons (see chapter one, page 2-3).[15] Developing such a multi-faceted history requires examination of an array of roles, topics and individual issues. Environmental history has been chosen for the methodology, as the field has evolved as the broadest and most complex discipline of historical research.[16] The research methods used by the discipline reflect this complexity, tending to be more numerous and versatile than those used by other fields of historical research.[17] Lehmkuhi and Wellenreuther claim traditional methods of historical research are unable to supply adequate material on environmental change for such a wide scope, and a multidisciplinary approach towards methodologies and data collection is required including seeking research findings from a range of fields within

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[14] Lewis Mumford, *The City in History: Its Origins, Its Transformations, and Its Prospects* (Harmondsworth, Eng.: Penguin, 1966), 29-35.
[15] Gary Miedema, "When the Rivers Really Ran: Water-Powered Industry in Toronto," in *Hto Toronto's Water from Lake Iroquois to Lost Rivers to Low-Flow Toilets*, ed. Wayne Reeves and Christina Palassio (Toronto: Coach House Books, 2008), 66-73.
[16] Myllyntaus, 2.
[17] Ibid.

the sciences and humanities.[18] To work with such a scope authors Merchant, and McNeill, describe key approaches to developing environmental histories. One focuses on biological interactions between humans and the natural environment and the resulting ecological complex that is either sustainable or disrupted.[19] A second, views environmental history as a series of levels of human interactions with nature, ecology, production, reproduction and ideas.[20] Another considers environmental politics and transformations in political and economic power. This is concerned with the history of attitudes, ideas, government policies and laws in relation to the natural world and the environment.[21] A fourth approach considers environmental history as a narrative; for example, industrialisation and the resultant environmental degradation followed by the rehabilitation sites because of deindustrialisation.[22] A further approach focuses on the cultural and intellectual history of ideas regarding nature, its representations in the arts and literature, and their changes over time. This includes how such ideas have influenced the development of contemporary physical environments, public attitudes towards nature, and what these reveal about the people and societies that produced them.[23] In many cases, environmental history method interweaves and combines these main approaches to include human socio-economic, political and cultural responses and their various interactions with the natural environment.[24]

As part of the research method, this thesis uses qualitative case study methodology. The complexity of environmental history research, in combination with descriptive and exploratory research questions, fits the criteria for use of qualitative case study methodology. The use of this methodology according to Yin is suitable for research seeking answers to descriptive and explanatory questions; requires covering contextual conditions as it is thought they are relevant to the phenomena under study; and where the boundaries between context and phenomena are unclear.[25] Case studies are also unrestricted in the amount and variety of data sources and types that include both quantitative and qualitative data.[26] The use of wide-

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[18] Ursula Lehmkuhl and Hermann Wellenreuther, *Historians and Nature: Comparative Approaches to Environmental History* (New York: Berg, 2007), 39.
[19] Merchant, xv.
[20] Ibid.
[21] Ibid, xv; J. R. McNeill, "Observations on the Nature and Culture of Environmental History," *History and Theory* 42, no. 4 (2003): 6.
[22] Merchant, xv.
[23] McNeill, 6; Merchant, xvi.
[24] McNeill, 6; Worster, 289-307.
[25] Robert K. Yin, *Applications of Case Study Research*, 3rd ed., Applied Social Research Methods Series (Thousand Oaks, Calif.: SAGE, 2012), 4-5.
[26] Ibid, 10-11.

ranging data allows for multiple facets of a phenomenon to be examined, revealed and understood, with outcomes greatly benefitting from the use of multiple sources of evidence.[27] Utilising this methodology has enabled this examination of Melbourne's watercourses as a single complex urban system within its own context, utilising different data types from a range of sources.[28] This thesis utilises a combination of approaches, as detailed above, within the context of Melbourne's watercourses to consider the following: Levels of human interaction with the natural environment over time from initial European settlement onwards. Environmental and related policies of government authorities; the economic and technological changes motivating urban expansion; industrialisation, later deindustrialisation, and ongoing urban renewal; and public opinion and attitudes towards watercourses and their natural environment.

Research Themes

The research themes used in this thesis to establish an urban environmental history of Melbourne's watercourses comprise of the following. The pre-urbanised conditions of the watercourses. How the areas watercourses impacted upon urbanisation; its form and structure. How urbanisation impacted on the form, structure and ecology of the watercourses. Human interactions with Melbourne's watercourses at the government, business and public levels. Changes in public and government attitudes towards the city's watercourses and their environs. Resulting effects on the watercourses surrounding Melbourne's urban perimeter.

Data categories for urban environmental history of Melbourne's watercourses

The data categories for this research have been informed by the research questions, approaches in environmental history and available data. This research has benefitted from the fact Melbourne's watercourses were the responsibility of a single government authority, the Melbourne Metropolitan Board of Works (MMBW) known since its restructure in 1991 as the Melbourne Water Corporation.[29] From 1891 to 1991 the MMBW developed and

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[27] P Baxter and S Jack, "Qualitative Case Study Methodology: Study Design and Implementation for Novice Researchers," *The Qualitative Report* 13, no. 4 (2008): 544.
[28] Ibid.
[29] Dingle and Rasmussen, 153,375; James Viggers, David Lindenmayer, and Haylee Weaver, *Melbourne's Water Catchments Perspectives on a World-Class Water Supply* (Melbourne: CSIRO Publishing,, 2013), 87.

maintained an extensive historical archive, much of which is now stored at the Public Records Office, Victoria (PROV). However, the collection is incomplete as significant sections (particularly data regarding watercourse modification) either went unrecorded, were lost or remain in storage at PROV awaiting sorting and cataloguing. Available data, including MMBW archives, in conjunction with the research questions and environmental history approaches have informed the main data categories, the periods, and themes for this research (see chapter one, pages 19-21).

Data sources

Since this thesis is essentially an urban environmental history it derives data from a range of primary and secondary sources reflecting the complexity and variety of subjects included. The analysis of these varying data types using a range of methods creates a more detailed interpretation of the impact urbanisation has had on Melbourne's watercourses. The resulting history has not been previously documented in this form as it draws together archival data rarely analysed to create an otherwise unexamined urban environmental history of Melbourne.

One of the most intensive tasks involved with environmental history research is data sourcing and collection.[30] To that end, this thesis has sourced primary data from the following government depositories and organisations:

State Library of Victoria

State Library of Victoria Picture Collection

Historical Plan Collection including MMBW series

Imaging nineteenth century - Victorian Digitising Project collection

Picture Illustrated Newspaper Collection

Map collection - Melbourne and suburbs

Pictures collection – Melbourne and Victoria

Public Records Office – Victoria

MMBW – Historical archive

MMBW – Base plans collection

MMBW – Field and level books

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[30] Lehmkuhl and Wellenreuther, 39.

Public Works Department – Historical archive

Victorian Railways – Historical archive

Parish and township maps archive

Land records archive

Melbourne Corporation and Melbourne City Council – Town Clerk files

National Library of Australia - Trove

Historical newspapers archive

Historical pictures and photo archive

Map collection

Journals, articles and data set collection

Picture Victoria

Historical images collection – Melbourne and its suburbs

In addition, the State Library of New South Wales holds data referring to the early development of Melbourne including government documents and maps, as Melbourne was part of New South Wales until the Colony of Victoria was created in July 1851.[31] The State Libraries of South Australia and Queensland also hold a selection of rare, historical 'grey literature' published by the MMBW and several other former government departments involving Melbourne's urban development in relation to watercourses; this is in print and electronic formats produced by government departments, academics, industry and business.[32]

Data types

Types of data include historical archives of reports, plans, maps, journal articles, newspaper archives and serial records of government agencies, research papers, design manuals, asset management publications, project designs and proposals, and photographs, both historical and contemporary. Considerable grey literature has also been sourced from both historical and contemporary government, semi-government, community and other interest groups, and business and industry consultation firms.

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[31] A. G. L. Shaw, *A History of the Port Phillip District: Victoria before Separation*, Second Miegunyah Press Series (Carlton, Vic.: Melbourne University Press, 1996), 237.

[32] "Grey Literature 101 Introduction," University of New Mexico Health Sciences Library and lnformatics Center, accessed June 25, 2017, htlp:/llibguides.health.unm.edulgraylit.

Further data was created from developing an image library of a variety of Melbourne's watercourses taken by the author. In addition, a range of mapping exercises was used to create composite maps for comparison of the changes to Melbourne's urban watercourses over the period beginning with European settlement in 1835 until the present. Maps were also produced to illustrate historical descriptions provided only as text in newspaper articles and personal memoirs and journals. These maps were created to show historical stream routes and former waterscapes, the scale of floods across the urban fabric, and changes over time to watercourses as the city expanded.

Contemporary sources including newspapers, personal diaries and journals, provided data that was otherwise not recorded or available from any other source. As Presland submits, much of what is now the greater Melbourne area was changed or obliterated before being properly described.[33]

Data Analysis

Historical Archives

Data sourced from historical archives were analysed using historical method. This involves analysis of the form and content of historical documents before being used as evidence.[34] The first step is ensuring a document is readable and comprehensible; making sense in the context, location and period it was produced.[35] For example, many digitised copies of the *Argus* (a Melbourne newspaper extant between 1846 and 1957) contain words and paragraphs that are barely legible, requiring interpretation. Many of the terms and words also require definition and consideration of the context, and time in which they were published. The second stage assesses a document's location in time and place; when it was composed; location/s of production; social setting and who composed it.[36] Is the document's composition correct; does creation date correlate with location and does the source compare with other similarly dated and composed works? The third stage is confirmation of authenticity including checking the type and quality of language and phrasing used; whether it compares to other sources dated from the same period and whether the materials used in

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[33] Presland, "The Natural History of Melbourne – a Reconstruction," 30.
[34] Martha C. Howell and Walter Prevenier, *From Reliable Sources: An Introduction to Historical Methods* (Ithaca, N.Y.: Cornell University Press, 2001), 17.
[35] Ibid.
[36] Ibid, 43.

production such as paper types, typefaces, graphic symbols, correlate with similar documents and their creation dates.[37] Following establishment of authenticity, the next process involves internal criticism to determine the meaning, trustworthiness, accuracy and reliability of statements.[38]

Image Analysis-Historical and contemporary photographs, digital images and landscape paintings

This research utilises photographic and digital images as a visual method for display and analysis of historical conditions and evolving changes that have affected Melbourne's watercourses since the 1850s. It was during this period the use of photographic images for recording personal and societal histories began. Since that, time images have been increasingly integrated into all levels of society, to become important records and tools for historical research.[39] This is reflected by the extent of the State Library of Victoria's historical photographic collections, which includes more than 300,000 digitised images (and many images not yet digitised), concerning the history of Melbourne and Victoria. [40] Another benefit of using images is the ability of the researcher to generate their own images within the context of a research topic.[41] Banks considers the incorporation of images into the creation or collection of data may reveal insight that may not be illustrated by any other means.[42] Achterberg suggests photographs encompass a vast array of information that may be used effectively in historical research for illustration, evidence, contrast, comparison, and for purposes of analysis.[43] This research utilised photographs and digital images as a visual time-line of Melbourne's watercourses to illustrate conditions during different periods and changes over time. The method for collecting contemporary images of watercourses using a digital

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[37] Ibid, 44.
[38] Ibid, 60; Homer C. Hockett, *The Critical Method in Historical Research and Writing* (New York: Macmillan, 1955), 14.
[39] Tinkler. xi.
[40] State Library of Victoria, "Picture Research" State Library of Victoria accessed 30th October 2014, http://guides.slv.vic.gov.au/content.php?pid=184713&sid=1551964.
[41] Tinkler. xi.
[42] Marcus Banks and Uwe Flick, *Using Visual Data in Qualitative Research* (London: Sage Publications, 2007), 4.
[43] Robert Achterberg, "Photographs as Primary Sources for Historical Research and Teaching in Education: The Albert W. Achterberg Photographic Collection" (PhD diss, University of Texas, 2007), x, accessed March 16, 2014, https://repositories.lib.utexas.edu/bitstream/handle/2152/3538/achterbergr40536.pdf?sequence=2&isAllowed=y

SLR camera was part of a multi-method approach combined with 'walking the landscape' as a method of historical reinterpretation (page 46).[44]

In addition to photographs, landscape paintings have also been used to observe and record landscape and ecological changes along watercourses prior to the development, acceptance and wide spread use of photography. A range of artworks was produced in 19th century Melbourne depicting rivers, tributaries and wetlands that were otherwise not recorded before being significantly changed or erased. The images produced by the first surveyors working in the Melbourne area depict the landscape and flora before the rapid development of the city and suburbs. The use of landscape artworks for mapping environmental and ecological changes is detailed in preliminary research by Gaynor and McLean.[45] Their pilot study analysed artwork of the Swan River region in Western Australia to determine patterns of ecological change, supported by detailed site analysis and other historical data. The prevalence of large trees and general make-up of the area's flora was analysed, the results indicating the artworks appeared to illustrate feasible changes to the landscape. These were compared with site-specific study that demonstrated specific correspondences between the artworks and other sources.[46]

The method of visual analysis utilised for this research has been adapted from Tinkle and involves firstly identifying the basic details within an image and what is seen.[47] The second stage involves interpretation of what is featured in an image and how it is depicted. The third step is consideration of material evidence or how the image is experienced; as an object or a screen and how material factors affect use of the image and what meaning it conveys to people. The fourth step is considering contextual research; examining the contexts of production, encounter and viewing. The last step involves reflection of the types of meanings an image may provide or been attributed with; what it means to the researcher, photographer, viewers, and people that may be present in the image.[48] These five approaches to analysis have been utilised in the analysis of historical images about Melbourne's urban watercourses.

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[44] Jo Guldi, "Landscape and Place," in *Research Methods for History* eds. Simon Gunn and Lucy Faire (Edinburgh: Edinburgh University Press, 2012), 67.
[45] A. Gaynor and I. A. N. McLean, "Landscape Histories: Mapping Environmental and Ecological Change through the Landscape Art of the Swan River Region of Western Australia," *Environment and History*, no. 2 (2008).
[46] Ibid, 189.
[47] Tinkler. 19.
[48] Ibid.

Field Work - Walking the Landscape as Method of Historical Reinterpretation

Walking as a method in qualitative research has been documented across a diversity of disciplines. Schultz describes walking in research methodology by landscape architects in the design process for large-scale landscapes.[49] He argues walking provides on-ground engagement with space, allowing the development of a sense-of-place and interaction with the landscape on levels un-achievable using other research methods.[50] Green, and Hoskins, utilise walking as a research method for reading landscapes in their examinations of the creation of the English landscape from an historical context.[51] For Green '…the ground itself, where we can read the information it affords, is… the fullest and the most certain of documents.'[52] While Hoskins states: 'To write its history requires a combination of documentary research and of fieldwork, of laborious scrambling on foot wherever the trail may lead.'[53]

In this examination of Melbourne's watercourses, walking has been used as a method of historical reinterpretation, and as a method for data collection involving the photographing of current physical conditions, topographies, historical traces of forms and functions, and uses of Melbourne's watercourses.[54]

Walking as a method of historical reinterpretation has been drawn from the landscape history branch of historical research. Landscape historians have developed a range of methodologies for examining relationships between landscape, the built environment, and mapping, reconsidered through a radical history methodology.[55] Radical history involves the criticism of historical conventions that appear to be inaccurate, or skewed in their representations of involved participants. It also seeks to correct these inaccuracies and write to a wider audience.[56] This combination has been termed the 'spatial turn', the application of spatial awareness to radical history.[57] It has its foundations in the early 20th century when

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[49] Henrik Schultz, "Designing Large-Scale Landscapes through Walking," *Journal of Landscape Architecture* 9, no. 2 (2014): 6-7.
[50] Ibid, 6.
[51] J. R. Green, *The Making of England* (London: Macmillan, 1885); W. G. Hoskins, *The Making of the English Landscape* (London: Hodder & Stoughton, 1955).
[52] Green, vii.
[53] Hoskins, 14.
[54] Guldi, 67-70.
[55] Ibid, 66.
[56] Peter N. Stearns, *Encyclopedia of Social History* (New York: Garland, 1994), 616.
[57] Guldi, 66-67.

English radical historians commenced walking the landscape, in the production of a history of common life designed to challenge property rights of the elite landowners.[58] Spatial awareness has played a role in establishing courses of original watercourse lines and their diversions into underground pipes as per Meyers.[59]

Mapping

The importance of utilising mapping and the creation of custom maps for a specific research topic or theme is highlighted by Rumsey and Williams (2002): historical, contemporary and custom-made maps regularly contain information not available elsewhere.[60] Corner considers mapping as creative practice providing a valuable tool for uncovering previously unseen or unknown features and realities.[61] Digital versions of historical maps are utilised to study content and characteristics individually, historical landscapes, and changes to locations and features over time.[62] Two-dimensional mapping, manipulated and combined with other spatial data such as digital elevation models, provides an historical landscape with an increased awareness of how a land and waterscape may have historically looked.[63] This type and format of data is extremely valuable for reconstructing historical town, land and water -scapes.

Corner additionally identifies three important operations in mapping and composite map creation. The first is the creation of a field or base map, which includes a scale and area. Second is the extraction, isolation or de-territorialisation of features, parts or data. Finally, the display of the features chosen to be placed within the map context, either complemented or in some cases hidden; plotting, drawing-out and setting-up of relationships within the map field or the re-territorialisation of the parts.[64] At each stage of map creation decisions are made alternating between processors of accumulation, assembly, disassembly and reassembly. As the map develops these, depend upon features that stand out, disappear, become clear or are

[58] Ibid, 67.
[59] Myers, 117-25.
[60] D Rumsey and M Williams, "Historical Maps in GIS," in *Past Time, Past Place: GIS for History,* ed. A Knowles (Redlands: ESRI Press, 2002), 1.
[61] James. Corner, "The Agency of Mapping: Speculation, Critique and Invention," in *Mappings,* ed. Denis Cosgrove (London: Reaktion, 1999), 231.
[62] Rumsey and Williams, 1-2.
[63] Ibid, 2.
[64] Corner, 230-31.

created.[65] Corner names four thematic techniques evolving from this process for creating new maps including the two used in this research; layering and game-board.

Layering mapping is defined as two or more maps covering the same geographical area with the same map coordinate reference system that can be accurately layered or overlayed to create a composite map.[66] These maps are created by joining or layering whole or sections of separate maps together to create a single map illustrating information that may not be otherwise visible or appreciated. The technique is also used to observe sites where competing uses or activities overlap and may indicate how these have been integrated into one space or how they share a space.[67] The sharing of space may be complementary or opposing, depending on the uses and specific site features. In this research, overlaying of different maps and map data has been used to illustrate competing uses, structures, and activities required of urban watercourses. For example, the lower Moonee Ponds Creek, in Melbourne, has a history of use as transport canal; floodplain; reservation for railway lines; drainage conduit; reservation for an elevated freeway; cycle pathway; revegetation area; and parkland for residents. These competing uses and activities once featured on a layered map illustrate a range of competing uses many watercourses commonly must accommodate. The mapping illustrates how the creek has changed since 1854 at the macro-scale, how conflicting land uses share the same space, and modification of historical features to accommodate new uses. Without layering, this data, a series of individual maps would be required. Figure 13 illustrates a layered or composite map of the Moonee Ponds Creek. The layers identify conflicting uses along the creek, lost waterscapes, and modifications to the channel.

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65 Ibid, 231.

66 "Glossary of Terms - C," Open Geospatial Organisation, accessed March 28, 2016, http://www.opengeospatial.org/ogc/glossary/c.

67 Corner, 240.

Figure 13. Composite map layered from historical maps and contemporary GIS data.

Chapter Four: Impacts of urbanisation: Initial responses to Melbourne's watercourses

> Hoddle's grid aligned Melbourne more or less with the Yarra River, but took no account of the creeks…That the Yarra periodically flooded the adjacent parts of the town, that Elizabeth Street followed the line of an old watercourse…that run-off from the city streets silted up the river…[1]

Introduction

This examination of the urban environmental history of Melbourne's watercourses commences with the initial responses from those endeavouring to develop what Samuel Perry, the Deputy Surveyor-General of the colony of New South Wales, envisaged in 1836 as becoming, if properly planned, 'one of the most striking ornaments in the southern world.'[2] The period 1835 to1900 was highly significant for the city's watercourses as it included the first major human-initiated modifications to natural systems and physical structures. Many of these initial modifications have remained part of use and management practice, still evident amongst Melbourne's natural and designed watercourses.

As Melbourne developed as a commercial centre, the impact on watercourses involved transformation into various forms of urban infrastructure. However, some of the most significant pollution and degradation were created by industries established along the main watercourses. Indeed, the term 'Marvellous Smellbourne' was coined regarding the pollution in the Yarra discharged from noxious industries established along its banks.[3]

As has been seen, urban watercourses are intimately affected by the development and ongoing advancement of engineered urban water systems in parallel with urban expansion. Although there are many examples of the impacts of urban development on Melbourne's

[1] Andrew Brown-May, *Melbourne Street Life: The Itinerary of Our Days* (Kew, Vic.: Australian Scholarly Publishing, 1998), 10.
[2] Perry, S. 1839. Letter to Robert Hoddle cited in Michael Cannon, Ian MacFarlane, and Victoria Public Record Office, *The Early Development of Melbourne*, (Melbourne: Victorian Government Printing Office, 1984), 146.
[3] "The Abattoirs," *Evening News*, June 5, 1906, 6.

watercourses, this examination looks at the best-known examples in conjunction with the most common or typical responses and approaches subscribed to at the time by the city's governments, communities, engineers, planners and entrepreneurs. The same can be said for the range of people and organisations contributing to the changing roles and requirements placed on the use and subsequent changes to Melbourne's watercourses. This research focuses on the actors most evident or acknowledged in the urban environmental history of the city's watercourses. The following newspaper quote from the 1880s describes a common view, amongst certain sections of the community, towards watercourses during initial period of Melbourne's urban development. In September 1887, following the government raising the subject of formation of a Metropolitan Board of Works to stop sewage entering the Yarra with provision of a sewerage system, response from the media was swift. The *Mercury and Weekly Courier* stated: 'Rivers are Nature's outlets, and it is questionable whether the finest scheme man can devise for the disposal of sewerage could equal, on the score of health, the one here provided by nature.'[4]

As discussed in Chapter One, the history of change to watercourses located within Greater Melbourne's urban fabric has been short compared with many other cities. Melbourne was founded in 1835, and the city's watercourses have only been used and modified by urban populations for less than 200 years. Yet the city's urban growth and redevelopment has dramatically altered the region's watercourses, flood plains, riparian zones, and associated wetlands.[5] Indeed, imagining the diversity of landscapes and environments extant before European settlement is extremely difficult.[6] Indications of these past landscapes however, are often found along the city's watercourses. One such example is the remnant mangroves lining approximately 2.9 hectares of the Stony Creek Backwash bordering the Yarra estuary seven kilometres downstream from Melbourne's central business district.[7] The changes to Melbourne's watercourses could be considered as redesigned to flow within city, suburban, or peri-urban areas; based on the need to make their flows cause as little disruption to daily life as possible. These urban watercourses represent a vision of

[4] "Friday, September 2nd," *Mercury and Weekly Courier*, Septermber 2, 1882, 2.
[5] Presland, *The Place for a Village: How Nature Has Shaped the City of Melbourne*, 62-67.
[6] Ibid, 5-6.
[7] "Biodiversity Interactive Map -3.2," Department of Environment et al, State Government of Victoria accessed March 16, 2016, http://mapshare2.dse.vic.gov.au/MapShare2EXT/imf.jsp?site=bim (site discontinued).; "Mangrove Watch Australia: Regions," Mangrove Watch Australia Limited, accessed March 2, 2016, http://www.mangrovewatch.org.au/index.php?option=com_content&view=category&layout=blog&id=86&Itemid=300203.

designed water, resultant from a long global urban environmental history of treatment to watercourses flowing within the boundaries of urban centres. However, widely accepted engineering approaches developed during the 19th century are primarily responsible.[8] The first 70 years of Melbourne's urban development occurred as modern urbanism was emerging during the 19th century.[9] Modern urbanism developed as a response to the squalid living conditions and associated disease epidemics plaguing Britain's industrialised cities,[10] the same problems experienced by industrialised cities globally.[11] One of the principles underlying modern urbanism was the integration of watercourses into rationalised and scientifically managed forms.[12] The development of the empirical sciences during that time allowed urban mortality and morbidity to be illustrated accurately and permitted living conditions of modern urbanisation to be placed under unprecedented observation and examination.[13] One such examination was conducted during the mid-1800s in London by Dr John Snow.[14] His study of cholera outbreaks proposed the disease was frequently communicated through water contaminated with effluent discharged or leaked from sewers and cesspits into sources of fresh-water including watercourses and groundwater.[15] Snow illustrated his proposal with a disease map produced by the Board of Health depicting the prevalence of disease epidemics across London.[16] Snow's widely known study of the Broad Street cholera outbreak occurring in the Soho district of London, demonstrated his hypothesis that contaminated water spread cholera as opposed to the miasma theory of 'bad air' (see chapter five, page 129).[17] By mapping neighbourhood water pumps in relation to cholera outbreaks, Snow demonstrated the disease was radiating outwards from a single pump at which water was contaminated.[18] Due to this empirical research, scientifically based links

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[8] Matthew Gandy, "Rethinking Urban Metabolism: Water, Space and the Modern City," *City* 8, no. 3 (2004): 365-67; Sylvia Gierlinger et al., "Feeding and Cleaning the City: The Role of the Urban Waterscape in Provision and Disposal in Vienna During the Industrial Transformation," *Water History* 5, no. 2 (2013): 220.
[9] Shannon and De Meulder, 6.
[10] Melosi, *The Sanitary City: Urban Infrastructure in America from Colonial Times to the Present*, 42-44; Karvonen, 3-4.
[11] Gandy, "Rethinking Urban Metabolism: Water, Space and the Modern City," 365.
[12] "The Bacteriological City and Its Discontents," 14.
[13] Ibid, 15.
[14] Peter Vinten-Johansen, *Cholera, Chloroform, and the Science of Medicine: A Life of John Snow* (New York: Oxford University Press, 2003), 318.
[15] Ibid.
[16] Ibid.
[17] John M. Eyler, "The Changing Assessments of John Snow's and William Farr's Cholera Studies," *Sozial- und Präventivmedizin* 46, no. 4 (2001): 227.
[18] Steven Johnson, *The Ghost Map: The Story of London's Most Terrifying Epidemic--and How It Changed Science, Cities, and the Modern World* (New York: Riverhead Books, 2006), 193-94.

between water and public health and sanitation were developed.[19] Sewage, stormwater and flood flows had become hazards to the health and welfare of urban populations of London and other European cities.[20] The solution was to engineer water into centralised distribution and collection systems including urban watercourses. [21] Colonial politics and recognition of technical expertise meant treatment and design of Melbourne's watercourses during the 19th and early 20th centuries were largely driven by specialist engineers with experience of projects constructed in Britain.[22]

Archaeological evidence uncovered along Melbourne's Maribyrnong River suggests indigenous peoples had occupied 'Melbourne' for at least 40,000 years by 1835 when European settlement was established (see chapter two, page 21).[23] Managing the land through burning or fire-stick farming practices, their impact on natural ecological and hydrological systems was nonetheless minimal compared with dramatic changes brought about by Europeans.[24]

The impacts of early urban growth on Melbourne's watercourses were profound and far-reaching.[25] They included destructive land clearing practices, which changed water run-off patterns and altered natural processes of erosion. These practices included the drainage and filling of large wetlands close to the settlement for land reclamation and the redirection of the streams that fed them; the widening and straightening of rivers and streams to reduce flooding and improve drainage flows; the engineering of rivers into shipping and flood control channels; and the use of smaller streams as sewers.[26] Melbourne's site was chosen for its proximity to a fresh-water river.[27] Exploration of the region by Europeans failed to find any other substantial source of fresh-water.[28] Indeed, they recorded evidence of a landscape of salt and brackish water, occasional streams, and a capacity for flooding.[29] The Yarra River

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[19] Shannon and De Meulder, 6; Gandy, "The Bacteriological City and Its Discontents," 16.
[20] N. J. Barton, *The Lost Rivers of London: A Study of Their Effects Upon London and Londoners, and the Effects of London and Londoners Upon Them* (London: Phoenix House and Leicester University Press, 1962), 105-19; Gandy, "Rethinking Urban Metabolism: Water, Space and the Modern City," 365-66.
[21] "The Bacteriological City and Its Discontents," 16-19; Shannon and De Meulder, 6.
[22] Dingle and Rasmussen, 18-19, 27-32,42-44.
[23] Broome, 4-5.
[24] Mick, 25.
[25] Presland, *The Place for a Village: How Nature Has Shaped the City of Melbourne*, 62.
[26] Ibid,66; Miles Lewis, *Melbourne: The City's History and Development*, 2nd ed. (Melbourne: City of Melbourne, 1995), 32.
[27] John J. Shillinglaw and C. E. Sayers, *Historical Records of Port Phillip: The First Annals of the Colony of Victoria*, Heinemann Pioneer Series (Melbourne: Heinemann, 1972), 34; Presland, *The Place for a Village: How Nature Has Shaped the City of Melbourne*, 67.
[28] Shaw, 7-9.
[29] Shillinglaw and Sayers, 23-35.

became the source of the town's fresh-water, and main communication and transport route with the rest of the colony. The laying out of Melbourne's first streets was swift, using the colonial grid plan.[30] Initial clearing and forming of the streets allowed the first land sales to commence three months later, with the town experiencing rapid early growth, further driven by the Gold Rush of 1851, which caused a population influx.[31] Tens of thousands of people flocked to Melbourne before traveling on the gold fields, creating a flourishing economy.[32] By the early 1840s, the Yarra River was supplying the city with water polluted with waste from processing plants and the town's own sewage.[33] This led to the development of Melbourne's first off-stream fresh-water reservoir, 30 kilometres (19 miles) to its north. However, pollution from the sewage of a neighbouring town of the river supplying the reservoir, coupled with the fear that logging of the catchment would affect water quality and rainfall rates, saw the catchment closed to the public, reserved for the sole purpose of water harvesting.[34] The decision to develop closed water catchments put Melbourne's water planners' decades ahead of others globally.[35]As Melbourne grew without drainage or sewerage systems, rivers and creeks serving as open sewers soon developed into public health hazards.[36] Unregulated development around inner Melbourne resulted in large stretches of many streams and the main rivers becoming surrounded by concentrated urban uses.[37] Frequent flooding of watercourses also became a major hazard for urban life, property and infrastructure.[38] Rapid urban growth also created the need for port facilities to accommodate larger shipping, and infrastructure for land-based transport consisting of roads and railways.[39] The need for improved infrastructure and flood alleviation saw the larger rivers and their riparian zones heavily modified. Many tributaries were also modified for flood control and provision of transport infrastructure. Other tributaries were placed into barrel drains and

[30] Shaw, 70.
[31] Lewis, 40-41; Shaw, 70-71; "The Gold Rush-How It Began," *Kalgoorlie Miner,* October 14, 1931, 1.
[32] Michael Cannon, *Melbourne after the Gold Rush* (Main Ridge, Vic.: Loch Haven Books, 1993), 1-7.
[33] R. Seeger, "The History of Melbourne's Water Supply - Part I," *The Victorian Historical Journal* 19, no. 3 (1941): 109-10.
[34] A. E. Dingle, Helen Doyle, and Victoria Public Record Office, *Yan Yean: A History of Melbourne's Early Water Supply* (Melbourne: Public Record Office, 2003), 68.
[35] Viggers, Lindenmayer, and Weaver, 17.
[36] D. Astley-Gresswell, *Report on the Sanitary Condition and Sanitary Administration of Melbourne and Suburbs* (Melbourne: Robert S. Brain, Government Printer, 1890), 19.
[37] Senior, 413.
[38] Newnham, 144-45.
[39] Otto, 81-83.

covered, or drained and filled to solve pollution and flood issues.[40] Amidst the major engineering modifications, a small section of the Yarra River was landscaped, becoming the first stage of a riverside boulevard consisting of ornamental drives, parkland, recreation areas, and avenues of plane and elm trees.[41] The project commenced in 1897 as part of river realignment works and reported by the *Examiner* as officially opened in May 1901 by the Duke of Cornwall and York.[42] Further sections of the Yarra were later similarly managed.

The quest for sewerage and drainage provision for Melbourne was long and complex.[43] In the interim, located in the lowest contours of the area, all sewage and drainage flowed into watercourses and wetlands turning them into open sewers and cesspits.[44] Of all the landscape components within the Melbourne area, rivers, streams and wetlands experienced the most extensive alterations and used to service a variety of uses and requirements for Melbourne's developing urban fabric.[45] An example is the range of emerging uses for the lower section of the Yarra from its mouth at Hobsons Bay to approximately 12.4 kilometres (7.7 miles) upstream between the 1870s and 90s. This 8.6-kilometre (5.3 mile) section, from mouth to ports, was enlarged and partially realigned both to allow larger vessels quicker access to port facilities and to speed the conveyance of flood flows from urban areas.[46] The river was also further enlarged and realigned 3.8 kilometres (2.4 miles) upstream of the port. This additional section was modified to also prevent flooding, speed up elimination of pollution and refuse entering the river upstream, and the 'beautification' of the river banks with tree-lined avenues and parkland.[47]

Effects of early urban growth on Melbourne's watercourses

The impacts of early urban development upon Melbourne's watercourses are illustrated by comparison of descriptions of the Lower Yarra River written during the town's

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[40] John F. Lack and Footscray Council, *A History of Footscray* (North Melbourne: Hargreen Publishing in conjunction with the City of Footscray, 1991), 104.
[41] "Yarra Improvement. A Neglected Undertaking," *Age*, November 16, 1912, 22; "The Improvement of the Yarra," *Leader (Melbourne)*, September 11, 1897, 22.
[42] David Beardsell, Campbell Beardsell, and Royal Society of Victoria, *The Yarra: A Natural Treasure* (Melbourne: Royal Society of Victoria, 1999), 39-40; "Alexandra Avenue. Melbourne, Friday," *Examiner*, May 18, 1901, 11; Heritage Council Victoria, *Domain Parklands* (Melbourne: Heritage Council Victoria, 2013), accessed March 17, 2016, http://vhd.heritagecouncil.vic.gov.au/places/165951/download-report, 5-6.
[43] Dingle and Rasmussen, 18-21.
[44] Ibid, 32-34.
[45] Presland, *The Place for a Village: How Nature Has Shaped the City of Melbourne*, 62.
[46] Newnham, 144-45.
[47] "The Improvement of the Yarra," 22.

first two decades of development. In June 1837, travelling to Melbourne upstream along the Yarra, Mary Gardiner described the scene as:

> Of such luxurious foliage growing at each side actually in the water forming in many parts most grotesque arches overhead…Between the trees abound reeds of enormous size some upward of seven feet high which cause the land to be quite impenetrable to our eager searching eyes.[48]

Journalist Edmund 'Garryowen' Finn's *The Chronicles of early Melbourne, 1835 to* 1852 (1888) reinforces this image:

> …the Yarra Yarra flowed through low, marshy flats, densely garbed with ti-tree, reeds, sedge, and scrub. Large trees, like lines of foliaged sentinels, guarded both sides, and their branches protruded so far riverwise as to more than half shadow the stream. The waters were bright and sparkling; and, wooed by the fragrant acacias shaking their golden blossom-curls…[49]

These idyllic visions contrast sharply with barrister William Kelly's description of the same stretch of river in 1853 as he travelled upstream to the city. The southern bank of the Yarra was thickly vegetated with virtually impenetrable tea-tree scrub. A mile (1.6 kilometres) downstream from the city the banks were lined with slaughterhouses and fellmongeries, covered in mud and refuse, where pigs wallowed in decomposing offal. Kelly described the section of the northern bank, amongst the slaughterhouses where the boat had anchored, as a quagmire of dark liquid mud.[50]

As previously discussed, the initial settlement of Melbourne was established on the only river in the area providing fresh-water, the Yarra.[51] An otherwise comparable river, the Maribyrnong, was tidal with salt flows from Hobsons Bay reaching approximately 16.6 kilometres (10.3 miles) upstream, while the surrounding landscape to the south and west

[48]Mary Gardiner, "Diary," in *Gardiner Family Papers* (Melbourne: State Library of Victoria 1837).
[49] Edmund Finn, *The Chronicles of Early Melbourne, 1835 to 1852: Historical, Anecdotal and Personal*, Centennial ed. (Melbourne: Fergusson and Mitchell, 1888), 497.
[50] William Kelly, *Life in Victoria, or, Victoria in 1853 and Victoria in 1858: Showing the March of Improvement Made by the Colony within Those Periods, in Town and Country, Cities and the Diggings*, (Kilmore, Vic.: Lowden Publishing, 1977), 32-33.
[51] Shaw, 56.

consisted largely of wetlands of brackish water and grasslands.[52] The land to the northeast was largely plains and grassy woodland, with swamp scrub lining sections of the Yarra.[53] The map in figure 14 illustrates a reconstruction of the vegetation communities along the Yarra and Maribyrnong Rivers and central city area before European settlement and the establishment of Melbourne.

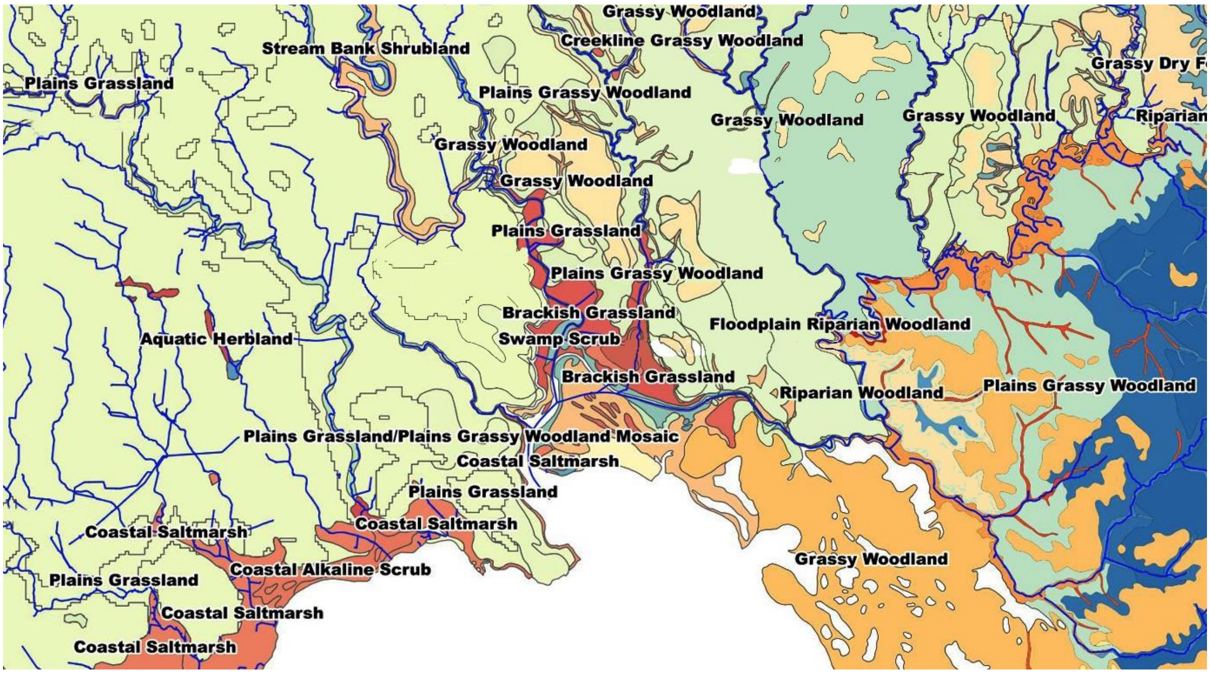

Figure 14. Vegetation types of Melbourne's central city area before urban development. Source: DELWP (2017)

The fresh-water provided by the Yarra was separated from tidal saltwater flows rising from Hobsons Bay by a low waterfall.[54] Although the falls dropped only 1 metre (3.5 feet), they formed a barrier allowing a source of fresh-water just above them.[55] Therefore, the availability of fresh-water at this point was the main reason for establishing the settlement on this site.[56] The Yarra was first seen by Europeans in 1803, when an exploration party was dispatched by the Governor of New South Wales, Richard King, to 'walk around' Port

[52] John. Lack, "Maribyrnong River," in *The Encyclopedia of Melbourne*, eds. A. May and S. Swain (Port Melbourne: Cambridge University Press, 2005), 443-44.
[53] Australian Research Centre for Urban Ecology, *Biodiversity of Metropolitan Melbourne* (Melbourne: Victorian Environmental Council 2009), 4-8.
[54] Shaw, 56; Presland, *The Place for a Village: How Nature Has Shaped the City of Melbourne*, 19-20.
[55]Cannon, MacFarlane, and Victoria Public Record Office, 230.
[56] Lewis, 1.

Phillip.[57] Members of the party included the acting Surveyor General of New South Wales, Charles Grimes, and a trained gardener, James Fleming who was chosen by King for his plant and soil identification skills.[58] Fleming was instructed to describe the landscape of the area, identify flora, assess soil types, and collect samples of stones, timber, plants, and soil.[59] The party mapped the entire Port Phillip shoreline and discovered the Yarra River and the falls.[60] Notes taken by Fleming described the landscape and recommended that the 'most eligible place' for the establishment of a settlement was located along higher ground of the Yarra River near the falls.[61] In 1835, the town that would soon be named Melbourne was founded on the northern bank close to the falls.[62] One of the very few existing maps illustrating the falls in some detail was drawn by Robert Hoddle and is featured in figure 15. The map in figure 16 shows both the original camps and shanties of Melbourne before the grid. The grid was later drawn in.

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[57] Shaw, 4-5,234; Shillinglaw and Sayers, 2-3.
[58] S Ducker, "James Fleming: The First Gardener on the River Yarra, Victoria," *Archives of natural history* 13, no. 2 (1986): 125.
[59] Ibid.
[60] Ibid, 125-27.
[61] Shillinglaw and Sayers, 34.
[62] Shaw, 56.

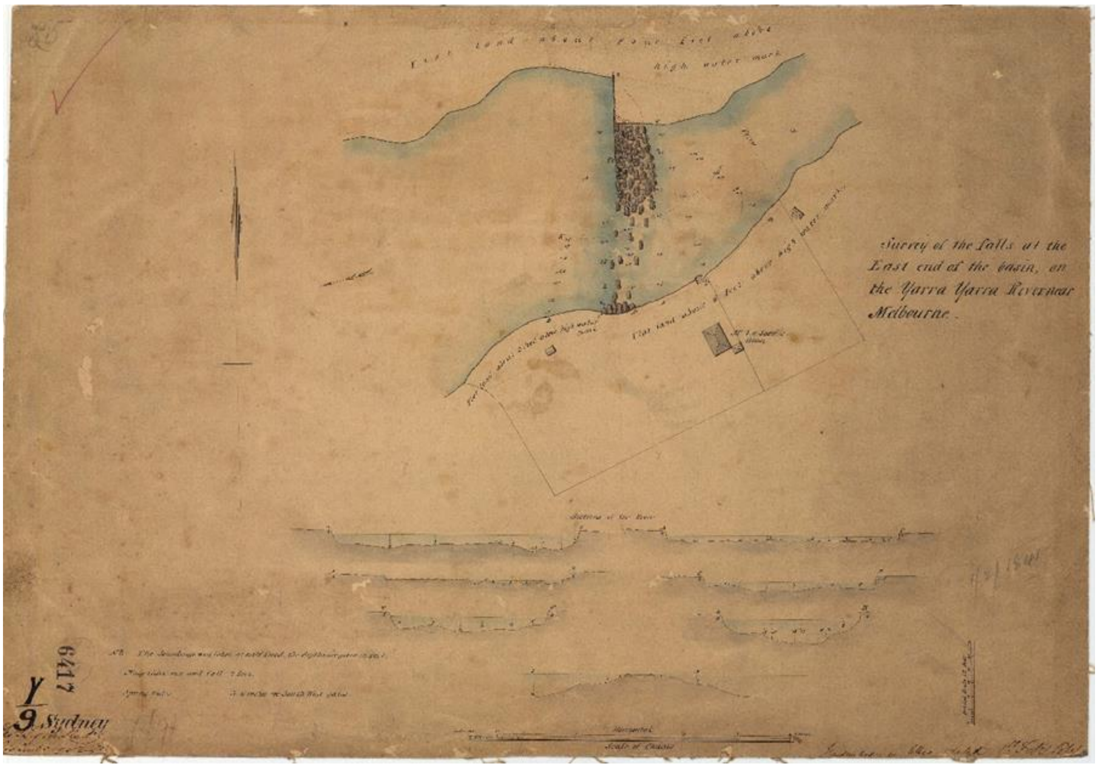

Figure 15. The falls on the Yarra in 1841. Source: PROV, VPRS 8168/P0005, Sydney Plans (digitised copy, viewed online 5 July 2017).

Figure 16. The original settlement with the grid overlaid. Source: SLV http://handle.slv.vic.gov.au/10381/170516

The central grid for Melbourne's streets was positioned so its southern edge aligned with the Yarra. Some believe the grid takes no account of the topography, thus the period floods of lower areas adjacent to the city.[63] However, the fact that a main street on a north-south axis (Elizabeth Street) essentially follows a creek bed, suggests the topography may have been considered in Hoddle's plan. The first tracks around the Melbourne region created by European settlers were often stock routes following pre-existing paths created by indigenous peoples.[64] In country where surface water was often limited, these paths were near permanent creeks and rivers.[65] Within the Melbourne region, indigenous people used the river and creek valleys for traveling to and from Port Phillip Bay and other inland sites and resources. [66] In all probability, the creek of Elizabeth Street may already have been in use as a stock route and path by indigenous people. The grid layout used for new towns and cities was favoured by colonial governments due to its ease of application on the ground and administrative simplicity; however, grids are widely criticised for their lack of open space, disregard for local terrain and conditions and their social anonymity.[67] In 1836, the Deputy Surveyor General of the colony issued instructions to the first surveyor at Melbourne, Robert Russell, to conduct a detailed survey and mapping of Port Phillip Bay shoreline and all the rivers and streams that flow into the bay.[68] A similarly detailed survey of the Yarra River was to follow including how far it was navigable by boat, the extent of tidal flows, the nature of its banks and streambed at several points, the speed of its current and the height of permanent water and flood flows.[69] These details were also to be recorded and mapped for all the watercourses entering the bay.[70] Progress on this survey was too slow for Bourke, who elected to tour the settlement himself in March 1837 with a replacement surveyor Robert Hoddle.[71] During the tour, Hoddle, under instruction from Bourke, laid out the grid for Melbourne and modified Russell's earlier plan. The grid was laid out with land clearing

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[63] Brown-May, 4-10.
[64] Maxwell Lay, *Melbourne Miles: The Story of Melbourne's Roads* (Melbourne, Vic.: Australian Scholarly Publishing, 2003), 29.
[65] Ibid.
[66] Presland and Victoria Archaeological Survey, 13; Mick, 30.
[67] Brown-May, 10.
[68] Michael Cannon, Ian MacFarlane, and Victoria Public Record Office, *Surveyor's Problems and Achievements, 1836-1839* (Melbourne: Victorian Government Printing Office, 1988), 6.
[69] Ibid, 6-7.
[70] Ibid.
[71] Ibid.

commencing before the landscape and smaller tributaries of the immediate area had been identified, described or mapped.[72] On 1st June 1837, Melbourne's first land sales began with the sale of 100 allotments within the grid.[73] An illustration of just how quickly the development of Melbourne was changing and erasing the landscape was evident in a letter written by the settlement's Superintendent Charles La Trobe to the Colonial Secretary in 1839. Just two years after the street grid was laid out La Trobe expressed concern about the unregulated rate and scope of damage created by extraction industries involving timber cutting, quarrying, and brick making.[74] He also questioned the 'free-for-all' methods industries were using to conduct their operations and considered the results would be detrimental to property values and the town's general environs.[75] However, consideration to protect the town's natural environment was largely ignored. An examination of the following photograph (figure 17) taken in 1888 looking across the Yarra from the central city area to South Melbourne shows the natural environment has been largely erased, with only the highly modified river remaining. The rock falls previously extended across the river where the road bridge is seen in the centre of the photograph.

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[72] Presland, "The Natural History of Melbourne – a Reconstruction," 30.
[73] Cannon, MacFarlane, and Victoria Public Record Office, *Surveyor's Problems and Achievements, 1836-1839*, 35.
[74] *The Early Development of Melbourne*, 55.
[75] Ibid.

Figure 17. View from central Melbourne across the Yarra showing the degree of development along this section of the river. Source: SLV http://handel.siv.vic.gov/10381/205908

The area's watercourses suffered further from the effects of urban development through the extraction of materials for building and construction during this period. The *Public Works Act 1865* (Vic.) enshrined the use of rivers and creeks for the extraction of building materials in legislation. The Act stipulated the Board of Lands and Works and their officers or any person acting under their authority might enter upon any land, river or creek and search for, dig, and remove any gravel, sand, or other materials such as quarry stone.[76] These actives were not to divert or disrupt the stream flows and were to be conducted beyond 45.7 metres (150 feet) above or below bridges, dams or weirs.[77]

[76] *An Act to Amend and Consolidate the Laws Relating to Public Works 1865* (Vic.), 955.
[77] Ibid.

First water supplies

Throughout Melbourne's history, the city has sourced its water from the region's surface fresh-water river systems and their catchments. During the first period of the city's development, the town depended almost exclusively on the Yarra River for fresh-water.[78] The early construction of water-supply infrastructure saw the Yarra modified; then a tributary, the Plenty, was used for water supply. This marked the beginning of the city utilising the Yarra, its tributaries and their catchments found to the north and east of the urban region. The Yarra and its tributaries remain Melbourne's primary source of potable water providing the city with 70 percent of its drinking water.[79] This water is harvested, managed, and supplied through a system of connected storage reservoirs, the major ones located within closed catchments.[80] The city has closed or protected water supply catchments in forested areas to the north and east of the city within national parks and state forest with limited public access.[81] These catchments are more than 157,000 hectares (387,955 acres) consisting largely of mountain ash (*Eucalyptus regnans*) forests.[82] Being closed to public access and other forms of land use including farming and urban development, much of the forest has remained undisturbed.[83] Globally, protected water-supply catchments are rare with Melbourne only one of five major cities managing its water supply in this way.[84] Research by Postel, Barton and Thompson (2005) indicates the cost of preserving catchment areas was approximately 10 percent of the cost to treat water for human consumption, an issue Melbourne obviated early in its water supply development.[85] During the period this chapter examines, (1835-1900) the main sources of Melbourne's water supplies as previously discussed were, firstly, the Yarra and by mid-century, the Plenty. These rivers also underwent most of the major engineered modifications regarding their use and management for the growing city's fresh-water

[78] Seeger, 107.
[79] "Yarra Catchment," Melbourne Water Corporation, updated October 3, 2017, http://www.melbournewater.com.au/waterdata/riverhealthdata/yarra/pages/yarra-catchment.aspx.
[80] Viggers, Lindenmayer, and Weaver, 3.
[81] "Water Catchments," Melbourne Water Corporation, updated October 30, 2017, http://www.melbournewater.com.au/whatwedo/supply-water/water-catchments/pages/water-catchments.aspx.
[82] Ibid.
[83] Ibid.
[84] "Water Supply Catchments," Melbourne Water Corporation, accessed March 20, 2016 https://web.archive.org/web/20081216021215/http://www.melbournewater.com.au:80/content/water/water_supply_catchments/water_supply_catchments.asp.
[85] Viggers, Lindenmayer, and Weaver, 17; Sandra L. Postel and Barton H. Thompson, "Watershed Protection: Capturing the Benefits of Nature's Water Supply Services," *Natural Resources Forum* 29, no. 2 (2005): 99.

supplies. The map of figure 18 shows the position of Melbourne's closed water catchments and reservoirs in relation to the city, Yarra and Plenty Rivers.

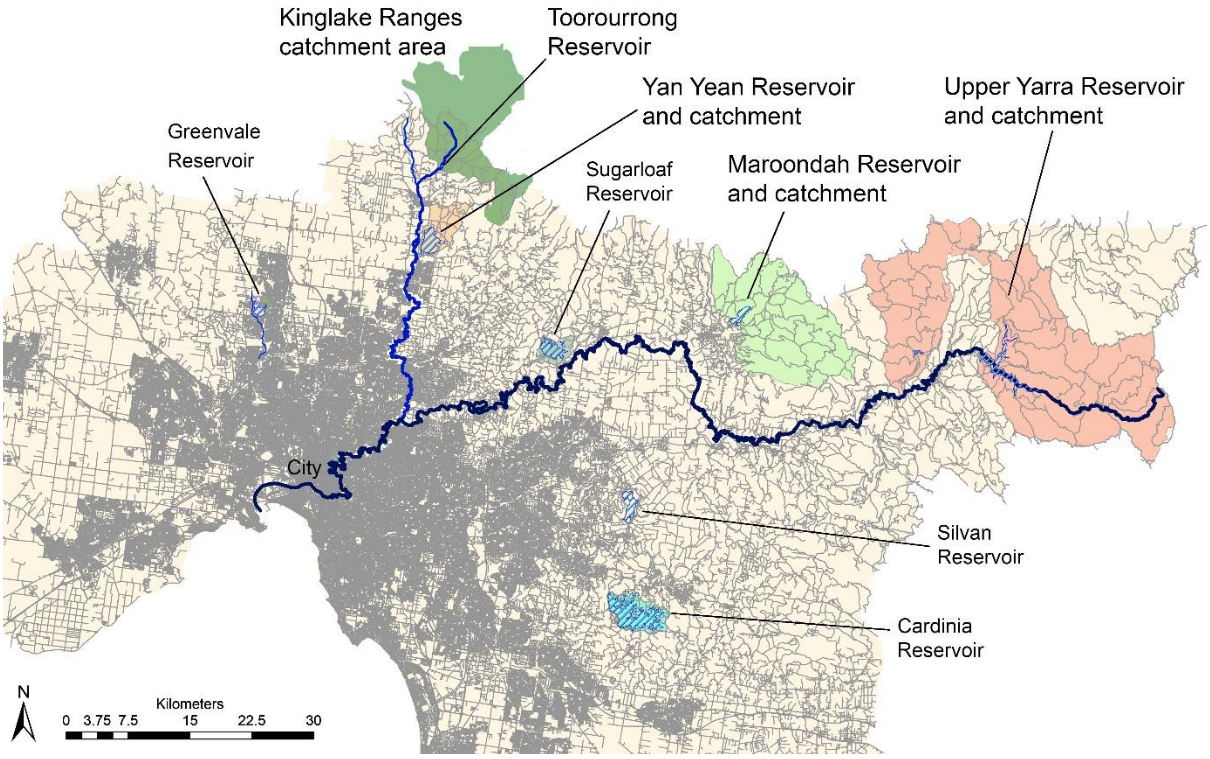

Figure 18. Melbourne's c*losed water catchments and main reservoirs. Suburban reservoirs have no or limited catchments and filled by conduit from outer reservoirs.*

Amongst the first impacts on the Melbourne area's watercourses caused by urban development was the development of a reliable supply of fresh-water, untainted by tidal flows. As previously discussed Melbourne was found adjacent to low, rock falls on the Yarra, a barrier that prevented tidal flows traveling upstream.[86] The falls dams of the 1840s saw the Yarra modified to retain fresh-water to stop tidal flows entering the domestic water supply.[87]

The earliest attempt to secure water for the developing town was the construction of a dam wall across the falls.[88] The settlement collected its water with buckets, then by filling horse-drawn carts or large barrels on wheels, delivering the water to barrels or butts located

[86] Presland, *The Place for a Village: How Nature Has Shaped the City of Melbourne*, 20.
[87] Cannon, MacFarlane, and Victoria Public Record Office, *The Early Development of Melbourne*, 229-35.
[88] Ibid, 229.

behind houses.[89] Although the falls formed a barrier between the tidal flows and fresh-water, frequently water collected from above the falls was reported as having become brackish due to high tides and low flows arriving from upstream.[90] Melbourne journalist Edmund Finn (1888) described Yarra water as*:*

> …frequently unfit for man or beast. In hot weather it was likened to a compounded dose of lukewarm water and Glauber salts; and though it was physic one would hardly throw to the dogs, the people of Melbourne had to swallow it, though often rectified with large dashes of execrable rum or brandy…[91]

In 1838 as an early solution to improving the quality of the water supply and to provide communication between the city's centre and South Melbourne, surveyor Hoddle proposed the construction of a dam across the falls, with the dimensions of 150 feet (45.7 metres) in width by a height of 1 foot (300 millimetres) above the falls.[92] Hoddle proposed this dam could provide not only fresh water for the town, but also to ships via a pipeline to Port Melbourne where shipping docked during the period.[93] Hoddle also considered that construction of a quay at Port Melbourne would save vessels from making the uncertain and circuitous trip of eight miles (12.9 kilometres) upstream along the Yarra to the town.[94] When approval was provided for a dam from the Governor of the colony in Sydney, due to concerns about a dam creating flooding of the town upstream, the height of the wall was stipulated to stop only tidal flows, with surplus flow over the top.[95] The concern for flooding also resulted in the Governor issuing the instruction that all land less than 6 to 7.6 metres (20 to 25 feet) above the surface of the river was not to be sold during the land sales of town allotments, as these low allotments may be flooded by dam construction.[96] In 1839, a vertical timber frame filled with rock and puddled clay – clay worked into a thick waterproof paste – was

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[89] Lewis, 29.
[90] Ibid, 29-30.
[91] Edmund Finn and Maggie Weidenhofer, *Garryowen's Melbourne; a Selection from the Chronicles of Early Melbourne, 1835 to 1852* (Melbourne: Nelson Australia, 1967), 40.
[92] Cannon, MacFarlane, and Victoria Public Record Office, *The Early Development of Melbourne*, 229.
[93] Ibid, 230.
[94] Ibid.
[95] Ibid, 234-35.
[96] Ibid, 133.

constructed across the river.[97] The first dam was swept away in a flood, as there was no provision for overflow on the wall.[98] Over the following summer 1840-1841, the town underwent an epidemic of illness that was attributed to the drinking of water polluted by tides frequently crossing the falls.[99] In late 1841, a replacement dam was constructed lower than the original to allow excess water flow over the top and prevent flooding.[100] Following its completion, the town experienced a series of severe floods, exacerbated by water spreading out both up and downstream cutting off sections of the town.[101] In early May 1842 construction commenced on a replacement puddled clay dam, however the incomplete structure was once again washed away by floods three months later.[102] In 1843 construction of a fourth dam was reported as allowing dry passage across the river by foot at any time.[103] However, the dam's design proved problematic as the constant tidal pressure destabilised the structure, requiring ongoing repair, and allowed an increase of silt deposition into the pool below the wall.[104]

By the early 1840s, the section of Yarra flowing through Melbourne had become a large drain, with noxious industries including abattoirs lining its banks and discharging refuse directly into its water.[105] Water-borne diseases became prevalent and the supply provided to the community was largely a mixture of mud and water, frequently of a brackish tidal nature.[106] Until the 1850s, Melbourne's water supply depended heavily on private ventures with local entrepreneurs developing a primitive water distribution system.[107] This consisted of a series of pumps installed along the Yarra just above the falls, private water carters, and the establishment of the Melbourne Water Company that pumped Yarra water to a holding tank, filtered it and sold clean water on to water carters.[108] In addition, various water supply

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[97] Michael Cannon, *Old Melbourne Town before the Gold Rush* (Main Ridge, Vic.: Loch Haven Books, 1991), 93; G. Reeves et al., "Specialized Applications," in *Clay Materials Used in Construction*, ed. G Reeves, I Sims, and J Cripps (London The Geological Society, 2006): 377.
[98] A.W. Greig, "Two Vanished Landmarks. The Falls and Batmans Hill," *Argus*, 1920, 7; Cannon, *Old Melbourne Town before the Gold Rush*, 93.
[99] Greig, 7.
[100] Cannon, *Old Melbourne Town before the Gold Rush*, 95.
[101] Ibid.
[102] Robert Douglass Boys, *First Years at Port Phillip: Preceded by a Summary of Historical Events from 1768* (Melbourne: Robertson & Mullens, 1935), 80; Greig, 7.
[103] "Colonial Intelligence Port Phillip," *Maitland Mercury and Hunter River General Advertiser*, 25 February, 1843, 4.
[104] Cannon, *Old Melbourne Town before the Gold Rush*, 95.
[105] Seeger, 109.
[106] Ibid, 109-10; Finn and Weidenhofer, 40.
[107] Dingle, Doyle, and Victoria Public Record Office, 6-7.
[108] Ibid.

schemes were proposed and hypothesised including pumping water from further upstream on the Yarra where it was believed the water was unpolluted, the construction of a large reservoir upstream from the city on the river, and the use of tunnels to divert fresh Yarra water to Melbourne.[109]

The water supply for the developing suburbs located some distance away from the Yarra was at best hazardous.[110] With no supply pipelines yet constructed for transporting water from the Yarra, many suburbs were collecting rain-water in above- and under- ground brick tanks occasionally complemented by cart-delivered Yarra water.[111] It appears smaller creeks were not generally utilised for water-supply, perhaps due to their size, lower flow rates that commonly ceased during the hotter months, and their increasingly common use as open sewers. For example, in July 1889 the Box Hill *Reporter's* description of the new suburb of Blackburn reported great care and attention being paid to laying out the suburb's sanitary and drainage patterns. Surface water drained into one un-named street, which was designed to carry all stormwater and sewage into a deep channel leading to a creek.[112] However, some creeks were dammed for irrigation uses, such as a section of Gardiners (also known as *Kooyongkoot)* Creek, a main easterly flowing tributary of the Yarra.[113] During the 1880s, a dam wall was constructed across a section of the creek, which had been previously mined for antimony (a metalloid used in the manufacture of cosmetics, solders and other metallic items).[114] The Freehold Investment and Banking Company, in conjunction with a land speculation syndicate, constructed what became known as Blackburn Lake to improve land values and provide irrigation water for local orchards.[115] The company also constructed a refreshment room and boat jetty in 1889, and organised picnic excursions by railway from Melbourne.[116] The trips proved highly popular with visitors and the area's endemic vegetation and habitat for 165 bird species became a valued attraction.[117] Figure 19 shows the lake in 1889 and two participants from one of the picnic excursions. Figure 20 is a 1923

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[109] Ibid, 4-6.
[110] Seeger, 117.
[111] Ibid.
[112] "Blackburn. A Model Township," *Reporter*, July 25, 1889, 3.
[113] Presland, *The Place for a Village: How Nature Has Shaped the City of Melbourne*, 68.
[114] "The Lake and Its Water," Blackburn Lake Sanctuary, accessed March 25, 2016, http://blackburnlakesanctuary.org/lakes-role.php.
[115] "Blackburn Lake's History at a Glance," Blackburn Lake Sanctuary, accessed March 25, 2016, http://blackburnlakesanctuary.org/history.php.
[116] Robin Da Costa, *Blackburn, a Picturesque History* (Lilydale, Vic.: Pioneer Design Studio, 1978), 89.
[117] Ibid.

advert for a housing subdivision near the lake. As land around the lake was subdivided into smaller blocks, developers used the lake as a feature to attract potential buyers and residents.

Figure 19. Blackburn Lake, 1889. Source: SLV H92.200/113

In 1906, surrounding land was subdivided and offered for sale as residential, orchard, garden and poultry farm blocks, while the lake was stocked with fish and promoted as being suitable for boating, swimming and fishing.[118]

[118] Ibid.

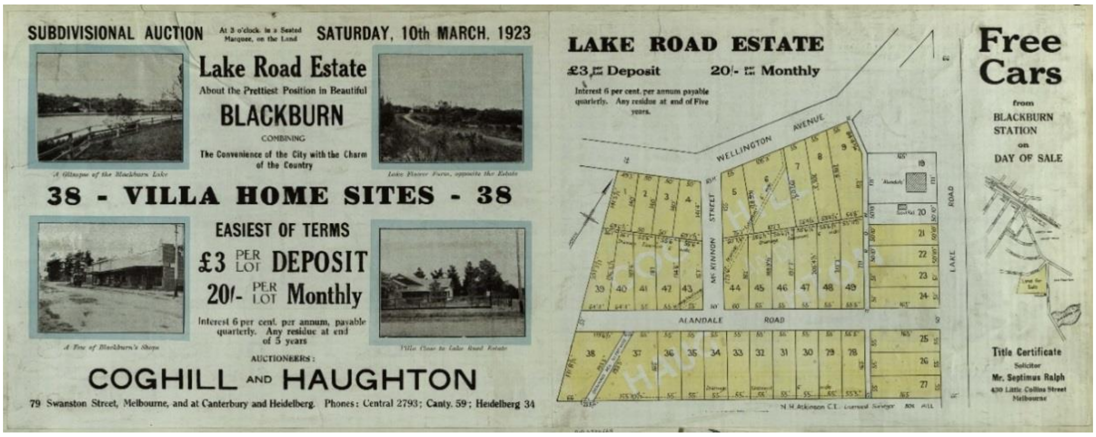

Figure 20. Subdivision advert from 1923. Source: SLV http://handle.slv.vic.gov.au/10381/175114

In 1842, Melbourne was incorporated, becoming a town, the town council responsible for water supplies and sewers, although it had little power to raise revenue for projects.[119] In addressing the town’s growing water supply problems, the city council engaged its surveyor, James Blackburn, to conduct a systematic investigation of alternative water supplies.[120] Blackburn, a civil engineer and architect, was an inspector for the commissioners of sewers in London; he had been transported to Tasmania for embezzlement in 1835.[121] There, he worked for the Department of Roads and Bridges, going on to establish an architectural practice in Hobart designing, amongst other projects, a water-supply system (unrealised) for the town.[122] In 1849, he moved to Melbourne and proposed the Yan Yean scheme, later working as consulting engineer on its construction.[123] Construction had commenced when Blackburn died from typhoid in 1854.[124] Blackburn’s engagement illustrates the dominance of British engineering design and knowledge, and its acceptance as universal solutions for urban water systems.

The construction of an off-stream reservoir to supply Melbourne originated from Blackburn’s first investigations. He preferred the simple supply of water by gravitation, diverted from its streambed and transported by an aqueduct flowing down a series of

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[119] Seeger, 108.
[120] Dingle, Doyle, and Victoria Public Record Office, 7.
[121] Viggers, Lindenmayer, and Weaver, 6.
[122] Harley Preston, “Blackburn, James (1803-1854),” *Australian Dictionary of Biography*, National Centre of Biography, Australian National University, accessed April 7, 2016, http://adb.anu.edu.au/biography/blackburn-james-1789.
[123] Viggers, Lindenmayer, and Weaver, 6; Dingle, Doyle, and Victoria Public Record Office, 6.
[124] Preston.

inclines.[125] Following his inspection of the region's streams and creeks, Blackburn decided the river with preferred flow rates and suitable elevation for a gravitational system was the Plenty.[126] The Plenty is formed by several streams flowing from the Plenty Ranges including Jack's Creek, the Eastern and Western Branches of the Plenty River, and Bruce's Creek.[127] It flowed through four miles (6.4 kilometres) of wetlands, including Rider's Swamp, the site Blackburn chose at Yan Yean, 30 kilometres (19 miles) north-east from Melbourne, for construction of an off-stream reservoir.[128] For Blackburn, the wetlands meant a large and valuable supply of water was lost to evaporation and absorption.[129] He proposed closing off Rider's Swamp with an embankment creating an off-stream reservoir.[130] Within western cultural tradition, wetlands were referred to as 'swamps,' considered places of black water associated with miasmatic vapours.[131] The common response was to drain and reclaim.[132]

In 1851, Victoria separated from New South Wales, and the Victorian Legislative Council formed. Sewage and water supply of Melbourne became the responsibility of firstly a select committee, (which accepted Blackburn's scheme), then the Board of Commission of Sewers and Water Supply tasked with construction of the Yan Yean scheme.[133] This commenced in late 1853, under the supervision of Matthew Jackson, also trained and practiced in Britain.[134] Jackson had been employed on a range of projects including bridges, lock gates for harbours, water pumps and reporting on the collapse of Yorkshire's Bilberry dam.[135] As the Yan Yean project progressed, Jackson modified it to allow water for additional suburbs. This required a larger reservoir, achieved by raising the height of the

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[125] The Select Committee on the Sewerage of and Supply of Water for Melbourne, *Report from the Select Committee on the Sewerage and Supply of Water for Melbourne* (Melbourne: Legislative Council of Victoria 1853), 48.
[126] Dingle, Doyle, and Victoria Public Record Office, 8-11.
[127] George A. Gibbs and Melbourne and Metropolitan Board of Works, *Water Supply Systems of the Melbourne and Metropolitan Board of Works* (Melbourne: D.W. Paterson, 1915), 11.
[128] David Dunstan and City of Melbourne Counci., *Governing the Metropolis: Politics, Technology and Social Change in a Victorian City: Melbourne, 1850-1891* (Carlton, Vic.: Melbourne University Press, 1984), 140; Gibbs and Melbourne and Metropolitan Board of Works, *Water Supply Systems of the Melbourne and Metropolitan Board of Works*, 17.
[129] The Select Committee on the Sewerage of and Supply of Water for Melbourne, 49.
[130] Viggers, Lindenmayer, and Weaver, 6.
[131] Rodney James Giblett, *Postmodern Wetland: Culture, History, Ecology*, Postmodern Theory (Edinburgh: Edinburgh University Press, 1996), 3; Lois N. Magner, *A History of Infectious Diseases and the Microbial World*, (Westport, Conn.: Praeger, 2009), 19-20.
[132] Giblett, 3.
[133] Seeger, 116.
[134] Viggers, Lindenmayer, and Weaver, 8-9.
[135] Dingle, Doyle, and Victoria Public Record Office, 21-22.

embankment.[136] To save costs Jackson decided to source water from the Plenty below the marshes, requiring construction of an aqueduct of only two miles (3.2 kilometres) in length rather than Blackburn's four.[137] Meanwhile as construction commenced at Yan Yean, an outbreak of fires in Melbourne resulted in the destruction of several city buildings, causing the Board of Commission to decide reliable water supply to the city was so crucial a temporary supply was required.[138] In 1854, a large iron water tank with a capacity of 150,000 gallons (567812 litres) was erected atop 15 foot (4.6 metre) high stone piers on Eastern Hill, to supply stand pipes across the city at a reasonable pressure.[139] The stand pipes were used to supply water for firefighting, street washing and dust control for unsurfaced streets. The Eastern Hill tank was supplied with water from the Yarra, pumped by a steam pump setup on the river bank.[140] Until construction of the tank water for firefighting, as with the city's entire supply of potable water, was sourced from the Yarra above the falls (see page 80).[141] Following completion of Yan Yean, water for firefighting was supplied via a system of fire plugs, consisting of ball valves, inserted into the underground water pipe street mains at regular intervals.[142] In December 1857, the first water supplied by Yan Yean was turned on in Melbourne at an official ceremony.[143] Figure 21 shows the reservoir when first completed in 1859 in comparison with an image from 2016. Although only 40 kilometres from the centre of Melbourne, the locked-up catchment area retains a feeling of remoteness.

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[136] Ibid, 22.
[137] Ibid; Special Reporter No.1, "The Metropolitan Water Supply. Its Early History," *Age,* August 12, 1886, 5.
[138] Dingle, Doyle, and Victoria Public Record Office, 22-23.
[139] Ibid, 23.
[140] Ibid.
[141] R. Seeger, "The History of Melbourne's Water Supply – Part One," *The Victorian Historical Journal* 22, no.1 (1947): 106-116.
[142] Dingle, Doyle, and Victoria Public Record Office, 52-53.
[143] R. Seeger, "The History of Melbourne's Water Supply - Part 2," *The Victorian Historical Journal* 22, no. 1 (1947): 29.

Figure 21. Yan Yean Reservoir following completion, 1859, and contemporary view, 2016. Sources: SLV http://handle.slv.vic.gov.au/10381/29482 - Author photo (2016).

However barely eight months after the first flows reached the city, the Melbourne *Argus* stated, 'There is water a Plenty; but the water is not of the quality that was predicted of it.'[144] In August, the *Argus* described Yan Yean water as dangerous to health and called for a thorough investigation.[145] The water sourced from below the marshes was discoloured and polluted, containing organic impurities that gave it a straw-colour and offensive odour.[146] This was a result of flow through beds of decaying vegetation.[147] In answer to growing concerns about water quality, the government established a select committee in October 1858 who concluded the water did contain impurities, and recommended an open-cut channel through the marshes.[148] The committee also considered draining the marshes would enable

[144] "Monday, January 25, 1858," *Argus*, January 25, 1858, 5.
[145] "Tuesday, August 10, 1858," *Argus*, August 10, 1858, 4.
[146] Dingle, Doyle, and Victoria Public Record Office, 40.
[147] Dunstan and Melbourne Council, 140.
[148] "Yan Yean Reservoir Water Supply," *Argus*, February 25, 1859, 7.

reclamation for farming.[149] The recommendations were not adopted, and in 1860, another parliamentary enquiry was conducted resulting in two sources of contamination being identified. A tributary, Bruce's Creek, polluted with the sewerage from the town of Whittlesea and surrounding district and by geese, pigs and cattle; the bed of the reservoir containing decomposing vegetable matter not fully removed on the site and manure left by animals used in pulling earthmoving equipment during construction.[150] To address these issues the committee recommended the diversion of Bruce's Creek; that channels supplying water be kept clear of vegetable matter and animal intrusion; and draining of the reservoir to enable removal of all vegetable matter.[151] The whole episode resulted in the abolition of the Board of Commission of Sewers and Water Supply, its powers transferred to the Board of Land and Works.[152] The recommendations of this committee were also largely ignored by the Board and successive governments until the early 1880s when Yan Yean water quality had further declined, and clearer links between pollution and disease established.[153] During this time, the link was also formed between activity and development within catchment areas and water quality.[154] This link became increasingly evident as water polluted by human activities in the Whittlesea region continued to flow into the reservoir.[155] In addition, George Perkins Marsh's 1864 book *Man and Nature; or Physical Geography as modified by human action,* argued rainfall was higher in wooded than open areas.[156] Marsh was an environmentalist, lawyer, diplomat, businessperson and scholar who published two books concerning human impacts on the earth.[157] These are widely considered the first discussion of modern environmental problems.[158] Marsh's views were quickly adopted by local scientists and engineers, and consequently resulted in the Board prohibiting logging and grazing at Yan Yean.[159] In 1872, the catchment was officially permanently reserved for water harvesting.[160]

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[149] Ibid.
[150] "Purification of the Yan Yean Water," *Argus*, August 7, 1860, 3; Dingle, Doyle, and Victoria Public Record Office, 46-47.
[151] "Purification of the Yan Yean Water," 3.
[152] Dunstan and Melbourne Council, 140.
[153] Dingle, Doyle, and Victoria Public Record Office, 67,80.
[154] Viggers, Lindenmayer, and Weaver, 12.
[155] Ibid, 12.
[156] Marsh, 196.
[157] David. Lowenthal, *George Perkins Marsh: Prophet of Conservation* (Seattle: University of Washington Press, 2000), .xv-xxi.
[158] Ibid.
[159] Dingle, Doyle, and Victoria Public Record Office, 68.
[160] State Government of Victoria, "Lands permently reserved from sale," *Victoria Government Gazette* 79, (December 20, 1872): 2302.

This set a precedent for the development of Melbourne's future reservoirs and 'closed catchments'.[161]

Nonetheless, by the late 1870s Yan Yean's water quality had already declined dramatically. In February 1881, the board appointed by the government to report on the condition of water from the reservoir stated: 'The samples collected have one common character; they have a turbid opalescence and are unsightly; they have a mawkish taste and a repulsive and unpleasant odour.'[162] On inspection of the site, the committee determined polluted water was entering the reservoir from three creeks converging to flow through Whittlesea, becoming the town's open sewer. The board recommended diverting the creeks from the reservoir and sourcing water from the unpolluted eastern branch of the Plenty River and creeks from higher up in the Great Dividing Range.[163] This time the recommendations were fully implemented as a greater understanding of the links between polluted water and disease developed through the new science of bacteriology and germ theory.[164]

The creeks diverted from high up in the Great Dividing Range were channelled into a new reservoir, Toorourrong. Completed in 1886, the water travelled to Yan Yean along the stone-lined Clear Water Channel.[165] Yan Yean was finally receiving water from the Plenty sourced from above the marshes and the Whittlesea Township as proposed by the first select committee into the water from Yan Yean in 1859.[166]

Construction of the Yan Yean system was the result of engineering solutions to supply Melbourne with fresh-water. Despite engineering's dominance, the ecological idea that water-catchments require protection from human-based development and logging became a feature in the city's water-supply system. The closed-catchment system was one of the few times engineers, water planners and government moved beyond engineering solutions in managing the use of the Melbourne region's waterways.

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[161] Viggers, Lindenmayer, and Weaver, 17; J.M. Powell, "Austrailan Watermarks: Resource-Environment Transactions in an Emergent Democracy," in *Water: Histories, Cultures, Ecologies*, ed. Marnie Leybourne and Andrea Gaynor (Crawley, W.A.: University of Western Australia Press, 2006), 57.
[162] J. Brady, J. Newbury, and G. Foord, *Yan Yean Water Supply: Report of the Board Appointed to Enquire into the Present Condition of the Yan Yean Water and to Suggest Any Immediate Remedy* (Melbourne: State Parliment of Victoria, 1881), 1.
[163] Dingle, Doyle, and Victoria. Public Record Office, 81-82.
[164] Ibid, 82.
[165] Seeger, "The History of Melbourne's Water Supply - Part 2," 44-45; Heritage Council Victoria, *Yan Yean Water Supply System* (Melbourne: Heritage Council Victoria, 2017), accessed February 6, 2018, http://vhd.heritagecouncil.vic.gov.au/places/13088, 3.
[166] "Yan Yean Reservoir Water Supply," 7.

Development of Melbourne's first ports: Transformation of the lower Yarra

'As the river is the easiest route to travel over, it has remained in existence longest as a utility: even the new railroad usually clung to its banks.'[167] Lewis Mumford's observation could describe the main uses of the Lower Yarra since Melbourne's foundation. The Yarra's lower reach was the only access and communication route with the rest of the world. Early Melbourne was heavily reliant on shipping for the supply of materials, goods and people, essential for development of a growing city.[168] This reliance is evident in the number of ships leaving Port Phillip during the first six months of 1840, consisting of 141 vessels, just five years after Melbourne was founded.[169] The development of Australian's first passenger, stream rail service saw the northern bank of the Yarra at the corner of Flinders and Swanston Streets become the site for the station and subsequent development of rail infrastructure.[170] The river underwent decades of modification culminating in the lower Yarra's redesign primarily as a shipping channel. Since flooding significantly damaged port facilities, the river also served as a stormwater drain.

During the first decades of its development, access to Melbourne was by ship, the most efficient method of long distance transport.[171] At the time the Yarra flowed to the north-west from the city then turned back to the south-west at its confluence with the larger Salt-Water (now Maribyrnong) River. The Maribyrnong then flowed in a southerly direction to its mouth with Hobsons Bay, in the north-west corner of Port Phillip Bay, as shown in figure 22, an 1864 map of the Yarra and Maribyrnong estuary. The lower reach of the Yarra was narrow and winding, filled with various obstructions.[172] These included several submerged reefs, a sand bar at the river's mouth, and a shallow bar of mud at the confluence of the Yarra and Maribyrnong Rivers.[173] The confluence also contained significant amounts of loose stone lodged in the bed, resultant from the Yarra's flow slowing when entering the wider

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[167] Mumford, *The Culture of Cities*, 316.
[168] Lewis, 32-33; Kelly, 32-33.
[169] John Noble, *Port Phillip Panorama: A Maritime History* (Melbourne: Hawthorn Press, 1975), 60.
[170] David Moloney, and Celestina Sagazio, "The Port Melbourne and St. Kilda Railway Lines," *Historic Environment* 6, no. 4 (1988): 3.
[171] Cannon, *Old Melbourne Town before the Gold Rush*, 41.
[172] B Botterill, "The Melbourne River Wharves (from Queens Bridge to the Charles Grimes Bridge) "a Vanishing Port," " in *Minor Ports of Australia*, ed. P Ridgway (Perth: Australian Association for Martime History 1988), 79.
[173] Ibid.; P. Milner, "Engineering the Port of Melbourne" in *1992 Conference on Maritime Technology for the 21st. Century, the University of Melbourne, 25-27 November 1992*, (Parkville, Vic.: University of Melbourne, Dept. of Mechanical and Industrial Engineering, 1992), 3; Noble, 66.

Maribyrnong.[174] From the confluence, upstream to central Melbourne and the falls, the main obstacles for shipping largely consisted of mud banks.[175]

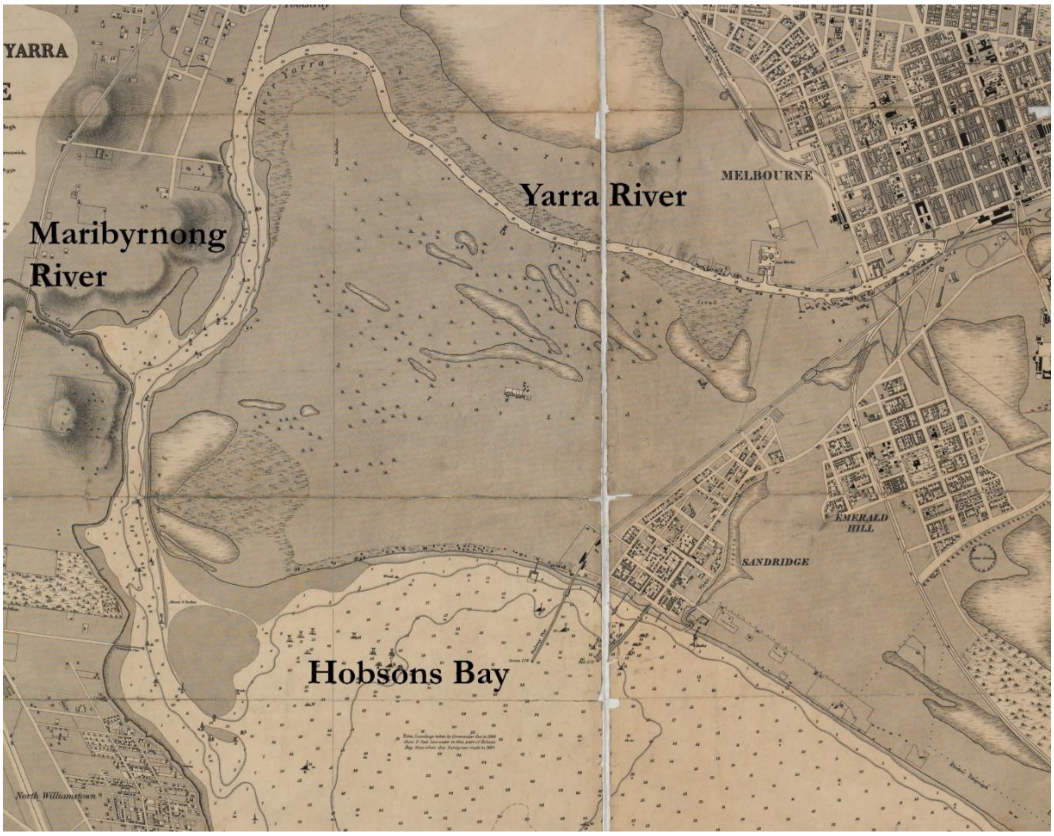

Figure 22. The Yarra and Maribyrnong confluence and estuary mouth at Hobsons Bay, 1864. Source: SLV http://handle.slv.vic.gov.au/10381/93001

Journalist Edmund Finn (page 60) described the lower Yarra during the late 1830s as:

> …so half-choked with the trunks and branches of fallen trees and other impedimenta as to render its navigation a matter of difficulty and delay even the smallest of coasters. Its low sides were lined with thick ti-tree scrub and trees over twenty feet high, and skirted with marshes covered with a luxuriance of reeds, wild grass and herbage.[176]

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[174] Cannon, *Old Melbourne Town before the Gold Rush*, 378.
[175] Ibid.
[176] Finn, 3-4.

Due to the conditions on the Yarra and shallow water levels, only smaller vessels requiring a depth of 2.1 metres (6.9 feet) or less of water could enter and navigate upstream. Larger vessels were anchored in Hobsons Bay, 14.5 kilometres (9 miles) downstream, with passengers and goods transferred by lighters (flat bottomed barges requiring only 2.1 metres (7 feet) depth of water) and other, smaller vessels.[177]

Upon arrival to Melbourne by ship in 1853, William Kelly's (page 60-1) trip upstream from anchorage in Hobsons Bay in a steam lighter took almost two hours just to reach the Yarra's confluence.[178] As large vessels were prohibited from entering the river, in 1840 port facilities were developed at Sandridge (now Port Melbourne) located on the shoreline of Hobsons Bay, as a port for passengers landing from vessels anchored in the bay. A road was also constructed in a line from the port to the falls on the Yarra.[179] The falls were used by many passengers to cross the river into Melbourne after walking along the bush-track of 2.4 kilometres, (1.5 miles) from Sandridge Beach into Melbourne.[180] By 1849, the beach had become Town Pier, continuing to provide for passenger services well into the 20th century.[181] In 1854, Australia's first steam-powered passenger rail service was opened linking the port with Melbourne.[182] The railway crossed the Yarra immediately upstream from the falls, with the first city station located on land between the river and Flinders Street, along the southern edge of the city's street grid.[183] This railway established Flinders Street Station as central to a future rail network.[184]

Much of the Yarra's lower reach was straight except for a large bend where the river turned back towards the bay in a southerly direction.[185] Commonly the prevailing winds delivered sailing vessels to the bend, named Humbug Reach, where they were 'humbugged', that is, became becalmed due to the change in direction, unable to proceed until the wind direction changed or they were towed.[186] A towpath was cut through the tea-tree scrub along

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[177] C. Forell, "Melbourne's Port Was Tailored to Measure," *Age*, October 16, 1954, 38.
[178] Kelly, 32.
[179] Milner, 3.
[180] William Westgarth, *Personal Recollections of Early Melbourne and Victoria* (Melbourne: George Robertson and Co., 1888), 10.
[181] Milner, 3.
[182] Moloney, 3.
[183] Ibid, 3-4.
[184] Ibid, 3.
[185] Cannon, *Old Melbourne Town before the Gold Rush*, 378.
[186] "Humbugged," in *Penguin Student Dictionary* ed. R Allen (London: Penguin Books, 2006), 430; *Old Melbourne Town before the Gold Rush*, 378.

the eastern bank to allow access for horses towing ships.[187] Another problem occurred when flows in the river were low, resulting in only 1.5 metres (five feet) of water across the bar at the Yarra's mouth, necessitating a wait for adequate water depth. When delays became too long, cargo was transferred into smaller lighters and towed upstream into Melbourne to the port just below the falls.[188]

The city's first port was found directly below the falls on the Yarra River, opposite the present location of central Melbourne. Scouring of the northern bank by the water's velocity flowing off the falls had created a pool. The basalt-rock barrier of the falls prevented shipping traveling further upstream and the pool provided a large enough space for ships to moor and turn around, within proximity to central Melbourne.[189] A few piles driven into the pool for mooring vessels were the beginning of the first port, named Queens Wharf, with the first Customs House built during the late 1830s on its northern bank.[190] The flood of 1839, (page 99) severely damaged the early port infrastructure, with further floods subsequent decades discouraging construction of permanent port infrastructure.[191] Therefore, the establishment of port facilities remained limited and the river navigable only for small vessels.[192] The discovery of gold in North Central Victoria in 1851 resulted in state's population increasing more than threefold in three years from 77,000 to 237,000.[193] The influx of tens of thousands of people to the gold fields via Melbourne saw the city's limited port facilities stretched. By 1852, in excess of 3000 vessels had arrived in Hobsons Bay, with the tonnage or amount of cargo handled by the port now a third of large ports such as Liverpool.[194] On a particularly busy day in October 1853, there were 340 ships using Hobsons Bay and the Yarra.[195] However, despite this, lighters were still required to transport cargo over the 14.5 kilometres (nine miles) to Queens Wharf.[196] Shipping increases added to the argument for the deepening and widening of the Yarra, however dredging during the late 1840s resulted in limited effect on water depths.[197] Between 1856 and 1868, dredging works

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[187] Noble, 55.
[188] Cannon, *Old Melbourne Town before the Gold Rush*, 377; Noble, 55.
[189] Lewis, 23.
[190] Milner, 3.
[191] Ibid.
[192] Ibid, 5.
[193] Cannon, *Melbourne after the Gold Rush*, I.
[194] Dunstan and Melbourne Council, 154.
[195] Cannon, *Melbourne after the Gold Rush*, 29.
[196] Dunstan and Melbourne Council, 154; Cannon, *Old Melbourne Town before the Gold Rush*, 380.
[197] "Great Harbour Projected. How the Port Has Grown. Sir John Coode's Great Part," *Argus*, September 9, 1926, 32.

in the Yarra from its confluence with the Maribyrnong to Queens Wharf saw 767979.3 cubic metres (1,004,479 cubic yards) of silt removed.[198] This material was dumped along the Yarra's southern bank restricting the river to its channel and preventing floodwaters flowing into the southern wetlands.[199] The *Leader* described the material dredged from the Yarra as hard red and blue clays, dead trees, logs, branches and roots.[200] Dredging only deepened the river by one metre (three feet), and it remained unable to accept larger vessels.[201]

The city's port facilities stayed disorganised despite repeated requests from businesses, the City Council, and Chamber of Commerce for a Harbour Trust.[202] A bill was passed in 1876, and the Trust appointed in 1877.[203] Its first function was to examine the engineering data and proposals regarding the improvement of the Yarra and ports.[204] Much of the data was contradictory and no proposal sufficiently comprehensive. The Trust engaged notable civil engineer Sir John Coode.[205] Amongst his best-known work were harbours of Colombo in Ceylon (Sri Lanka) and Table Bay in Cape Town, South Africa. Arriving in February 1878, Coode observed several floods on the Yarra. The largest was in March when the river rose to within one metre (three feet) of the largest flood recorded during the period, the 1863 flood (page 102).[206] Coode's report was released to the Harbour Trust in April 1879 recommending major modifications.[207] His proposals, detailed by his plan of 1879, shown in figure 23, included construction of docks close to Melbourne's business centre and the railway terminus and the creation of a shipping channel accommodating large vessels while allowing for flood flow discharge.[208] The direct modifications to the Yarra included; widening and deepening of the river by dredging; straightening of the river by cutting a canal of 2000 metres (6562 feet) in length by 130 metres (427 feet) wide, by a depth at low water of six metres (20 feet). The canal would bypass Humbug Reach and reduce the distance from

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[198] "The River Yarra," *Argus*, February 2, 1889, 6.
[199] Ibid.
[200] "Imporvement of the Yarra," *Leader*, July 4, 1863, 11.
[201] "Great Harbour Projected. How the Port Has Grown. Sir John Coode's Great Part," 32.
[202] Milner, 5; Cannon, *Melbourne after the Gold Rush*, 38-39,42.
[203] "Great Harbour Projected. How the Port Has Grown. Sir John Coode's Great Part," 32.
[204] Ibid.
[205] Milner, 5; D. R. Crawford, "Coode, Sir John (1816-1892),"*Australian Dictionary of Biography*, National Centre of Biography, Australian National University, accessed August 16, 2016, http://adb.anu.edu.au/biography/coode-sir-john-3250/text4915; "Great Harbour Projected. How the Port Has Grown. Sir John Coode's Great Part," 32.
[206] "The Flood in Melbourne," *Geelong Advertiser*, March 19, 1878, 3.
[207] Milner, 6; John Coode, Sir, -, *Report by Sir John Coode, C.E., on Works of Improvement to the Port of Melbourne (1879 and 1886)* (Melbourne: J. Kemp, Government Printer, 1910), 13.
[208] Charles Daley, *The History of South Melbourne: From the Foundation of Settlement at Port Phillip to the Year 1938* (Melbourne: Robertson & Mullens, 1940), 301.

Queens Wharf to the bay from 12.4 kilometres (7¾ miles) to 10.8 kilometres (6¾ miles).[209] Further works to alleviate flooding included dredging the river from the new channel to just above Princes Bridge to 3.8 metres
(12 feet) depth to a width of between 24 to 32 metres (79-104 feet).[210] In addition, the removal of all rock barriers including the falls was recommended to just above Princess Bridge, a further 600 metres (2000 feet) upstream from the falls.[211]

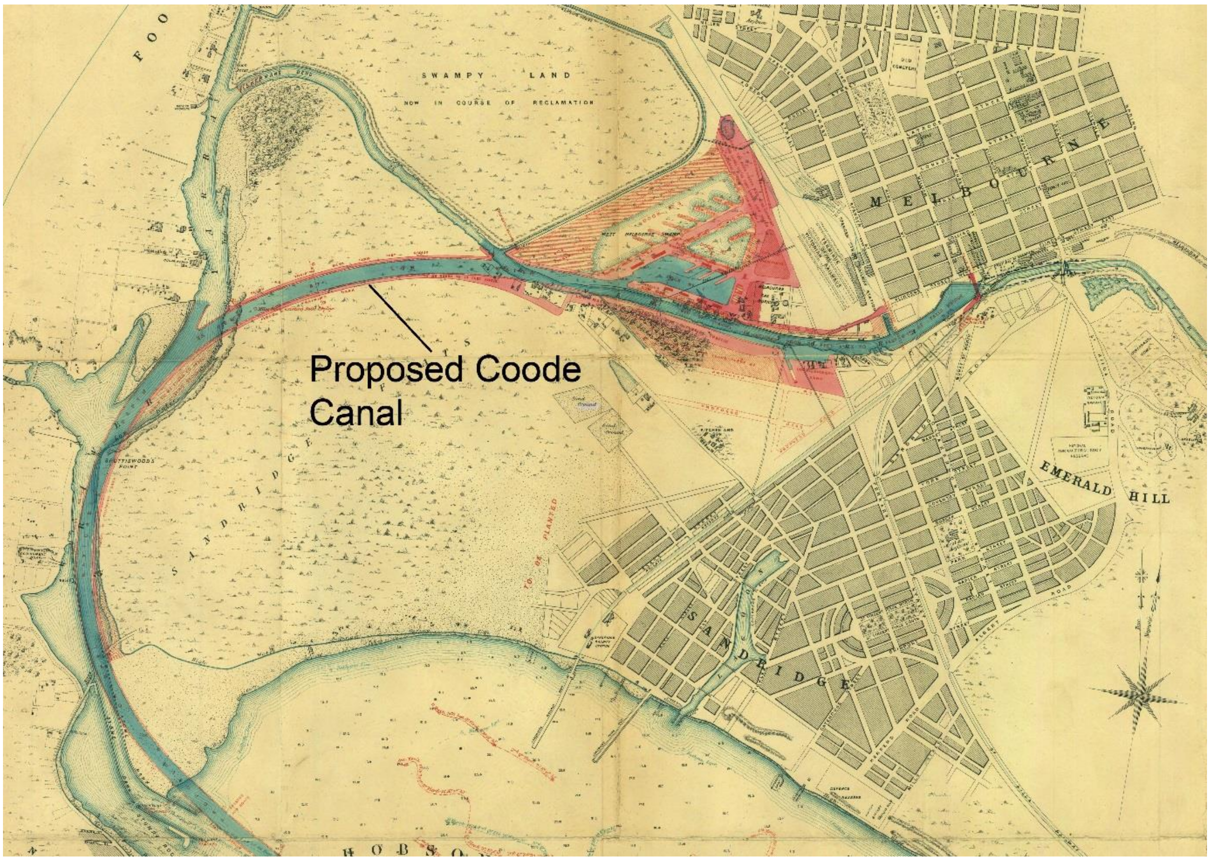

Figure 23.Coode's plan, 1879. Source: SLV http://handle.slv.vic.gov.au/10381/157608

[209] Milner, 6; Coode, 9-13.
[210] Milner, 6.
[211] Ibid, 7; Coode, 13-14.

The canal opened in 1886.[212] By 1900 the effect of the first 75 years of use for shipping, port facilities and flood management resulted in the Lower Yarra flowing along an entirely engineered channel.[213]

First industries – shipping, quarrying, and noxious industries: rivers of blood and other nasties

> Large "boiling-down" establishments were placed near the banks, adding their liberal quota of animal refuse to the witch-broth as it sluggishly crept by; and-saddest and worst of all-in yards erected in the swamp, and from one to three feet deep in miry slush, were crowds of beautiful cattle, shut up in filth, stench, and starvation, awaiting (as they often do for several days) the mercy of death.'[214]

This Lower Yarra scene described by Australian author and illustrator, Louisa Meredith, in 1861 had become a common view along sections of several watercourses in Melbourne. The once-celebrated qualities of rivers and creeks including the clear, sparkling water and the colourful and unique vegetation, described and praised by Gardiner and journalist Fin, had been transformed into what Lack (1985) describes as 'Rivers of blood and excrement…'.[215]

The urban environmental history of abuse of Melbourne's watercourses by industry features sporadically within literature focused on the city's manufacturing history and heritage. Although rivers and creeks are mentioned, they often feature as background or an underlying aspect to the history of specific industry or period. For example, Parsons' (1982) examination of manufacturing industries along the Lower Yarra during the period 1870-90. This section examines the development of industries along several watercourses. Processing and manufacturing industries developed simultaneously with the growth of the city. In Melbourne, the two main rivers and several creeks were developed into industrial

[212] Milner, 6.
[213] James Boyce, *1835: The Founding of Melbourne & the Conquest of Australia* (Collingwood, Vic.: Black Inc., 2011), 3; Presland, *The Place for a Village: How Nature Has Shaped the City of Melbourne*, 84-85.
[214] Louisa Anne Meredith, *Over the Straits: A Visit to Victoria* (London: Chapman and Hall, 1861), 188.
[215] John. Lack, "'Worst Smellbourne': Melbourne's Noxious Trades," in *The Outcasts of Melbourne: Essays in Social History*, ed. Graeme Davison, David Dunstan, and Chris McConville (Sydney: Allen & Unwin, 1985), 192.

watercourses.[216] Globally, industry's use of urban watercourses isolated sections of waterways, floodplains, and wetland areas from the urban fabric.[217] In Melbourne's case, large sections of the Lower Yarra, and Maribyrnong Rivers, along with sections of the Stony, Moonee Ponds and Merri Creeks, were cut off from the urban fabric, and consequently the public, by industrial land use. The separation was due to construction of a range of industrial complexes that included: factory complexes; port infrastructure; industrial facilities; and quarrying operations.[218] When *Age* journalist John Larkin observed in 1980 that public access along the Lower Yarra was 'in great disorder', he was recording the last days of a century-long condition.[219] Part of the problem was the initial use and later zoning of riverbank and floodplain land for industrial and commercial uses. Successive state and local government authorities, and those responsible for planning, sought to isolate noxious and polluting land-uses from residential areas.[220] The initial preference in Melbourne for industrial use of marshy or flood-prone land was due to its low purchase price and direct water access suitable for production processes, shipping, and waste disposal.[221] As the suburbs expanded, industries, particularly noxious ones, were encouraged to develop and relocate to such land. The government rented low-lying Crown land to industries to concentrate industrial development and remove noxious uses from the city.[222] Although isolated from the city they were nonetheless within its proximity.[223] The rivers and wetlands became putrid dumping grounds.[224] The use of watercourses in this way created the impression described by Senior (1992), that watercourses were '…unhealthy, unpleasant, and consequently unwanted.'[225] It was these very perceptions that the *Age's* (1980) *Give the Yarra A Go* campaign sought to challenge (see chapter eight, page 314).[226]

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[216] Ibid, 187.
[217] Stéphane Castonguay and Matthew D. Evenden, "Introduction," in *Urban Rivers: Remaking Rivers, Cities, and Space in Europe and North America*, ed. Stéphane Castonguay and Matthew D. Evenden (Pittsburgh, Pa.: University of Pittsburgh Press, 2012), 2-3.
[218] Lack, 187.
[219] John. Larkin, "Clear a Path by the River," *Age,* February 29, 1980.
[220] J. Byrne and D. MacCallum, "Bordering on Neglect: 'Environmental Justice' in Australian Planning," *Australian Planner* 50, no. 2 (2013): 164.
[221] A. E. Dingle, "Manufacturing " in *The Encyclopedia of Melbourne,* ed. A. May and S. Swain (Port Melbourne: Cambridge University Press, 2008), 437-41.
[222] Ibid.; "Removal of Noxious Trades,"*Age,* October 13, 1881, 1.
[223] G. Vines and B. Lane, *Industrial Land and Wetland: The Relationship between the Natural Environment and Industrialisation in Melbourne's Western Region* (Melbourne: Gary Vines, 2013), 18.
[224] "Noxious Trades Commission,"*Argus,* December 27, 1870, 3.
[225] Senior, 414.
[226] John Larkin and Peter Ellingsen, *Give the Yarra a Go!* (Melbourne: David Syme & Co, 1980), 3.

The first industries set up along the Lower Yarra were maritime and port facilities.[227] By 1840, maritime industries servicing shipping and the ports were established along the Yarra. The iron steamer *Fairy Queen* was imported from Britain and launched on the 3rd April 1841 travelling between Melbourne and Williamstown, found on the western shore of Hobsons Bay.[228] As the ports were developed, industries servicing shipping quickly followed. The most common scattered along the Yarra's southern bank included; boat building; sail making; engineering; and boiler making.[229]

During the 1840s as export, industries were being set up and goods produced, the ships bringing in supplies required ballast for the return journey. Consequently, one of the first industries beyond maritime concerns to develop was ballast quarries along Stony Creek, the southernmost tributary on the Yarra's western bank. From 1841, basalt was quarried from rock outcrops along the creek bank and transported downstream by barges to vessels anchored in Hobsons Bay.[230] Stone quarried from the creek was later used for construction of the first piers and various buildings around Melbourne.[231] The quarries resulted in extensive reshaping of the stream banks, bed and surrounds, and destruction of riparian vegetation including mangroves. The subsequent large excavations were later utilised as landfill sites, causing leaching of pollution into the Stony and Yarra, while also contaminating ground water.[232] Quarries in proximity to watercourses destroy local terrestrial and water ecological diversity, increasing suspended solids and turbidity of streams.[233] This increases water temperature, sedimentation, and siltation of streambeds and banks and decreases aquatic species' oxygen.[234] As the city developed, the need for stone for construction of buildings and roads increased leading to further basalt quarries along Merri Creek, a Yarra tributary flowing more than 80 kilometres from the north across basalt plains.[235] The creek valley's depth and width has been determined by the underlying basalt and older sedimentary deposits: it varies

[227] Gary. Vines and Andrew Ward, *Industrial Heartland: Introduction to the Western Region Industrial Heritage Study* (Highpoint City, Vic.: Melbourne's Living Museum of the West, 1990), 5.
[228] Boys, 109.
[229] T. G. Parsons, "Manufacturing on the Banks of the Yarra River, Melbourne: The Development of an Industrial Area 1870–1890," *Journal of Australian Studies* 6, no. 11 (1982): 21.
[230] Vines and Ward, 5.
[231] Ibid.
[232] Heritage Council Victoria, *Stony Creek Ballast Quarries* (Heritage Council Victoria, 2017), accessed October 31,2017, http://vhd.heritagecouncil.vic.gov.au/places/13781/download-report., 1.
[233] Doron Lavee and Sefi Bahar, "Estimation of External Effects from the Quarrying Sector Using the Hedonic Pricing Method," *Land Use Policy* 69 (2017): 541; Marko Miliša, Vesna Živković, and Ivan Habdija, "Destructive Effect of Quarry Effluent on Life in a Mountain Stream," *Biologia* 65, no. 3 (2010): 520.
[234] Lavee and Bahar, 520.
[235] Presland, *The Place for a Village: How Nature Has Shaped the City of Melbourne*, 78.

from wide floodplains with sloping sides to narrow, deep valleys with straight sides.[236] The narrow sections provided an easily accessible source of basalt, which could be quarried from the creek bank. Several basalt quarries were opened along the lower reach of the Merri Creek and local government opened a bluestone quarry to supply stone for buildings and roads.[237] The quarry cut into the creek's escarpment remains evident, although much of the site has been filled to form the northern end of Yarra Bend Park (see chapter eight, page 332).[238] During the late 1850s and early 1860s, Pentridge Prison at Coburg was constructed using basalt sourced from a nearby Merri quarry: in 1912, a concrete weir across the eastern end of the quarry excavation formed Coburg Lake and pleasure grounds were created.[239] In 1874, another quarry was opened on the Merri's western bank, by the Melbourne Corporation.[240] It was established to provide the council with crushed basalt screenings (gravel) suitable for construction of tarred footpaths.[241] Once the quarry ceased operation, the pit was used for the Collingwood refuse tip and is now within Quarries Park, on Clifton Hill's eastern edge.[242]

Although quarries were amongst the first industries to affect Stony and Merri Creeks, and the Yarra, development of animal processing industries created far more significant stream degradation. These developed during the early 1840s in response to an economic depression gripping Melbourne due to slow population growth. While sheep pastoralists had been highly successful, there was no means of processing the meat to last for the three-month journey to Britain and no local market for trading livestock.[243] Sheep became more valued for tallow than for wool and meat. Tallow extraction became the first manufacturing industry in Melbourne and boiling-down works were established along riverbanks. In 1844 four boiling-down plants existed on the Maribyrnong River adjacent to West Melbourne Lagoon (see chapter six, page 208).[244] The Maribyrnong River is often referred to as Melbourne's second river after the Yarra.[245] However, despite this title, and as Kenny (2006) notes, a

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[236] Ibid.
[237] Heritage Council Victoria, *Fitzroy City Council Quarry, Later Part Westfield Reserve, Later Bluestone Quarry, Yarra Bend Park* (Melbourne: Heritage Council Victoria, 2017), accessed March 11, 2017, http://vhd.heritagecouncil.vic.gov.au/places/103864/download-report., 2.
[238] Ibid.
[239] Merri Creek Management Committee, *Merri Creek and Environs Strategy, 2009-2014* (Brunswick East, Vic.: Merri Creek Management Committee, 2009), 35-36; "The Coburg Lake Scheme," *Age,* 1912, 7.
[240] "The Corporation Quarries and Crushing Plant," *Age,* November 4, 1876, 6.
[241] Ibid.
[242] Merri Creek Management Committee, 35-36.
[243] Vines and Ward, 7.
[244] Ibid.
[245] Melbourne Water, *Know Your River: Maribyrnong River* (East Melbourne: Melbourne Water, 2009),8-9 .

comprehensive history of the Maribyrnong is yet to be written.[246] At the time of writing, a detailed historical examination of the river remains absent from the literature. The river, previously known as the Saltwater, was renamed in 1923 due to ongoing negative connotations regarding the noxious industries lining the banks and the quality of its water.[247] The river was discovered by Europeans in 1803, during the Grimes survey, (page 62) at the same time of the Yarra.[248] The group's discovery of a rock - fish trap built by indigenous inhabitants on the river, is one of the very few recorded artefacts found along a watercourse predating European settlement of the Melbourne region.[249] The river is formed by the confluence of Deep and Jacksons Creeks, west of the north-west suburb of Tullamarine, adjacent to Melbourne's International Airport.[250] The headwaters of the creeks rise in the western foothills of the Great Dividing Range and flow 41 kilometres (25.5 miles) before joining the Yarra, on the western end of the Yarra or Coode Canal (page 82).[251] The Maribyrnong flows through a deep valley cut down through the basalt flows of Melbourne's western plains, its upper and middle reaches along a winding course consisting of large loops and bends.[252] The lower reach, similar to the Yarra, is part of a large estuary spreading over a wide area across the Maribyrnong's eastern floodplain.[253] Besides being heavily industrialised, the Maribyrnong was also the first watercourse in Melbourne to have a community-based management organisation, advocating for the river's care and improvement. In 1906, the Lord Mayor of the City of Essendon, Councillor John Downing, formed the Essendon River League.[254] Membership included the council, private citizens, business and associated interested community groups.[255] An historical forerunner to contemporary management committees and friends of groups, that advocate and care for many watercourses across Melbourne, the league completed a range of improvement projects involving landscaping, tree planting, erosion control, snagging and construction of a riverside

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[246] L. Frost, "Afterword," in *The Essendon River League 1906-1966*, ed. Society Essendon Historical (Moonee Ponds, Vic.: Essendon Historical Society, 2006), 10.
[247] Ibid,28.
[248] Shillinglaw and Sayers, 27-29.
[249] Ibid, 27; Jones, 5.
[250] Presland, *The Place for a Village: How Nature Has Shaped the City of Melbourne*, 94-95.
[251] Ibid.
[252] Ibid, 37.
[253] Ibid, 96.
[254] Judy Maddigan and Essendon Historical Society, *The Essendon River League and the Maribyrnong River* (Essendon, Vic.: Essendon Historical Society, 1995), 1.
[255] Russ. Keilar, "Essendon River League: Story of Its Origin and Progress," *The Essendon gazette and Flemington spectator, Keilor, Bulla and Broadmeadows reporter*, February 4, 1934, 1.

boulevard.[256] The league ceased operation in 1965 following 59 years of advocating and caring for the river.[257]

Development of the tallow industry heralded the beginning of Melbourne's infamous noxious industries along stream banks and floodplains. The next came in 1849 when Melbourne's first centralised public abattoir was constructed below the city.[258] The decision to create public abattoirs and locate them on crown land, commonly along watercourses, was proposed in 1838 by Superintendent William Lonsdale.[259] Lonsdale argued that as the town population increased, butchers could not find suitable slaughtering sites in proximity to markets and shops. His solution was to establish a common slaughtering ground on crown land, by the Yarra, and to prohibit unlicensed slaughtering within town boundaries.[260] The first, Melbourne City Council Abattoir, was located on Lonsdale's former common killing ground on the Yarra.[261] The council and government argued due to the warm local climate, markets and shops required quick and regular supplies of fresh meat.[262] The abattoir was, however, rarely inspected and operated chaotically. The buildings, poorly ventilated and overfilled with all waste, discharged directly into the Yarra.[263] Responding to criticisms regarding the abattoir's conditions and practices, council relocated it beyond Melbourne's city limit to the western suburb of Flemington on the Maribyrnong.[264] By 1861, municipal abattoirs had been constructed along the Lower Yarra stretching from Collingwood to Williamstown.[265] During the 1870s it was estimated over 600,000 head of livestock was being slaughtered yearly, much of the liquid and solid waste discharged into watercourses or directly into Port Phillip Bay.[266] Included in the waste was yearly production of over 3000 tons of blood, over half discharged into the Maribyrnong River alone.[267] The *Argus* published a description of the effluent flowing from the Merri into the Yarra in 1880:

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[256] Ibid,1-4.
[257] Maddigan and Essendon Historical Society, 8; Frost, 50.
[258] John. Lack, "Abattoirs," in *The Encyclopedia of Melbourne*, ed. A. May and S. Swain (Port Melbourne: Cambridge University Press, 2005), 1.
[259] Marc Trabsky, "Institutionalising the Public Abattoir in Nineteenth Century Colonial Society," *Australian Feminist Law Journal* 40, no. 2 (2014): 180.
[260] Ibid.
[261] Lack, "Abattoirs."
[262] Ibid.
[263] Trabsky, 181.
[264] Ibid.
[265] Lack, "Abattoirs."
[266] Lack, 175.
[267] Ibid, 176.

> …the water is covered (in some places to a depth of several inches) a black, greasy, putrid substance…It is a foul, fatty, fetid matter, and it is so thick in some places it has impeded the flow of the stream and a portion of the creek… converted into a stagnate pool…The stench is so horrible that a person who visited the spot yesterday was immediately besieged with retching pains and had to retire.[268]

The discharge of effluent from abattoirs significantly changes water quality, chemistry, and oxygen levels.[269] It also introduces pathogen microorganisms from animal waste, transferable to humans through contact with the water.[270] Abattoir waste composed of solids, liquids, and fats effects on fish and aquatic life habitat and leads to its decline or destruction.[271]

The establishment of the first abattoir and its use of the Yarra set the precedent for other noxious industries to follow. From the 1850s industries involved with the processing of animal by-products developed.[272] Located along the Lower Yarra stretching from Collingwood in the north to Stony Creek in the south-west, along the Lower Maribyrnong, and the Moonee Ponds and Merri Creeks, industries included abattoirs; fellmongers; tanneries; bone mills; soap and candle making works; meat preserving plants; and gas works.[273] The West Melbourne gasworks was sited downstream from the city council's abattoirs, supply commencing in January 1856, manufacturing gas from coal imported from Britain, unloaded on a dock on the Yarra's northern bank. [274] The manufacture of gas was a particularly polluting process (see chapter six, page 266-7), discharging waste into the Yarra. In 1864, the pollution formed a plume floating long distances downstream; anglers expressed concern at effects on fish stocks.[275] Over seventy years after the gasworks' establishment, Melbourne's *Age* (1932) described the water as thick black tar and reddish-brown liquid, the tar thickly coating dock piers below water-level.[276]

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[268] "Pollution of the Yarra,"*Argus,* January 5, 1880 6.
[269] M. O. Benka-Coker and O. O. Ojior, "Effect of Slaughterhouse Wastes on the Water Quality of Ikpoba River, Nigeria," *Bioresource Technology* 52, no. 1 (1995): 5.
[270] Ibid.
[271] JY Magaji and CD Chup, "The Effects of Abattoir Waste on Water Quality in Gwagwalada-Abuja, Nigeria," *Ethiopian Journal of Environmental Studies and Management* 5, no. 4 (2012): 542.
[272] Vines and Ward, 12.
[273] Ibid, 7-12; Bernard Barrett, *The Inner Suburbs: The Evolution of an Industrial Area* (Carlton, Vic.: Melbourne University Press, 1971), 88-105; Lack, 172-80.
[274] Ray Proudley and Gas and Fuel Corporation of Victoria, *Circle of Influence: A History of the Gas Industry in Victoria* (Melbourne: Hargreen in conjunction with the Gas and Fuel Corporation of Victoria, 1987), 28,35.
[275] "Angling: Perch Fishing in the Yarra," *Victoria and Sporting Chronicle,* October 8, 1864, 3.
[276] "River Pollution. Outfall from Gas Works,"*Age,* November 19, 1932, 21.

In December 1870, the *Argus* reported on a tour undertaken by the Noxious Trades Commission inspecting industries found adjacent to watercourses. The commission visited and examined the following: 18 abattoirs and slaughter yards; 15 boiling down works; six bone mills; six breweries; three glue works; three meat preserving plants; three piggeries; 16 soap and candle works; 11 tanneries; 20 wool scouring and fellmongering companies; and 15 miscellaneous plants including a gas works, and earth-closet manure depot.[277] Figure 24 is an 1875 photograph of The Melbourne Meat Processing Works, typical of the types of noxious industries located along Maribyrnong that were discharging waste into the river. The commission's progress report stated most industries visited allowed large amounts of noxious waste to enter watercourses due to the common practice of storing piles of waste along stream banks. Additionally, many industries had constructed drains or ditches discharging directly into watercourses.[278] Although the commission recommended a raft of regulations and changes to waste management, by the late 1880s noxious industries were more foul and offensive than ever.[279] For example, the Coal Canal, constructed in 1877 at the lower section of the Moonee Ponds Creek (see chapter six, page 266-7) was enlarged to receive all drainage from Newmarket livestock saleyards.[280] These saleyards, covering 24 acres (10 hectares), were built in 1858 along the northern boundary of Melbourne City Council Abattoir, on the Maribyrnong River.[281] A major problem with lower Moonee Ponds Creek was the almost flat elevation of a constructed channel flowing into the Yarra. The pollution and waste flowing downstream met with tidal flows rising from the Yarra resulting in the pollution drifting back and forwards on the tide, along the creek. The *Age* (1887) reported that due to the tide prohibiting creek flows entering the Yarra, pollution and debris was trapped along a section of creek, silting the bed and creating a large putrid lake risking residents' health.[282]

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[277] "Noxious Trades Commission," *Argus,* December 27, 1870 3.
[278] Ibid.
[279] Lack, 188-89.
[280] Ibid, 189; Leigh and Melbourne Metropolitan Board of Works, 25.
[281] Heritage Council Victoria, *Former New Market Saleyards and Abattoirs* (Melbourne: Heritage Council Victoria, 2000), accessed October 31, 2017, http://vhd.heritagecouncil.vic.gov.au/places/3105/download-report. 3.
[282] "The Moonee Ponds Creek," *Age,* December 30, 1887, 6.

Figure 24. The Melbourne Meat Processing Works, typical of industries along the Maribyrnong River, 1875. Source: SLV H96.160/1719

Melbourne’s manufacturing industries were largely unregulated before 1900, governments interested only in stimulating manufacturing by offering a range of incentives and cheap leases for Crown land, commonly along larger watercourses.[283] As discussed on page 85, the only regulation was to isolate polluting industries to city outskirts.[284] Despite complaints, government enquiries and commissions, authorities remained reluctant to interfere with industries that continued to destroy waterways’ ecologies.[285] By the late 1880s, such pollution earned Melbourne the derisory title *‘Marvellous Smellbourne’*.[286] As examined above, unregulated industrial development had wide-ranging effects. However, a more unusual effect was highlighted by the *Argus* (1887) in an article describing a trip up the Yarra during the late 1850s and the novel way the pilot navigated the torturous lower reach:

[283] Lack, 199.
[284] Ibid.
[285] Ibid.
[286] “The Abattoirs,” 8.

> I thought you were feeling your way up the river; I find you are smelling your way.' 'Well,… to be plain with you, I am just doing the very thing you say. A nose is more use to a man in this river after nightfall than his eyes. When the wind is in the sou east coming round Humbug Reach, and he gets a sniff from the tallow works he knows whereabouts he is; and when the wind is from the nor'rard or west'ard he has the piggery on the other bank to verify his latitude.[287]

Evidently, the first sights, sounds, and smells of Melbourne were of the noxious industries lining the Yarra's banks.[288] While the experience on the water, according to Meredith (1861), was similar to: 'a sail down a sewer: or, perhaps…a very dirty ditch, redolent of every conceivable abomination…dead, bloated carcases of dogs, cats, pigs, and the Yarra only knows what else ! were floating abundantly in the "gruel, thick and slab"'. [289]

Rivers and Creeks as Boundaries within Melbourne's Urban Fabric

Melbourne's waterways have a history of use as boundaries between communities. Before the establishment of Melbourne, the indigenous clans of the Port Phillip region utilised the waterways as estate limits; for example, that of the *Yalukit william* clan was the area along the southern bank of the Yarra River between Gardiners Creek in the east to the confluence of the Yarra and Maribyrnong rivers in the west.[290] The survey of Melbourne's street grid relied on creation of a datum point and running out section lines to create a right-angled or orthogonal grid.[291] As discussed on page 83, the grid took little account of land or waterscapes. Once Melbourne's central street grid was established, the subdivision of land beyond the grid saw surveyors starting from a datum on Batmans Hill to divide the land adjoining Moonee Ponds Creek.[292] It was divided into mile-square sections (2.6 square kilometres) within an area of 640 acres (259 hectares), all sales based on these sections.[293] This process was sanctioned by London's Colonial Office to ensure methodical surveying and sale. The lack of permanent, substantial sources of fresh-water played a significant role in

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[287] A.S., "The Yarra Yarra of Old," *Argus*, May 28, 1887, 13.
[288] Lack, 199.
[289] Meredith, 186,88.
[290] Presland, *The Place for a Village: How Nature Has Shaped the City of Melbourne*, 204.
[291] Lay, 12-13.
[292] Ibid, 13.
[293] Ibid.

subdivision. In water-poor landscapes the regulation referred to as Order 41, introduced by Governor Darling in 1829 was strictly enforced.[294] The order stipulated no one property could include both sides of a watercourse.[295] Where this was unavoidable, the watercourse became a section boundary. Therefore, the location of roads was often determined by the requirement of maximising the number of blocks with water access. Roads became secondary to ensuring water access and were usually located on section lines, the exception being where a watercourse formed a section.[296] The 1839 map (figure 25) shows the extent of 25 acres (259 hectare) sections marked out for sale in Sydney, 12th September 1838. The map also illustrates the sectional survey method using watercourses as boundaries while ensuring the greatest number of blocks accessing water.[297]

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[294] Ibid, 15.
[295] Ibid.
[296] Ibid, 13-15.
[297] Ibid, 33.

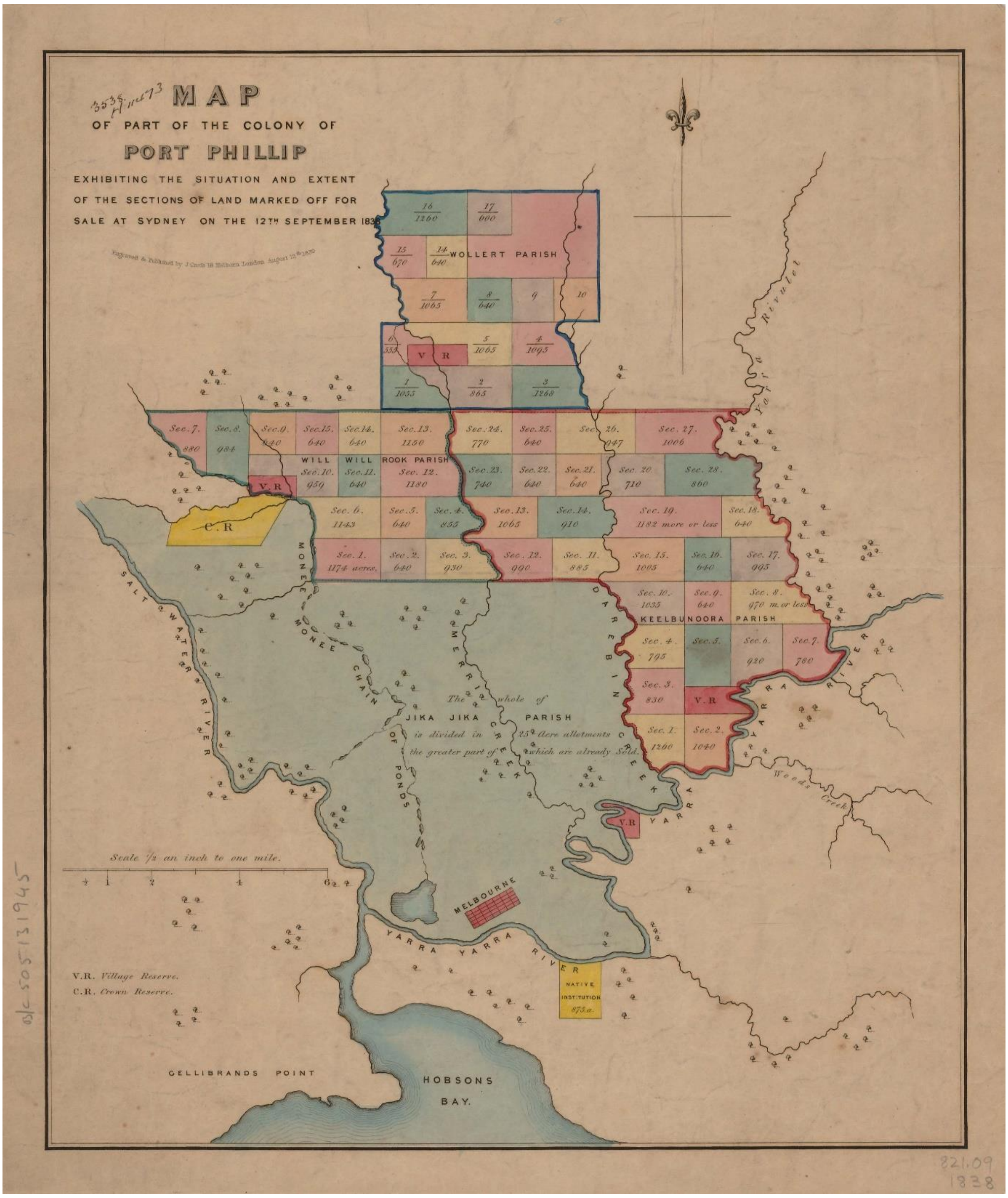

Figure 25. Land surveyed for September 1838 sale, with watercourses as boundaries. Source: SLV http://handle.slv.vic.gov.au/10381/114236

There is a lack of literature on the use of watercourses as boundaries in Melbourne, although Senior (1992) makes brief reference to this.[298] The history of the survey of sub-divisions and roads of Melbourne has been used in attempting to provide some insight into this little-considered aspect of Melbourne's rivers and creeks.

Australia's European settlement period (late 18th - early 19th centuries) coincided with the development of the modern suburb.[299] Aware of the urban conditions in London, early colonial governors embraced the suburban idea.[300] Suburban, as opposed to urban, areas provided free circulation of air, picturesque landscapes, and refuge from an artificial, noisy city environment.[301] While Melbourne's city area grew, the suburban ideal was significantly embraced expanding the city outwards to create the first inner suburbs.[302] As discussed on page 206, the earliest roads through Melbourne's suburbs were originally stock routes, evolved from the paths formed by indigenous communities, located along watercourse valleys.[303] Sub-divisions were commonly rectangular in layout, frequently using watercourses as boundaries.[304] For example, land lying between the Merri and Moonee Ponds Creeks was subdivided in blocks marked in long east-west strips, without road reserves, maximising blocks with water access.[305] Roads terminated at creeks and without organisation or money for road and bridge construction, the creeks became natural boundaries between the subdivisions.[306]

Gold rush wealth allowed for improvements to roads and the construction of railways, significantly accelerating suburban development.[307] Legislation passed in late 1854 allowed creation of separate municipal boroughs containing over 200 franchised householders.[308] The boroughs could levy local rates and apply for government subsidies for infrastructure provision.[309] As watercourses had created barriers between sub-divisions, clusters of populations able to form the new boroughs were often separated by boundaries of water. .

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[298] Senior, 414.
[299] Graeme Davison, "The Great Australian Sprawl," *Historic Environment* 13, no. 1 (1997): 12; ibid.
[300] Ibid, 10,12.
[301] Ibid, 12.
[302] Cannon, *Old Melbourne Town before the Gold Rush,* 380.
[303] R. J. Johnston, "An Outline of the Development of Melbourne's Street Pattern," *Australian Geographer* 10, no. 6 (1968): 455; Mick Woiwod, 30; Presland and Victoria Archaeological Survey, 13.
[304] Johnston, 455.
[305] Lay, 33.
[306] Ibid, 33-37.
[307] Cannon, *Melbourne after the Gold Rush,* 250.
[308] Ibid, 251.
[309] Ibid.

Figure 23 illustrates Melbourne's suburbs in 1891, shown in assorted colour shades. The creeks and rivers are highlighted in blue showing suburban boundaries.

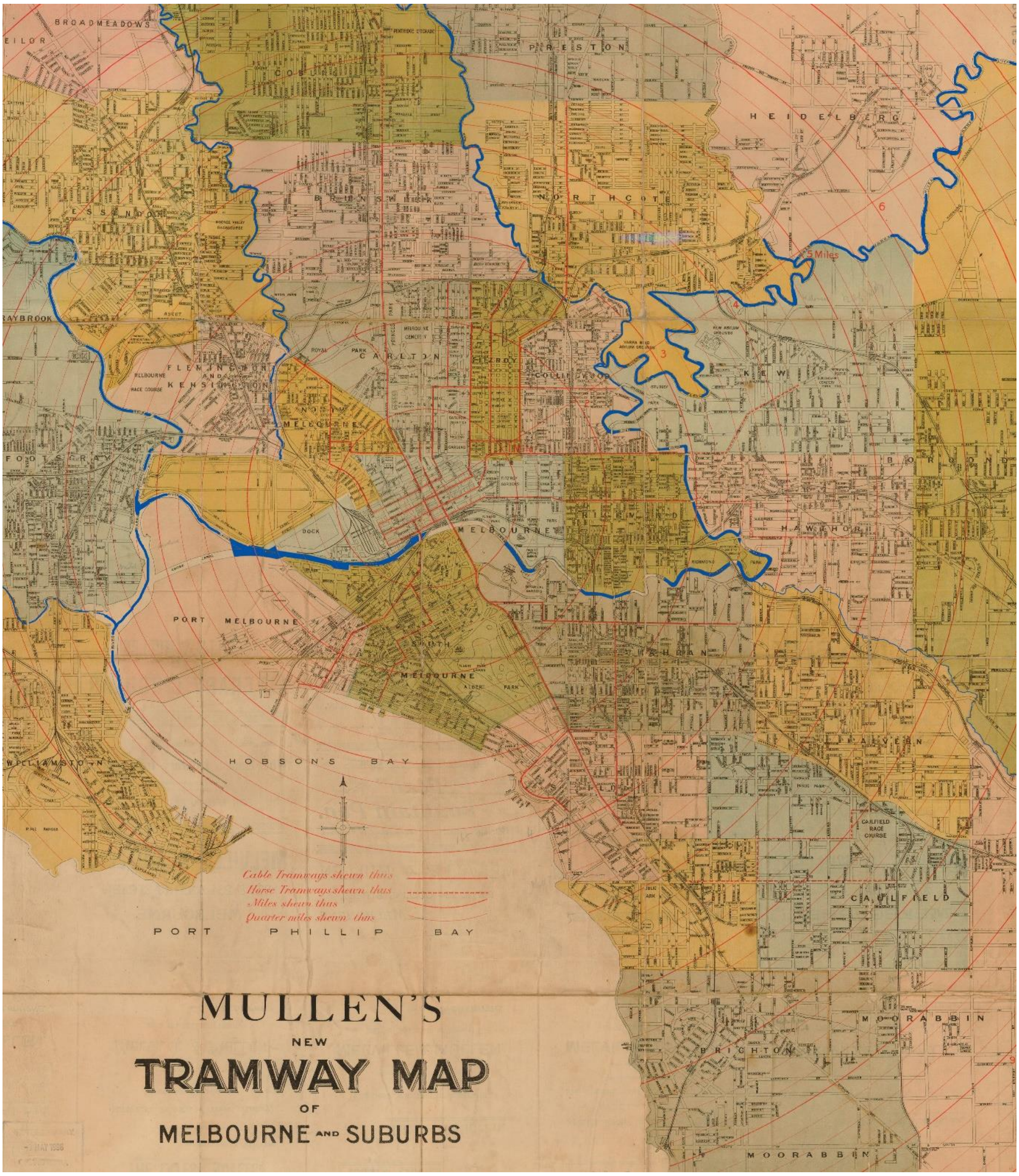

Figure 26. Municipalities with boundaries along watercourses, 1891. Source: SLV http://handle.slv.vic.gov.au/10381/119478

Many of Melbourne's local municipalities used watercourses as boundaries just as indigenous peoples of the region had done.[310] In some cases, local councils also used the watercourse as a suburb's defining feature. Richard Broome's history of Coburg reflects this in its title, *Coburg: Between two creeks*. Coburg is located between the Merri and Moonee Ponds Creeks although Broome barely addresses the importance of these watercourses.[311] As the suburbs' individual councils became established, problems developed due to what Senior (1992) describes as the common view that watercourses used as boundaries were outside council responsibilities.[312] Disputes were constant over watercourse management, bridge provision, pollution flows and flooding, and the issue of downstream councils addressing problems originating upstream. In April 1869, a conference was held between all inner councils with the Yarra as a boundary to discuss a proposal that the central government take control of the river from Hobsons Bay for 14 kilometres (8.6 miles) upstream to Dights Falls.[313] The proposal's basis was to keep the Yarra in a 'healthy condition,' however as none of the councils appointed representatives or shown any interest in the proposal, the conference committee held the proposal over.[314] During March 1887, a bridge on the Moonee Ponds Creek between Brunswick and Essendon was mooted, but disagreement on its precise location raged between councils.[315]

As suburbs developed, disagreements continued. In 1896, a Fitzroy councillor inspected pollution of Merri Creek bordering the suburb with Northcote and announced all pollution and other problems affecting the creek originated from upstream suburbs or the neighbouring council.[316] Disputes also raged over modifications to creeks. In 1929, Malvern Council argued that due to beautification works along Gardiners Creek forming the municipal boundary, its border with the City of Hawthorn had been changed. The council argued it had lost six acres (2.4 hectares) of land and rate revenue from the affected properties.[317] Such arguments persist to the present day: in 2009, three councils with the Yarra as a boundary were in fierce disagreement over construction of a shared path and bridge proposed to link the Yarra main trail with the Darebin Creek trail within the ecologically significant

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[310] Presland, *The Place for a Village: How Nature Has Shaped the City of Melbourne*, 61; Senior, 414.
[311] Broome.
[312] Senior, 414.
[313] "Conservancy of the River Yarra,"*Argus*, April 27, 1869, 6.
[314] Ibid.
[315] "The Proposed Moonee Ponds Bridge,"*Argus*, March 11, 1887, 10.
[316] "Bad State of the Merri Creek," *Argus*, January 15, 1896, 7.
[317] "Malvern Municipality-Adjustments of Boundary," *Prahran Telegraph*, May 24, 1929, 5.

Willsmere billabong reserve.[318] Utilising watercourses as municipal boundaries continues to influence Melbourne's watercourse management and create disputes.

Flooding

Civilisations have always lived with the threat of floods.[319] Flooding may occur locally, regionally, or result from upstream rainfall events as runoff flows downstream.[320] As discussed in chapter two, the impervious surfaces of urban areas decrease absorption leading to increased runoff exacerbating flooding.[321] Cioc (2002) asserts that the word 'flood' is anthropocentric, its basis in the tendency of humans to perceive rivers as having fixed lengths and a width observed during normal flows.[322] Lübken (2012) similarly argues modern societies perceive rivers as fixed-length canals, discarding times when the width spreads out across floodplains during floods. Consequently, floodplains are continually utilised for agricultural and urban development, as though separate from the watercourse's system.[323] A consequence of this view has resulted in global urban populations, living with a constant threat of flooding exacerbated by the unpredictability and irregular occurrence of urban floods.[324] The low-lying areas along the Yarra's southern bank were developed in the 19th century. Although all Melbourne's watercourses were flood-prone, records were made only of the 'important' floods. Consequently, Melbourne's flood records are not comprehensive. In 1881, the Melbourne *Argus* published an account of one of the area's earliest recorded floods. In late December 1839 at the flood's height, one could row through Melbourne's streets starting from the steps of the Customs House across the flat land of the south to Port Melbourne and within the central part of Melbourne, up Flinders Street to Elizabeth Street, then beyond Lonsdale Street.[325] The route of a trip across the flood waters by row boat is illustrated in figure 27.

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318 "Creek Trail Finally on the Right Path," *Heidelberg Leader*, August 19, 2009, 7.
319 Gregory S. Aldrete, *Floods of the Tiber in Ancient Rome*, Ancient Society and History (Baltimore: Johns Hopkins University Press, 2007), 3.
320 I. Douglas et al., "Characterisation of Urban Streams and Urban Flooding," in *Advances in Urban Flood Management*, ed. R. M. Ashley, Balkema-Proceedings and Monographs in Engineering, Water, and Earth Sciences (Leiden, The Netherlands: Taylor & Francis, 2007), 30-31.
321 White and Howe, 263.
322 Mark Cioc, *The Rhine an Eco-Biography, 1815-2000* (Seattle: University of Washington Press 2002), 33.
323 Uwe Lubken, "Rivers and Risk in the City: The Urban Floodplain as a Contested Space," in *Urban Rivers Remaking Rivers, Cities, and Space in Europe and North America* ed. Stéphane Castonguay and Matthew D. Evenden (Pittsburgh University of Pittsburgh Press, 2012), 131.
324 Ibid.
325 J Dawson, "The Great Flood of 1839," *Argus*, February 28, 1881, 6.

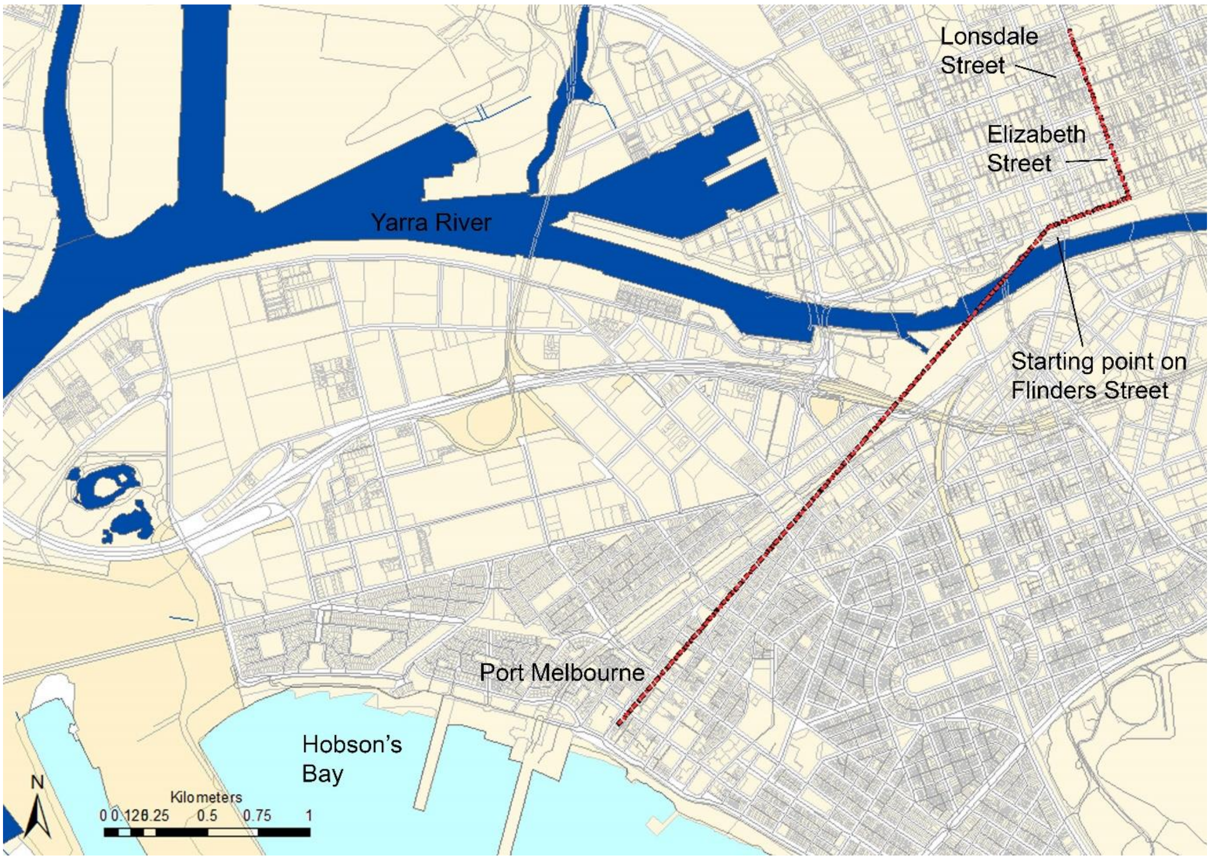

Figure 27. Route of the trip during the 1839 flood.

Evidence of the scope of floods along the Yarra was originally recorded by Charles Grimes in 1803 (page 82).[326] Grimes noted the river appeared to rise between 8 to 10 feet (2.4 – 3 metres) by 'wreck' observed on the trees.[327] On the map of the Port Phillip shoreline and lower reaches of the Maribyrnong and Yarra Rivers, Grimes recorded a notation of observed flood marks 20-30 feet (6 to 9.1 metres) about the riverbanks.[328]

The availability of a significant source of fresh-water dominated the choice of the location for Melbourne, with little thought regarding Grimes' observations of flooding, much less consideration of destructive power of such large floods.[329] Consequently, the city soon

[326] Shillinglaw and Sayers, 28-29.
[327] Ibid.
[328] Charles Grimes, T. Slater, and Victoria Department of Crown Lands Survey. *Port Phillip [cartographic material] / surveyed by C. Grimes, 1803; lithographed at the Department of Lands and Survey, by T. Slater, 14.2.79.* (Melbourne: Dept. of Lands and Survey, 1879).
[329] Shaw, 56; Presland, *The Place for a Village: How Nature Has Shaped the City of Melbourne*, 67.

experienced flooding resulting in destruction of infrastructure. The 1839 flood would be the first in a series during the city's first 75 years, as listed in table two.[330]

Table 2. Floods on the Yarra in the Greater Melbourne region from 1839 to 1910

Date	Peak flow – (cumecs) cubic metres per second
1839-December	510
1844-October	340
1849-November	793
1861-April	Unrecorded
1863-October	400
1863-December	1189
1864-July	425
1866-October	340
1878-March	538
1879-October	382
1880-September	680
1889-September	300
1891-July	935
1893-September	355
1897-January	380

Table 2. Floods on the Yarra River in Greater Melbourne region from 1839 to 1900. Source: Lacey 2004, page 255.

Aldrete (2007) stresses the attractiveness of flat floodplains for urban development and contends this attraction also makes them highly vulnerable to destruction caused by floods.[331] The development of Melbourne on the floodplains of the Yarra and Maribyrnong just upstream of the river's estuary, frequently flooded as flood flows collected in the Great

[330] Geoff Lacey, *Still Glides the Stream: The Natural History of the Yarra from Heidelberg to Yarra Bend* (Melbourne, Vic.: Australian Scholarly Publishing, 2004), 243.
[331] Aldrete, 1.

Dividing Range accumulated on the low floodplains, where it meet tidal flows rising from Hobsons Bay.

Flooding experienced in Melbourne's first decades was regional, such as the 1839 flood when rain fell for three days unceasingly.[332] Melbourne's largest recorded 19th century flood was also caused by a major weather system. During December 1863, following three days of continuous rainfall, totalling over 5 inches (127 millimetres) and combined with a south-easterly gale, the tide banked up the Yarra, slowing its flood flow from discharging into the bay.[333] At the height of the flood, the river peaked at 1189 cubic metres per second (0.5 cubic feet per second).[334] Melbourne's *Argus* reported the heights for the 1863 flood along the city and suburban section of the river as listed in table three.[335] The locations where the flood heights were recorded are illustrated in figure 28. Figure 29 is a photograph of the flood illustrating the spread of the Yarra's flood waters adjacent to the city centre.

Table 3. Recorded flood heights along the city and inner suburbs reach of the Yarra during the 1863 flood.

Location & map reference	**Water height (feet)**	**Water height (metres)**
Cremorne railway bridge-Richmond - **1**	22.83	7
Botanical Gardens bridge - **2**	19.43	5.9
Princess bridge - **3**	15.17	4.6
The Falls-upstream side - **4**	13.10	4.0
The Falls-downstream side - **5**	11.25	3.4
Gasworks- riverside behind Spencer Street railway station – now Southern Cross railway station - **6**	10.17	3.1
Emerald Hill Abattoirs - **7**	8.70	2.7
Mouth-Yarra River - **8**	6.12	1.9

332 Dawson, 6.
333 A.W. Greig, "Old Story Retold: The Flood of 1863," *Argus*, February 25, 1928, 7.
334 Lacey, 243.
335 "Prevention of Floods," *Argus*, September 8, 1863, 13.

Intersection of Flinders and Queen streets - **9**	9.91	3
Intersection of Flinders and Market streets - **10**	8.70	2.7
Intersection of Flinders and Spencer streets - **11**	6.85	2.1
Road at western end of Australia Wharf - **12**	7.27	2.2
Intersection of Gladstone and Montague Streets-Emerald Hill - **13**	6.30	1.9

Table 3. The recorded flood heights of the 1863 flood along the city and inner suburbs reach of the Yarra. Source: Adapted from Argus (1883), page 13.

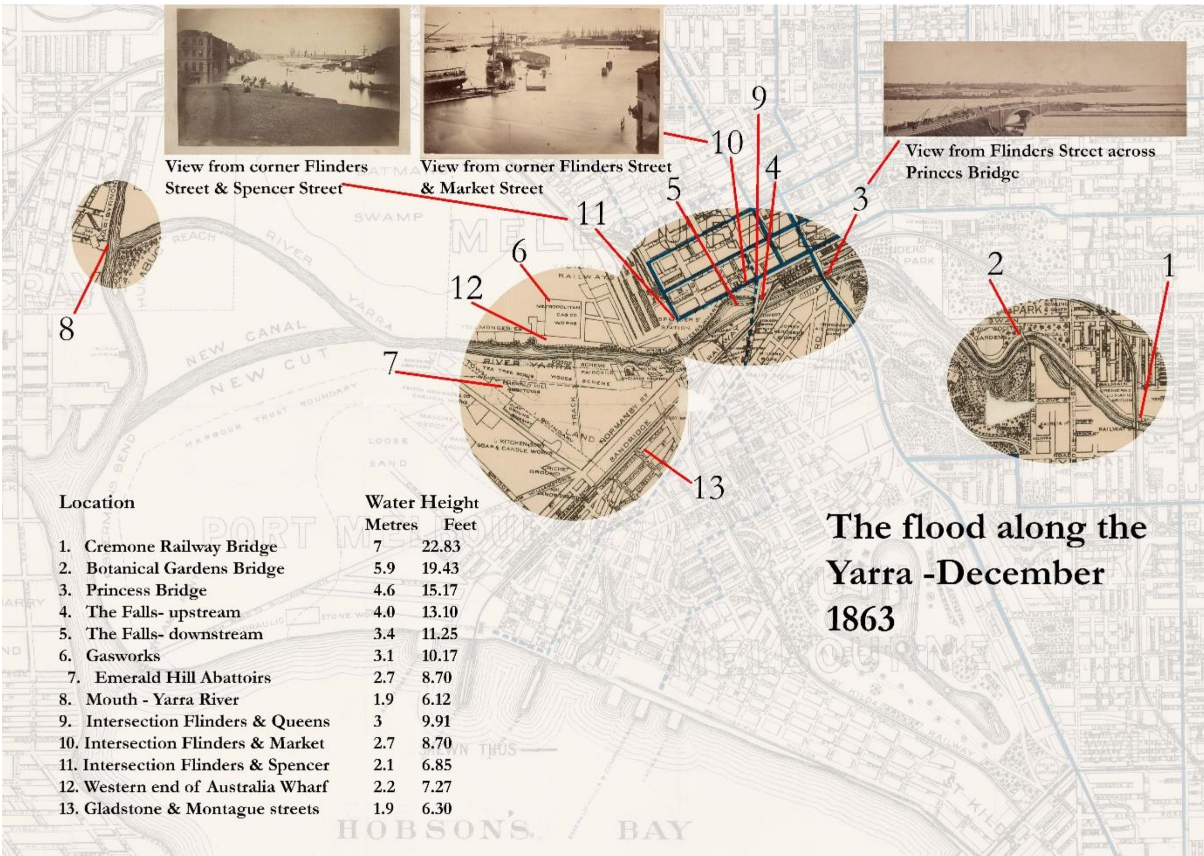

Figure 28. Location of the recorded 1863 flood levels along the Yarra.

The flood resulted in several deaths and dramatic damage to buildings, property and infrastructure.[336] Several timber houses were swept along the Yarra, and tree found on St Kilda Road, (a major north-south route through the city) was observed to have a high-water mark of 9 metres (30 feet) on its trunk.[337]

Figure 29. View from the city, during the 1863 flood, across Queens Wharf on the Yarra. Port Melbourne is on the horizon. Source: SLV H6255

Melbourne newspapers regularly reported on the city's floods. Residents and professionals suggested solutions, argued for action and narrated effects of floods on their lives and property. In 1864, a report from a government-appointed board on flood prevention was published in the *Argus*. The board recommended modifying the city reach of the Yarra into a 91 metre (300 feet) wide channel, using a lock and weir for boats traveling up past the city, the removal of all reefs, and construction of an embankment along the river.[338] Another report suggested that although the river had been 'snagged' several years ago in the eastern

[336] Greig, 7.
[337] Ibid.
[338] "The Prevention of Floods in the Yarra," *Argus,* September 27, 1864, 5.

suburb of Hawthorn, the amount of debris washed down by this and previous floods had built up, obstructing flow.[339] The term 'snag' refers to woody debris including logs, branches, and living riparian vegetation; its removal is known as both de-snagging and snagging.[340] It was believed de-snagging removed obstacles, which restricted flow velocity, causing bank erosion and flooding, and delaying drainage of flood plains and wetlands.[341] In September 1878, the *Argus* reported that the removal of 16 trees from the Yarra's bed near Princes Bridge had greatly improved river safety and beauty, as well as aiding in flood prevention.[342] Another article from December 1891 reported on the outcome of the Yarra River Snagging Conference.[343] The conference members strongly recommended immediate snagging of the Yarra as vital.[344] Local engineers contributed to the discussion.[345] One, Charles Phillips, published *An Essay on the Floods of Melbourne* in 1878. He proposed a scheme similar to Coode's, using description of the entire Yarra River system including its rise in the Great Dividing Range.[346]

Although Coode's scheme provided Melbourne with improved shipping capacity and port facilities, it did not solve the lower Yarra's flooding problems. Significant floods were recorded in 1889, 1891, 1893, and 1897 (page 101).[347] The Yarra Floods Board was appointed in 1891 by the minister of Public Works, consisting of 12 engineers, supervised by English civil engineer, Clement Hodgkinson.[348] Hodgkinson worked for the Surveyor General's Office, local councils, and government committees and departments, on a range of projects in Melbourne including water supply, flood control, ports, and sanitation.[349] Under the Yarra Improvement Act of 1896, recommendations by the Yarra Floods Board could be

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339 "Destructive Floods in the Yarra," *Geelong Advertiser*, December 24, 1863, 2.
340 Wayne D. Erskine and Ashley A. Webb, "Desnagging to Resnagging: New Directions in River Rehabilitation in Southeastern Australia," *River Research and Applications* 19, no. 3 (2003): 233.
341 Ibid, 233-34.
342 "Snaggin the Yarra," *Argus*, September 18, 1878, 6.
343 "The River Yarra Snagging Conference," *Argus*, December 18, 1891, 10.
344 Ibid.
345 R. Adams, *The Report of the Yarra Flood Commission Analyzed by Robert Adams* (Melbourne: Wilson and Mackinnon Printers, 1864).
346 C. Phillips, *An Essay on the Floods of Melbourne and on the Port of Melbourne* (Melbourne: Fergusson and Moore, Printers, 1878).
347 Lacy 2004, 244.
348 "Upper Yarra Improvements: Boulevard Taverner," *Australasian*, November 19, 1898, 36.
349 H Nunn,"Hodgkinson, Clement (1818-1893)," *Australian Dictionary of Biography*, National Centre of Biography, Australian National University, accessed April 14, http://adb.anu.edu.au/biography/hodgkinson-clement-3774.

executed by the Board of Land and Works.[350] It recommended the Yarra be widened to 91 metres (300 feet) wide commencing at Princes Bridge, where the Coode modifications ended, and upstream for 2.8 kilometres (1.8 miles).[351] The work included cutting a new channel near the Botanical Gardens to straighten sharp bends in the river, and the inclusion of five separate tree lined avenues signifying pedestrian path, bicycle track, carriageway, and equestrian track.[352]

Despite the completion of the Yarra Improvements in 1901, flooding remained a problem.[353] Such flooding may be caused by local drainage and surface overflows (referred to as pluvial flooding).[354] An example is the 1972 flood of Elizabeth Street, when the barrel drain overflowed and created localised flooding after 75 millimetres (3 inches) of rain fell within just over an hour.[355]

Attempts to drain Elizabeth Street and erase the creek had been ongoing since European settlement.[356] Despite remaining under Elizabeth Street for decades, the creek surfaces every few decades to wreak havoc on the urban fabric. After years of flood and sewerage flows along Elizabeth Street, in 1884 the *Argus* published a detailed account of proposed improvements to the street sanctioned by the City Council to eliminate, finally, the floods and bad odours associated with the street.[357] The scheme proposed the construction of two large underground barrel drains along the north-south axis of Elizabeth Street, starting in the south at Flinders Street and terminating in the north at Therry Street diagonally opposite the Queen Victoria Market. Both drains were reported as joining underneath Flinders Street into one large drain 306m by 2.8m (12ft by 9ft) and thence continuing underneath Flinders Street Station and rail yards, discharging at the northern bank of the Yarra River.[358] On Wednesday 20th June 1883, the foundation stone for the culvert underneath Flinders Street Railway station was laid by Melbourne's Lord Mayor, Councillor James Dodgshum.[359] The culvert was to form the outlet for the drain yet to be constructed along Elizabeth Street. A

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[350] T. Dingle and A. Brown-May, "Yarra River " in *The Encyclopedia of Melbourne*, ed. A. May and S. Swain (Port Melbourne Cambridge University Press, 2005), 787-90.
[351] "Upper Yarra Improvements: Boulevard Taverner," 36.
[352] Ibid.; "Our Illustrations. The Yarra River Improvements," *Leader*, October 9, 1897, 5.
[353] Dingle and Rasmussen, 307-10.
[354] Douglas, 233.
[355] "Deluge Sets 87-Year Record," *Canberra Times*, February 18, 1972, 1.
[356] Cannon, *Old Melbourne Town before the Gold Rush*, 126-30; "Elizabeth Street Has a Colourful Past," *Argus* December 24, 1937, 12.
[357] "Elizabeth-Street Improvements," *Argus*, June 3, 1884, 7.
[358] A.W. Greig, "The Story of Elizabeth Street: Once an Unhealthy Hollow," *Argus*, May 4, 1935, 5.
[359] "Melbourne Drainage," *Australasian*, June 23, 1883, 6.

very large crowd attended the ceremony followed by an official function at the town hall where attending politicians were reported as supporting the need for the establishment of a Metropolitan Board of Works to manage the Yan Yean water supply (page 24-5) and address the city's ongoing sanitation and drainage problems. The article also reported the new underground drains for Elizabeth Street and associated wood paving of the street would control the stenches, dust and mud experienced on Elizabeth Street.[360] In October 1884, the *Sydney Morning Herald* provided a detailed account of the underground drains being constructed.[361] The article explicitly explained the new drains were not sewers but for stormwater only. If such a combined sewer system was adopted the Yarra River and Hobson's Bay, it was reported, would become mere cesspools. The design of the drains could stop the un-fragrant and vile odours associated infamously with Elizabeth Street. The new drains were designed with half gratings and a trap at intervals every 30.1 metres (chain and a half). These were designed to allow all liquid substances discharged into the channels to drop into the drains, instead of traversing the entire length of the street surface.[362] It was also believed the design would allow early detection of pollution as the gratings and traps would localise the source. The underground drainage system of Melbourne at that time was limited to Elizabeth and Swanston Streets, with these two streets accepting the runoff from the streets all-sloping from the east, north, and west. As such, most stormwater and waste drained to the southern end of Elizabeth Street.[363] The article further reported Elizabeth Street following the course of an ancient streambed, with evidence of the former channel being exposed during the excavation works for the eastern side drain. The new drain's traverse was approximately 1.2 kilometres (three-quarters of a mile).[364] The bottom of the drain was 3.7 metres (12feet) from the street surface.[365] The drain's ovoid shape with the lower section narrower than the upper created a strong as possible scour, for self-cleaning. However, in November 1884, an article in the *Evening News* reported that, following a half hour storm in Melbourne on 13th November, the newly completed Elizabeth Street drains overflowed and filled with silt and sand. The accumulation of material was so large several hundred feet of roadway was removed to access the blocked drains and remove a vast amount of rubbish.[366]

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[360] Ibid.
[361] "Victorian Topics: Melbourne Street Improvements - 1," *Sydney Morning Herald*, September 25, 1884, 4.
[362] Ibid.
[363] Ibid.
[364] Ibid.
[365] "The Elizabeth-Street Drain," *Argus*, July 22, 1884, 7.
[366] "Melbourne Drainage," *Evening News*, November 19, 1884, 6.

Urban drainage

Melbourne's drainage was not addressed on an integrated scale before the 20th century.[367] Prior to August 1897 when the first private property in Melbourne was connected to the newly completed metropolitan-wide sewerage system, the city's urban drainage flows continually increased in complexity.[368] Melbourne's drainage was commonly a mixture of stormwater, effluent and industrial waste, collecting and flowing into the lowest contours of the urban fabric.[369] Following connection to a separate sewerage system (collecting sewage only, excluding rainfall), Melbourne's drainage of stormwater, flood flows and general urban runoff continued to cause problems affecting daily operations.[370]

Drainage of the urban fabric, like the need for fresh-water, is essential for the sustained health, safety, and survival of urban populations.[371] This is clear when examining Melbourne's first 75 years.[372] Poor or non-existent urban drainage infrastructure meant Melbourne frequently experienced hazards associated with floods and communicable diseases such as typhoid.[373] The additional water collected from the city's hard surfaces entering Melbourne's watercourses increased prevalence of flash flooding, erosion and scouring of streambeds and banks, leading to further degradation.[374] Effluent and runoff was also filling low-lying areas and wetlands, where it stagnated, creating further disease and environmental degradation problems.[375]

Impervious surfaces in Melbourne: The progressive increase of runoff into watercourses

As discussed in chapter two, pages 46-8, the construction of impervious surfaces across urban fabrics reduces the amount of rainfall and runoff being absorbed into the surface.[376] As a result, increased volumes and velocities of surface runoff enter rivers and

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[367] Dingle and Rasmussen, 151.
[368] Ibid, 79.
[369] Gresswell, 15-21.
[370] Senior, 414-18; Dingle and Rasmussen, 153-55, 307-10.
[371] Sanna-Leena Rautanen et al., "Sanitation, Water and Health," *Environment and History* 16, no. 2 (2010): 174.
[372] Dingle and Rasmussen, 34-37.
[373] "Great Flood in Melbourne," *Argus*, July 13, 1891, 5-6; Gresswell, 24-25.
[374] Paul and Meyer, 335.
[375] Dingle and Rasmussen, 32-33.
[376] Michael J. Paul and J. L. Meyer, "Streams in the Urban Landscape," *Annu. Rev. Ecol. Syst* 32 (2001): 335.

tributaries. The main effects to watercourses are an increased occurrence of flash floods, and acceleration of erosion to streambeds and banks.[377] Therefore, the area and density of impervious surfaces constructed across a catchment greatly impact runoff-flow rates entering watercourses, and ultimately the structure, and hydrological and ecological, functions.

Throughout urban history, impervious surfaces have been progressively used to cover increasingly larger areas of land and waterscapes.[378] The most significant categories of these surfaces are building rooftops and roads, developed progressively and in parallel with the rise of urban settlements. Trade routes between towns, and developing transport technology resulted in footpaths and ways becoming roads.[379] As urban centres grew, the need for efficient roads increased as unpaved roads that became quagmires in winter and rough, undulating dust bowls during the summer, slowed transportation and the movement of goods and people.[380] The development of asphalt paving in 1872, was one of the first uses of the impervious material for a street surface.[381] Asphalt was laid in front of Newark City Hall in New Jersey, and thus revolutionised road and path construction by providing an advantageous method to create a synthetic, solid, durable, and waterproof surface.[382] However, impervious surfaces of urban centres, including Melbourne, during the 19th and early 20th century differed in materials, densities, and area when compared with the imperviousness of contemporary urban fabrics.

During the period covered in this thesis, 1835-2000's, the area and density of Melbourne's impervious surfaces progressively increased as the city and suburbs developed. While advances in engineering, materials technology, and urban design, resulted with increasingly sophisticated impervious surfaces being constructed. As Melbourne developed, building sizes and densities increased, while social demands for improved road and path surfaces, and expansion of the road system, saw the covering of increasing areas of the urban landscape with hard surfaces. During the 1840s, Melbourne's urban area consisted of unmade

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[377] Ibid.
[378] David B. Jennings and S. Taylor Jarnagin, "Changes in Anthropogenic Impervious Surfaces, Precipitation and Daily Streamflow Discharge: A Historical Perspective in a Mid-Atlantic Subwatershed," *Landscape Ecology* 17, no. 5 (2002): 471-472.
[379] M. Lay, *Ways of the World: A history of the World's roads and of the vehicles that used them* (New Brunswick: Rutgers University Press, 1992), 17.
[380] Pierre Bélanger, "Synthetic Surfaces", in *Landscape Urbanism Reader*, ed. Charles Waldheim (New York: Princeton Architectural Press, 2006), 243.
[381] Ibid, 244.
[382] Ibid.

roads, interspersed through cleared land parcels and the first buildings and shanties.[383] Land clearing would have resulted in increased volumes and velocities of runoff entering watercourses as surface runoff and river discharges increase as vegetation is cleared.[384] The soils of the Melbourne city area were light grey and gritty loams over clay subsoil.[385] As the land was cleared of the protective vegetation cover, the loams became susceptible to water and wind erosion, resulting in the clay subsoil becoming exposed.[386] Once exposed the clay base became progressively compacted by traffic leading to less water infiltrating the surface. As Barnes, Morgan, and Roberge (page 47-8) maintain, compacted and high clay content soils are highly hydrologically active and behave as impervious surfaces.[387]

The increase in runoff caused significant erosion to Melbourne's streets as evident in an article from the *Port Phillip Gazette* published in 1841. The *Gazette* described the centre of Elizabeth Street, (see page 36-7) within the city grid, as having been eroded into a vast ditch that functioned as a deep drain.[388] The *Gazette* further reported a horse plunged into the ditch, and threw its rider who received several minor injuries.[389] Meanwhile the process of land clearing and forming streets was also causing problems. The *Port Phillip Patriot and Melbourne Advertiser* described navigating the streets of Melbourne during wet weather as a 'Herculean' activity due to tree stumps, lakes, rivulets, and bogs.[390] The first method employed to surface inner Melbourne's streets was the McAdam method of road surfacing (known as macadamisation).[391] This involved use of fragmented, angular stones, termed road metal that was spread in layers of 250 millimetres (ten inch) depth and compacted.[392] By the early 1890s, most roads across inner Melbourne had macadamised surfaces.[393] On occasion,

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[383] Max Lay, *Melbourne Miles: The story of Melbourne's Roads* (Melbourne: Australian Scholarly Publishing, 2012), 217.
[384] Jonathan Foley, et al., "Global Consequences of Land Use," 309, no. 5734 (July 2005): 571.
[385] Helmut Meuser and Robert Van de Graf, "Characteristics of Natural and Urban Soils," in *Dealing with Contaminated Sites*, ed Frank A. Swartjes (Dordrecht: Springer, 2011), 103.
[386] David Pimentel and Nadia Kounong, "Ecology of Soil Erosion in Ecosystems," *Ecosystems* 1, no. 5 (1998): 416.
[387] Kent B Barnes, J Morgan, and Martin Roberge, *Impervious Surfaces and the Quality of Natural and Built Environments* (Baltimore: Department of Geography and Environmental Planning, Towson University 2001), 3.
[388] "Domestic Intelligence: Elizabeth Street," *Port Phillip Gazette*, May 5, 1841, 5.
[389] Ibid.
[390] "Local Intelligence," *Port Phillip Patriot and Melbourne Advertiser,* August 5, 1841, 3.
[391] Maxwell Lay, *Melbourne Miles: The Story of Melbourne's Roads* (Melbourne, Vic.: Australian Scholarly Publishing, 2003), 220.
[392] Ibid.
[393] Andrew Brown-May, *Melbourne Street Life: The Itinerary of Our Days* (Kew, Vic.: Australian Scholarly Publishing, 1998), 34.

the crushed stone was mixed with clay to form a more durable surface.[394] However, these surfaces were permeable, allowing water to seep through the layers. In wet conditions, traffic kneaded the material creating a slimy, muddy surface, while when dry, the surface was susceptible to wind erosion.[395] During the same period Telford paving, or pitching, consisting of small cubes of stone laid on sand with cement mortar joints.[396] Pitching was used to pave major intersections and some streets, and was commonly covered with McAdam surface.[397] Although contributing to the runoff, these street surfaces were permeable to water. Therefore, roofs and cleared land provided much of the runoff flowing into Melbourne's watercourses.

Despite the use of these road surfaces, Melbourne's streets remained a source of dust storms, and mud, with improvement progressing slowly throughout the latter half of the 19th century. In 1877, the *Weekly Times* reported on a trip to Europe by the City of Melbourne's Town Clerk, Mr Fitzgibbon, to study road surfaces.[398] After inspecting a range of surfaces, including macadamised stone, stone pitches, asphalt, and wooden blocks, Fitzgibbon recommended surfacing many of Melbourne's streets with asphalt and wooden blocks. He argued these materials produced a clean, smooth, noiseless, and dustless surface, and eliminate the ongoing costs of maintaining existing metaled and stone-paved roads.[399] Despite Fitzgibbon's recommendations, little was done. The city's newspapers continually published articles reporting on the disgraceful conditions of the streets and calling for improvements to road surfaces. For example in June (1884) the *Age* reported the art of roadmaking and repair in Victoria was done with little scientific knowledge, and stated the condition of Melbourne's roads were the worst in colony.[400] The streets were described as being of such disgrace pedestrians were forced to wade through seven inches (180 millimetres) depth of mud while walking the city's streets during winter and blinded by dust in the drier months. Additionally vehicular traffic and horses were forced to plunge into deep ruts and gullies eroded into many street surfaces.[401] As a solution to the problems with McAdam surfaces wooden, hardwood blocks made from red gum (*Eucalyptus camaldulensis*)

[394] Lay, *Melbourne Miles: The Story of Melbourne's Roads*, 221.
[395] Ibid.
[396] Ibid; Brown-May, *Melbourne Street Life: The Itinerary of Our Days*, 34.
[397] Lay, *Melbourne Miles: The Story of Melbourne's Roads*.
[398] "Mr Fitzgibbon on Melbourne's Streets," *Weekly Times*, January 20, 1877, 16.
[399] Ibid.
[400] "The Streets of Melbourne," *Age*, June 24, 1884, 5.
[401] Ibid.

and soaked in tar were trialled in 1880, in Melbourne.[402] Laid on a concrete base, the paved surface was sealed with a top layer of tar, creating a durable waterproof surface.[403] Timber blocks became the most widespread paving method in Melbourne, with all city streets paved and tarred by 1900.[404] By the 1930s, new roads were still being built using timber blocks placed on a reinforced concrete base with a thin asphalt surface layer.[405] From 1910 onwards, asphalt gradually became the most widely used impervious surface for road construction across Melbourne and its suburbs.[406] First as the surface layer for timber blocks, it gradually replaced the block paving, to be used over a crushed rock base, with method developed and refined over the 20th century to provide one of the main and most widely spread impervious surfaces used across contemporary Melbourne.[407] Footpaths are another significant source of impervious surfaces within contemporary cities (see page 46-8). However, in Melbourne up until the 1880s most paths were gravel, with sections fronting particular properties paved with flagstones.[408] From the 1870s, footpath construction included tarring of gravel surfaces, while other paths were surfaced with asphalted or paved. All inner Melbourne's footpaths, by the 1880s, had been surfaced with hydrologically active materials, contributing to the increasing runoff entering the watercourses.[409] By the 1950s, central Melbourne had few, if any, roads and footpaths that had not been surfaced in asphalt, stone paving or concrete. The urban surface, with exception of parks, green space, vacant land, and various pockets along infrastructure and areas deemed wasteland, was largely covered with impervious surfaces.[410] The suburbs through were still developing and spreading with a lower density of buildings and roads, so impervious surfaces were not as concentrated as within the inner city. However, these surfaces contributed to the amount of runoff entering Melbourne's network of watercourses. For example, Leigh and the MMBW reported extensive suburban development along the Moonee Ponds Creek over the period 1946-1970 resulted in significant progressive

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402 Lay, *Melbourne Miles: The Story of Melbourne's Roads*, 224.
403 Ibid.
404 Susan. Priestley, *The Victorians: Making Their Mark* (McMahons Point N.S.W.: Fairfax, Syme and Weldon Associates, 1984), 139.
405 Lay, *Melbourne Miles: The Story of Melbourne's Roads*.
406 Ibid, 225.
407 Ibid, 225-26.
408 Ibid, 227.
409 Brown-May, *Melbourne Street Life: The Itinerary of Our Days*, 42; Lay, *Melbourne Miles: The Story of Melbourne's Roads*, 228; Priestley, *The Victorians: Making Their Mark*, 139.
410 Miles Lewis, *Melbourne: The City's History and Development*, 2nd ed. (Melbourne: City of Melbourne, 1995), 116-34.

increases in runoff and flood flows.[411] These increased flows resulted in stream bed and bank erosion, and flooding became continuing problems along the creek and tributaries.[412] Leigh and the MMBW also contended flooding and erosion problems became increasingly recurrent across Melbourne's entire watercourse network as the suburbs continued to develop outwards from the city.[413] As Schueler, Fraley-McNeal, and Cappiella report, watercourses with ten percent and greater impervious surface coverage within their catchment, illustrate signs of declining stream health.[414] While Schiff and Benoit identified a figure of only five percent impervious, surface coverage increases runoff enough for watercourses to show signs of impacts to stream health and structure.[415]

Melbourne's drainage during the 19th century

With the completion of Yan Yean Reservoir, the city received a cheap, convenient water supply, and consumption increased.[416] Melbourne became damper and smellier as the watercourses reached capacity and surrounding soils became increasingly saturated.[417] The saturation of soil by sewage was described by builder John Buncle (1889) when laying a new floor for a shop in Collins Street who 'after lifting a few boards, discovered some vile looking mud, which on being disturbed…smelt something horrible, and I had frequently to go into the open air to breathe freely.'[418] The pollution of watercourses and soil affected living conditions within the town.[419] The severity of noxious fumes arising from the surface of the Yarra was reported by the Melbourne *Argus* (1890) as affecting several masters and crewmembers aboard vessels docked at the city's main wharf to the point of hospitalisation.[420]

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[411] C. Leigh and Melbourne Metropolitan Board of Works, *Development of the Moonee Ponds Creek Drainage System* (Melbourne: Melbourne Metropolitan Board of Works, 1981), 91.
[412] Ibid.
[413] Ibid.
[414] T Schueler, L Fraley-McNeal, and K Cappiella, "Is Impervious Cover Still Important? Review of Recent Research," *Journal of Hydrologic Engineering* 14, no. 4 (2009): 310.
[415] Roy Schiff and Gaboury Benoit, "Effects of impervious cover at multiple spatial scales on coastal watershed streams," *Journal of American Water Resources Association* 43, no. 3 (June 2007): 712.
[416] Ibid, 33.
[417] Ibid.
[418] John Buncle, *Experiences of a Victorian Manufacturer / Yours Truly, John Buncle* (Melbourne: Rae Bros., printers, 1889), 16.
[419] Gresswell, 19; David Dunstan, "Dirt and Disease," in *The Outcasts of Melbourne*, ed. G Davison, D Dunstan, and C McConville (North Sydney Allen & Unwin 1985), 141.
[420] "Pollution of the Yarra and Saltwater Rivers," *Argus*, February 5, 1890, 4.

The Greater Melbourne area is located within a low-lying basin intersected by rivers and numerous small tributaries.[421] Almost as soon as the vegetation was cleared, and streets formed, rainfall and drainage flows began to erode the bare-earth roads.[422] The impact of soil entering the waterways dramatically changed the Yarra's colour. Melbourne became known as 'the only city in the world where the river flows upside down with the mud on top.'[423] The river's turbidity is not the result of pollution but fine silt and clay particles suspended in solution.[424] One early reference to the Yarra's colour was made by visiting journalist George Augustus Sala in 1885 when he described the river 'at Melbourne itself' leaving 'a good deal to be desired in the way of breadth, and especially of amiability of hue.'[425]

Melbourne's early economic system saw most available income spent on private development, at the cost of public infrastructure.[426] The result was increasing pollution as the waste, combined with rainfall and drainage from un-made streets, flowed to the city's lowest areas. Deep bogs and overflowing cesspits were scattered around Melbourne and waste overflowed into the streets, which within the central grid generally drained towards Elizabeth St entering the Yarra proximate to the falls where the water supply was drawn.[427] As the construction of streets modified natural drainage lines, flooding and formation of stagnate surface pools increased with saturated soils of the urban area leading to increased runoff entering waterways.[428] As consequence, Melbourne's drainage became the subject of much discussion. Richard Twopenny (1883) arrived in the city in 1876:

> There is no underground drainage system. All the sewage is carried away in huge open gutters, which run all through the town, and are at their worst and widest in the most central part…These gutters are crossed by little wooden bridges every fifty yards. When it rains, they rise to the proportion of small torrents…[429]

[421] Dingle and Rasmussen, 155.
[422] Brown-May, 10.
[423] Larkin and Ellingsen, *Give the Yarra A Go!*, 1.
[424] "Turbidity," United States Department of Interior - US Geological Survey, updated December 2, 2016, http://water.usgs.gov/edu/turbidity.html.
[425] George Augustus. Sala, "The Land of the Golden Fleece," *Argus*, August 8, 1885, 5.
[426] Cannon, *Old Melbourne Town before the Gold Rush*, 14.
[427] Ibid; Lewis, 32.
[428] Dingle and Rasmussen, 33.
[429] R. E. N. Twopeny, *Town Life in Australia* (London: Elliot Stock, 1883), 4.

A contemporary report from the Health Committee of the Melbourne City Council upon the condition of the River Yarra (1881) outlined the well-known problem of a city the scale of Melbourne having no proper drainage or sewerage system. The report was direct and descriptive:

> The circumstances are plain. An area of upwards of two hundred square miles, with as many lineal miles of roads and streets, upwards of fifty thousand dwellings, manufactories and buildings, and a population of nearly a quarter of a million, for its storm water, house, chamber and kitchen slops; the refuse fluid from manufactures, stables, urinals, and the other constituents of street drainage,… has no other receptacle and conduit than the river Yarra, which has thereby converted into an open sewer, and so defiled that the pollution, less or more, of a number of noxious trades upon its banks is looked upon as of no consequence.[430]

The drainage of Melbourne included the management of stormwater, flooding, and the role of watercourses as the hydrological cycle changed due to urban development, and the lack of a metropolitan-wide management scheme for sewage and waste. The effects were detailed in a report to the Board of Public Health by medical inspector Dan Gresswell (1890), (page 60-1). The report suggested tributaries and larger watercourses were generally unformed, with eroded banks and beds of soft crumbling material or basalt-rock. The streambeds flowed low in dry weather and contained deep waterholes forming strings of stagnant cesspools. When flowing, the water bubbled with decomposition, emitting foul odours. Sections of the watercourses had been faced with bluestone pitches or stone, with other larger creeks fully lined in stone and used as open sewers.[431]

The city's newspapers published editorial opinions and letters from the public complaining about state of the city's drainage and watercourses and providing solutions. The Elizabeth Street creek featured in the Melbourne *Argus* for decades. It appears to be the first in the Melbourne region to be modified. In 1842, in his *Personal Recollections of Early Melbourne and Victoria,* William Westgarth described Elizabeth Street and stated:

[430] City of Melbourne Health Committee, "River Yarra," ed. Health Committee City Council of Melbourne (Melbourne, Victoria: City of Melbourne, 1881), 5.
[431] Gresswell, 19.

> Melbourne missed a great chance in filling up with a street this troublesome, and, as a street, unhealthy hollow. Dr Howitt used to tell me he never could cure a patient, resident there, who had become seriously unwell. A reservation of the natural grass and gum-trees between Queen and Swanston streets would have redeemed Melbourne up to the first rank of urban scenic effect, and the riotous William's might, with entire usefulness, have subsided into a succession of ornamental lakes and fish ponds… [432]

Literature about the creek centres on the nuisance it caused. Besides being, a hazard to traffic, the stream had also became an open sewer and settling pond for town waste, a source of disease leading to public health epidemics.

In March 1905, the *Argus* published a rare description of Elizabeth Street from 1837, in an interview with Mrs Louis Humphries who had arrived in Melbourne from Launceston in September 1837. Humphries describes the street as a gully through which an often-dry creek travelled, on occasion becoming a raging torrent.[433] From her description, it appears Williams Creek was ephemeral, flowing seasonally. Its description as a 'gully' suggests it was a major drainage line, discharging into the Yarra several hundred metres above The Falls, where the Queens Bridge now crosses the river. The *Port Phillip Gazette* of May 1841 was quick to assign blame for the continual erosion of the street and reforming of the creek, stating: 'The sheer negligence of the local government has allowed an immense ditch to open itself through the centre of this street...'[434] The deepest section of the gully was at the southern end, scoured out by the flows running into and along Elizabeth Street. It was named River Townsend after the grocer whose business was established in early 1840 on the south-west corner – Townsend Corner – of the Collins Street intersection.[435] There were many failed attempts to drain the water into the Yarra. In 1844, a floating drain was constructed on Flinders Street, but believed useless. In 1849, a councillor proposed the construction of a barrel drain along Elizabeth Street, which he described as a morass emitting noxious and putrid vapours.[436] As the town developed, pavements and hard surfacing were gradually introduced, however the regular flooding of the lower section of the street continued after heavy rains.[437]

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[432] Westgarth, 14.
[433] Goulburnian, "Early Victoria: A Pioneers Story," *Argus*, March 25, 1905, 4.
[434] "Domestic Intlegence," *Port Phillip Gazette*, May 5, 1841, 5.
[435] Greig, "The Story of Elizabeth Street: Once an Unhealthy Hollow," 5.
[436] Ibid.
[437] Ibid.

In attempting to address the issues of pollution and odour control in small creeks many suburban councils either filled them, used them as refuse dumps or placed them in barrel drains. For example, Connors Creek in Kew was used as a sewer, and rubbish dump, to be filled, the channel pitched with stone, and eventually covered as a barrel drain (see chapter six, page 257-8).[438] An un-named tributary of Gardiners Creek, flowing through Hawthorn, was placed in various sections into a pitched basalt rock channel or barrel drain, becoming the main sewer.[439]

Barrel draining or erasure of small streams

Between Melbourne's foundation and the turn of the century creeks and smaller tributaries were considered by the population as flooding, pollution, or drainage nuisances, overall hazards to the health and safety of the city's residents.[440] Many of these nuisance watercourses were treated with approaches that tried to cover up, or hide, the problems they caused across the urban fabric. The first creeks to create problems for Melbourne were found within the central town grid, tributaries of the Yarra that flowed from the north.

Problems incurred by the Elizabeth Street creek were notorious, unlike others placed into barrel drains as solutions to sanitation and flood control: for example, the unnamed creek in Hawthorn (page 54) and a tributary of the Maribyrnong River now known as the Holmes Road Main Drain. During the 1880s expansion of the north-west suburb of Essendon increased sewage and runoff flows into low-lying areas and seasonally flowing creeks.[441] The brick portal of the Holmes Road drain is shown in figure 30, the sheer size of its construction illustrating the magnitude of flood flows it was designed to conduct.

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[438] Dorothy Rogers, *A History of Kew* (Kilmore, Vic.: Lowden Publishing Co., 1973), 115-16.
[439] Gwen Barton McWilliam, *Hawthorn Peppercorns* (Melbourne: B. Atkins, 1978), 8.
[440] Senior, 413-14.
[441] N. Schmeder, D. Helms, and E. Piper, *Moonee Valley Heritage Sturdy 2015* (Melbourne: Context and City of Moonee Valley, 2015), 73.

Figure 30. Holmes Street Main Drain outlet into the Maribyrnong River. Once a tributary of the river. Source: Author photo (2017)

Miasma to Modern Urbanism – The engineered disappearance of water from the urban surface

As mentioned, many of Melbourne's smaller tributaries and headwater streams were either placed into underground drains or filled. Larger watercourses were also modified with sections undergrounded, or converted into straight, wide channels, their banks lined with rock beaching or concrete. From the late-18th century until at least the 1980s engineering of watercourses, including undergrounding was standard practice in Melbourne, taking inspiration from British sanitary reformism.[442] De Meulder and Shannon (2008) assert that once water was linked to public health it was visually banished from the urban fabric.[443] The two main influences directing management approaches towards urban water systems,

[442] Leigh and Melbourne Metropolitan Board of Works, 91; Loforano, 5259.
[443] Shannon and De Meulder, 6.

waterways, wetlands and surface water in general, was the Miasmatic theory of disease causation, and modern urbanism.[444]

The 'Age of Miasmas' commenced in the 17th century when many cities had developed horrendous sanitary conditions and suffered disease epidemics, with little understanding of their causation.[445] Miasma theory, dating back at last to the fourth century B.C.E., was used to explain these 17th century epidemics.[446] Consequently, it prevailed within both scientific and public thinking until the mid-19th century and in some instances, beyond.[447] Modern urbanism was the transformation of the city into a rationalised and scientifically designed and managed urban form.[448] The 'sewered city' and later 'drained city' typologies (see page 44), outcomes of engineering solutions to improving public health, sanitation and safety, exemplify modern urbanism.[449] Melosi writes that a main characteristic of the modern city was the development of technical networks (for example sewerage systems), advanced during the nineteenth century by the engineering profession being informed by the prevailing environmental theory of the time; in this instance miasma theory.[450]

Miasma theory proposed the existence of 'miasmas' or poisonous emissions released from putrid decomposing organic matter including carcasses, rotting vegetable moulds, and invisible dust particles located inside buildings.[451] It was thought that upon entering the human body these caused disease.[452] The severity of disease was thought to be dependent on the strength of the offending miasma.[453] This was understood as determined by climate, elevation, proximity to the ocean, current weather conditions, and levels of available heat and

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444 Melosi, "How Bad Theory Can Lead to Good Technology: Water Supply and Sewerage in the Age of Miasmas," 232; Shannon and De Meulder, 6.
445 Melosi, "How Bad Theory Can Lead to Good Technology: Water Supply and Sewerage in the Age of Miasmas," 232.
446 John M. Last, "Miasma Theroy," in *Encyclopedia of public health* ed. Lester Breslow (New York: Macmillan Reference, 2001), 765.
447 Ibid.; Stephen Halliday, "Death and Miasma in Victorian London: An Obstinate Belief," British Medical Journal 323, no. 7327 (2001), 1469.
448 Gandy, *Emancipatory City? Paradoxes and Possibilities*, 178-79; Shannon and De Meulder, 5-6.
449 Gandy, "Rethinking Urban Metabolism: Water, Space and the Modern City," 366-67; Shannon and De Meulder, 5-6.
450 Melosi, "How Bad Theory Can Lead to Good Technology: Water Supply and Sewerage in the Age of Miasmas," 231-32.
451 Last, 765.
452 Ibid.
453 A. Susan Williams, *The Rich Man and the Diseased Poor in Early Victorian Literature* (Basingstoke: Macmillan, 1987), 15.

moisture during the decomposition process.[454] If a miasma was weakened by mixing with air, it might result in only physical or mental depression. However, in full strength a miasma could cause instant death.[455] In the ancient world, the most dangerous places considered to contain Miasmatic conditions were wetlands, (swamps) and marshes.[456] The theory dated back to ancient Greece during the fourth-fifth centuries B.C.E. when Greek physicians observed an association between marshland and malaria, leading to the development of a concept to explain disease as originating from natural processes.[457]

Throughout the industrial revolution until at least the 1880s, miasma theory remained the dominate explanation for disease causation.[458] Over the same period, the unprecedented effects of mass urbanisation and industrialisation upon cities resulted in watercourses becoming open sewers, accepting all domestic and industrial effluents.[459] Following the introduction of the water closet during the late 18th century, the increasing amounts of waste led to the government, in 1815, permitting the discharge of sewage directly into urban sewers and drains, previously only legislated for stormwater.[460] Pollution coupled with overcrowding, squalid urban living conditions and rising mortality rates saw Britain become one of the first countries to initiate solutions to improve environmental conditions.[461] In 1842, the publication of Barrister and Sanitarian Edwin Chadwick's *Report on the Sanitary Condition of the Labouring Population of Great Britain* introduced the 'English Sanitary Idea', linking filth with disease.[462] Like most sanitary reformers of the time, Chadwick was guided by miasmatic disease theory.[463] Throughout the report, he frequently referred to miasmas as injurious to health and identified poor drainage, marshes, stagnate surface water,

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[454] Ibid.
[455] Ibid, 5.
[456] Magner, 19-20.
[457] Last, 765; George Rosen, *A History of Public Health*, Expanded ed. (Baltimore: Johns Hopkins University Press, 1993), 8-9.
[458] Melosi, "How Bad Theory Can Lead to Good Technology: Water Supply and Sewerage in the Age of Miasmas," 232.
[459] Trench and Hillman, 27; Malcolm David Newson, *Land, Water and Development: Sustainable and Adaptive Management of Rivers*, 3rd ed. (New York: Routledge, 2009), 12.
[460] Myers, 253-55.
[461] Loforano, 5259.
[462] Melosi, *The Sanitary City: Urban Infrastructure in America from Colonial Times to the Present*, 43-57; "How Bad Theory Can Lead to Good Technology: Water Supply and Sewerage in the Age of Miasmas," 232; Shannon and DeMeulder, 5.
[463] Melosi, "How Bad Theory Can Lead to Good Technology: Water Supply and Sewerage in the Age of Miasmas," 232-35.

and polluted watercourses, as significant sources of miasma emissions.[464] With this basic understanding of environmental factors as the cause of disease, Chadwick began to envisage metropolitan-wide administrative structures complimented with technical-base solutions for controlling environmental problems.[465] He proposed a centralised hydraulic system to provide potable-water to homes with flush toilets and remove effluent to sewers that discharged waste as liquid fertiliser onto adjacent agricultural land.[466] Although unrealised, the scheme proved a major turning point in the development of modern sanitary systems, with a further push occurring in 1858 when London's population experienced a horrific odour emanating from the River Thames. Known as the 'Great stink of London', the stench of putrefying sewage caught in the tidal section of the Thames, disrupted the sitting of Parliament and resulted in progress towards construction of a combined metropolitan-wide water-carriage sewerage system.[467] The system-involved construction of large interceptor sewers crossing and collecting flows from all existing sewers and watercourses to transport waste to a treatment plant downstream.[468] It also involved the integration of the Walbrook, Fleet, Tyburn and Westbourne rivers into the system as combined underground sewers.[469] The outcome of the 'Great Stink' was the emergence of modern urbanism as a scientific discipline, a combination of the Stink event with miasma theory, Chadwick's sanitary condition report, the ascendancy of engineers and the public health movement.[470] In a call for the solutions of engineering and modern urbanism to solve the Thames sewage problem *The Times* (1858) stated:

> This is pre-eminently an iron age…So we beg to suggest that hearing be given to those engineers who propose to deal with this matter in the spirit of an iron age…Why can not the most obnoxious part of our sewage…be conveyed in iron pipes along and just under the banks of the river far enough for the purpose?[471]

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464 Edwin Chadwick, *Report on the Sanitary Condition of the Labouring Population of Gr. Britain* (Edinburgh: University Press, 1965), 91-166.
465 Melosi, *The Sanitary City : Urban Infrastructure in America from Colonial Times to the Present*, 47-48.
466 Ibid, 48.
467 Ibid, 53.
468 Myers, 7-58.
469 Ibid, 59.
470 Thomas Glick, "Science, Technology, and the Urban Environment: The Great Stink of 1858 " in *Historical Ecology: Essays on Environment and Social Change*, ed. Lester J. Bilsky (Port Washington, N.Y.: Kennikat Press, 1980), 138; Shannon and De Meulder, 6.
471 "The Sewage Question Reminds One of The," *The Times*, July 1, 1858, 9.

London's combined sewerage system controlled and rationalised water into a managed urban form.[472] It also heralded the arrival of the modern city, derived from empirical sciences, engineering and new forms of urban governance.[473]

The experience of polluted, overcrowded and squalid conditions of many urban centres, combined with miasma theory, significantly influenced the layout of colonial cities and towns in Australia. The first town plan for Sydney, produced by Governor Arthur Phillip, showed a preference for fresh air circulation and detached housing with one home designated per allotment.[474] As European settlements were established, a common theme developed in allotment size, Melbourne's commonly averaging half an acre.[475] Phillip's preference for fresh air, open space and individual dwellings has been credited to his travel as a naval officer to cities in Portugal, South American and his experience in England, which was undergoing massive urban development. From these experiences, Phillip's ideas of town planning were influenced by reservations about contagion, a severe problem within densely populated urban centres, as well as the overcrowded spaces of ships at sea.[476] Colonial Australia therefore evolved from being urban into suburban. From 1831 colonial administrators were instructed from London, under the Ripon regulations, (standardising all land sales and setting a minimum price per acre), to sub-divide all land within the environs of towns into the three main classifications of town, suburban, and country allotments.[477] This method shaped the future suburbs of Melbourne and its impacts on watercourses are discussed in chapters four and five.

Melbourne's sanitary conditions during the latter half of the nineteenth century rivalled those reported by Chadwick, the city's waterways flowing as putrid open sewers. Prior to the 1880s when bacteriology began to impact on ideas of disease causation, miasma was the dominant theory in Australia. In Melbourne, the Central Board of Health, set up in 1855 to advise the government on public health issues, was a leading advocate of the

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472 Gandy, "The Bacteriological City and Its Discontents," 14.
473 "Rethinking Urban Metabolism: Water, Space and the Modern City," 365-66.
474 Davison, 10; B. H. Fletcher, "Phillip, Arthur (1738-1814)," *Australian Dictionary of Biography*, National Centre of Biography, Australian National University, accessed June 9, 2016, http://adb.anu.edu.au/biography/phillip-arthur-2549.
475 Patrick Troy, "The Structure and Form of the Australian City: Prospects for Improved Urban Planning. Urban Policy Program Issues Paper 1," ed. Urban Planning (Queensland: Griffith University, 2004), 5
476 Davison, 10-11.
477 Helen Doyle, *The Oxford Companion to Australian History*, ed. John Hirst, Graeme Davison, and Stuart Macintyre (South Melbourne: Oxford University Press, 2012); Davison, 11.

theory.[478] Its reports to Parliament and local councils commonly attributed the spread of disease to atmospheric conditions including occurrence of winds blowing from the east, sudden and dramatic changes in temperature, and contaminations inhaled from stagnate water.[479] Following the proposal of a Yarra Pollution Bill in 1867, the Medical Society of Victoria, on discussing the bill, suggested a flood on the Yarra would cause decomposed matter to be deposited over swamps around the city.[480] It claimed this would result in the ground becoming impregnated with obnoxious substances as the flood waters drained, stating: 'the result would be that miasma in its worst forms would be created.'[481] Throughout the last decades of the 19th century, miasma theory was slowly supplanted by bacteriology.[482] However, the public's belief in miasma remained, resulting in the subject becoming the basis of complaint for letters to the editor of newspapers and being used in other creative ways. For example, real estate agents tailored the theory to their advantage when selling suburban property, placing their own skewed interpretations on suburban mortality rates to demonstrate suburbs located on higher contours were healthier than the ones in lower areas. Disregarding all other factors including age, nutrition, access to medical care and personal hygiene, agents promoted the benefits of fresh air, in their view abundant in higher suburbs that also happened to have lower mortality rates.[483] In a letter to the editor of the *Argus* (1887) 'Sanabilis' wrote: 'One great source of miasma producing fever, exists in the small drains leading from houses into the main drain or gutter.'[484] The *Illustrated Sydney News,* (1889) referring to the city as 'Malodorous Melbourne,' stated:

> [E]vil smelling drains are steadily breathing forth on the midnight air a miasma which hangs like a death pall over the city…there is abundant reason to fear that the air they breathe…the people of Melbourne are daily receiving into their systems, surely, though unconsciously, the germs of disease and death.[485]

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[478] Barrett, 55.
[479] Ibid.
[480] "The Yarra Pollution and the Medical Profession," *Age*, March 28, 1867, 5.
[481] Ibid.
[482] Graeme Davison, *The Rise and Fall of Marvellous Melbourne*, 2nd ed. (Carlton, Vic.: Melbourne University Press, 2004), 145.
[483] Ibid.
[484] "Flushing Small Drains," *Argus*, January 25, 1887, 7.
[485] "Malodorous Melbourne," *Illustrated Sydney News*, October 31, 1889, 11.

As late as 1927 in a letter to the *Age* editor, 'Civic Progress' wrote, 'The foul miasma from the gutters…is sufficient to cause a pestilence…'.[486] Nonetheless, Melbourne's major sanitary condition report produced by Greswell (1890), (see page 146) did not refer to miasmatic theory.[487]

Separate sewerage system: Melbourne un-sewered

By the time, Melbourne developed a metropolitan-wide management approach to its sewage and liquid wastes, the city was 56 years old.[488] Its population at the time according to state census of 1891 was 474,440 residents.[489]

In 1886, the *Australasian* reported what it termed a 'remarkable phenomenon' where on both sides of the Yarra, opposite Melbourne's central city area myriads of small fish appeared on the surface of the water. Many were dead with others gasping for air and swimming with difficulty. The article assumed the fish were suffering from an 'admixture of noxious matter' polluting the river.[490] Melbourne was awash with the waste of its residents and industry.[491] At the time, drainage for the city and its suburbs consisted of a fragmented system of open channels.[492] Most street channels were not connected to underground systems and discharged directly into small local watercourses.[493] Outbreaks of contagious disease during the 1880s increased with expansion of the metropolis.[494] The major disease to threaten the population of Melbourne during this period was typhoid fever. Between 1870 and 1890, death rates of over eight per 10,000 people were consistently recorded in Melbourne, compared with only 1.7 people per 10,000 in London.[495] Melbourne's sanitary condition had raged as both a political and societal issue since 1848 when filthy conditions of streets and waterscapes were blamed for poor population health.[496] The unwillingness of government to

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486 "Coburg Needs. To the Editor of the Age," *Age,* November 9, 1927, 18.
487 Gresswell, 5-36.
488 Dingle and Rasmussen, 27.
489 J. Caldwell, "Population," in *Australians Historical Statistics*, ed. Wray Vamplew (Broadway: Fairfax, Syme, and Weldon Associates, 1987), 23-41.
490 "The Pollution of the Yarra," *Australasian*, February 6, 1869, 21.
491 Tony and Rasmussen Dingle, C, *Vital Connections: Melbourne and Its Board of Works 1891-1991* (Ringwood, Melbourne: McPhee Gribble, 1991), 32.
492 Dingle and Rasmussen, 36.
493 Ibid.
494 Dunstan and Melbourne Council, 272.
495 James Jamieson and Medical Society of Victoria, *Typhoid Fever in Melbourne: Its Prevalence and Causation: An Address Delivered at the Annual Meeting of the Medical Society of Victoria, 12th January, 1887* (Melbourne: Stillwell, 1887), 2.
496 Dunstan and Melbourne Council, 121.

spend money exclusively in the city resulted in Melbourne's sewerage problem continuing unabated.[497]

Dan Gresswell, formerly a public health administrator in England, published his *Report on the Sanitary Condition and Sanitary Administration of Melbourne and Suburbs* in 1890. He reported most of Melbourne's watercourses had very low flow rates during dry periods. The Merri and Moonee Ponds creeks were bubbling with decomposition and notoriously for their stenches. The Yarra River flowing though the centre of the metropolitan area collected and drained sewage from almost every suburb. Gresswell believed rectifying waterway conditions was an engineering question, with a metropolitan-wide sewerage system the long-term solution. In the interim, he argued for the immediate cleansing and flushing of the watercourses and application of lime, often used to prevent odours emitting from sewage sludge.[498]

Creation of the Melbourne Metropolitan Board of Works: Melbourne's first sewage system

As has been seen, Melbourne's sewage problem became the focus of debates, municipal conferences, constitutional crisis, political deadlocks, and Royal Commissions in the first fifty years of the city's existence.[499] In June 1890, it was proposed to establish a Board of Works with authority to build sewers and operate Melbourne's water supply.[500] In March 1891, the Board met for the first time, established under *An Act to provide for the better Local Management of the Metropolis and for the creation of a Melbourne and Metropolitan Board of Works. [20th December, 1890.]*[501] Its third schedule applied to the management of Melbourne's urban watercourses:

> All the bed soil and banks of the River Yarra Yarra and of all other public rivers creeks and watercourses within the metropolis…shall without any conveyance

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[497] Dingle and Rasmussen, 18.
[498] Gresswell, 19; Bjarne Paulsrud and Eikum Arild Schanke, "Lime Stabilization of Sewage Sludges," *Water Research* 9, no. 3 (1975): 297.
[499] Dingle and Rasmussen, 17-27.
[500] Dingle, Doyle, and Victoria Public Record Office, 21-22.
[501] Melbourne Metropolitan Board of Works, *A Manual of the Melbourne and Metropolitan Board of Works Act 1890, and of the Acts to Amend the Same, Viz. Act 1351, of 1893, Act 1491, of 1897, and Act 1523, of 1897 : Together with the Lands Compensation Act 1890, the Water Act 1890, Division 1, Part V, by-Laws and Regulations Made by the Board, and Table of Contents and Index* (Melbourne: Melbourne: Robert Barr, Printer to the Board,1898), 1.

> assignment or transfer be and become vested in the Board upon trust for the purposes respectively of supplying water to the inhabitants of the metropolis of providing for the sewerage and drainage of the metropolis and the commerce and recreation of the inhabitants of the metropolis, but subject to the estate and interest of any person existing therein at the passing of this Act and to the right of Her Majesty to resume possession at any time without payment of compensation of any land required for any public purpose with the consent of Parliament or for public highways.[502]

The Melbourne Metropolitan Board of Works (MMBW) had 39 members selected from the City of Melbourne and the inner and middle suburbs. Representatives from each local council were selected by councillors from within their municipality.[503]

The first task for the board was to design, construct, and maintain a metropolitan-wide sewerage system and treatment facility.[504] By this time, Melbourne had a population of almost half a million.[505] The 1888 Royal Commission had determined Melbourne was in dire need of an underground (deep drainage) sewerage system, and the Commission had requested designs from three local engineers for suitable schemes.[506] All looked to Europe for solutions, with final presentations to the Sanitary Committee consisting of elements drawn from the latest European systems. Their three separate designs all utilised water for transporting sewage and collected only sewage and waste, excluding rainwater. The main sewers would travel along the contours of river and stream banks within the area as the sewage would be brought by gravity to a pumping station then pumped out to flat farm land for irrigation, south west of Melbourne.[507] The city's topography, being low and flat, created problems for sewerage systems designed on gravitation to ocean outfalls.[508] The commission was greatly impressed with local engineer William Thwaites' design, composed of a separate system that

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[502] Ibid, 21.
[503] Dingle and Rasmussen, 24.
[504] Gibbs and Melbourne and Metropolitan Board of Works, *Water Supply and Sewerage Systems of the Melbourne and Metropolitan Board of Works: Compiled from Official Documents*, 54-55.
[505] Dingle, 27.
[506] Robert David La Nauze and Melbourne and Metropolitan Board of Works, *Engineer to Marvellous Melbourne: The Life and Times of William Thwaites* (North Melbourne, Vic.: Australian Scholarly Publishing, 2011), 117-21.
[507] Dingle, 42; La Nauze and Melbourne and Metropolitan Board of Works, 119.
[508] J. W. McCarty and C. B. Schedvin, *Australian Capital Cities: Historical Essays* (Sydney: Sydney University Press, 1978), 96.

only collected sewage, with all rainfall and other surface drainage excluded.[509] In presenting his design, Thwaites argued:

> Taking 700,000 people as the basis, 60 gallons per head, you get 42,000,000 gallons to start with as the polluted drainage water. There are about 40,000 acres covered in Melbourne with population. At 3,000 gallons an acre that comes to 120,000,000: and if you deal with your water supply alone, you have only to deal with 40,000,000. If you deal with water, say the tenth of an inch of rainfall that makes 160,000,000 so that even taking in that very small amount you make it necessary to increase the size of your sewers four times.[510]

Thwaites' proposal used gravity to move the sewage along the mains to a pumping station beside the Yarra south-west of the city. The sewage would be pumped south to flat farming land for treatment and disposal. As the region's watercourses flowed along the lowest contours, sewerage mains would follow alongside Melbourne's rivers and creeks.[511] The design of a sewage-only system was unique for that period, as London's system of the mid-late 1800s, and many European, and North American cities all utilised combined sewers.[512] The Commissioners' first recommendation was recruitment of an engineer with high attainments from Britain, Europe or the United States, experienced with deep drainage projects of large cities with similar ground contours to Melbourne's.[513] James Mansergh from Great Britain was recruited: his previous projects included England's first modern sewage farm, and the planning of sewerage systems for the towns of Derby, Burton-On-Trent, Plymouth, Coventry, and Southport.[514] Analysing Melbourne's conditions, Mansergh compared the Yarra with the Thames, concluding it could never accept Melbourne's sewage as the Thames accepted London's. The tidal scour was only a fraction of that generated by the Thames, thus Melbourne's sewage would be sent slowly to the land-locked bay where

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[509] La Nauze and Melbourne Metropolitan Board of Works, 118-21.
[510] Royal Commission to Inquire into and report upon the sanitary condition of Melbourne, *Sanitary Condition of Melbourne: Third Progress Report, Drainage & Sewerage*, (Melbourne: Robert S. Bane Government Printer, 1889), 14.
[511] Dingle and Rasmussen, 42.
[512] Loforano, 5259-60.
[513] "The Sanitary Commission," *Argus*, April 18, 1889, 8.
[514] Dingle and Rasmussen, 42.

tidal flows were too weak to send it into the ocean.[515] Therefore, Mansergh proposed and costed eight different sewerage schemes, allowing for 75 gallons of sewerage per person per day. His report stated:

> The sewers will therefore take all the water passing through w.c.'s, lavatories, baths, and urinals, all chamber slops, water used in cooking, washing food, clothes, floors, & c., and generally from sinks, in kitchens, cellars, and sculleries, from stables, cowhouses, & c., and from the washing of paved yards-under stringent regulations where these are small in area. They will also take such liquid trade and factory refuse as will not prejudicially affect the brickwork, stonework, concrete, ironwork, or any other parts of the structure of sewers, pumping stations, machinery and all their accessories. When all these sources of pollution have thus been disposed of, the existing surface channels may be retained generally and continued in use for carrying off the rainfall to the natural water-courses as at present.[516]

Thwaites was appointed Board of Works engineer-in-chief, the engineer whose design had so impressed the Royal Commission. He assisted Mansergh by providing data on Melbourne's rainfall.[517] Both Thwaites' and Mansergh's ideas for a separate sewerage system were not new for Melbourne. George Gordon, winner of a competition established by the Lord Mayor of Melbourne for an essay on the Drainage of Melbourne competition had recommended the idea in his 1881 essay 'Non Olet' ('No Smell').[518] Gordon was chief engineer of the Water Supply Department until 1875. His proposal, which directly referred to the 'Third Report of the English River Commission', recommended the separation of sewage and household wastes from stormwater and general urban runoff.[519] The reason given for the separation was the impossibility of constructing sewers of adequate size to accept flows generated by flash floods.[520] The main difficulties confronting the designing of a sewerage

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515 Dingle, 44.
516 James Mansergh, *Report on the Sewerage and Sewage Disposal of the Proposed Melbourne Metropolitan District: Addressed to the Honourable Duncan Gillies M.L.A., Premier of Victoria, Etc., Etc., Etc* (Melbourne: Robert. S. Brain, Government Printer, 1890), 15.
517 La Nauze and Melbourne and Metropolitan Board of Works, 121-26.
518 "The Drainage of Melbourne," *Argus,* September 16, 1881, 6.
519 "The Drainage of Melbourne. The Prize Essay," *Argus,* September 17, 1881, 20.
520 La Nauze and Melbourne Metropolitan Board of Works, 12; "The Drainage of Melbourne. The Prize Essay," 20.

system for Melbourne included: the large area, over which the population was dispersed, with only limited areas having a density of 60 to 65 persons per acre (0.405 hectare), with many outer suburbs consisted of only 5 to 10 persons per acre. The extensive range of comparatively flat land elevated only slightly above the high-water mark of tidal flows; and the lack of an outfall into a larger body of water or ocean within reasonable distance of the city.[521]

Once the Board of Works was set up, Thwaites' first task was the examination of Mansergh's eight proposals to determine the most suitable for Melbourne.[522] Thwaites, a local civil engineer and public servant, had worked largely for the Victorian Department of Public Works across the colony. These included ports, reservoirs, roads and bridges and large-scale wetland reclamation works.[523] He is credited with design and construction of Melbourne's first metropolitan sewerage system when employed as the engineer-in-chief of the MMBW.[524] In his report to the board Thwaites recommended Mansergh's scheme, similar to his own, presented to the Sanitary Commission's hearings in 1888.[525] The scheme consisted of a Northern and Southern System, located on each side of the Yarra.[526] The sewerage would flow by gravity to a pumping station located south-west of the city at Spotswood, where it would be pumped to the head of the outfall sewer.[527] The outfall sewer then conducted sewage by gravity to the treatment farm at Werribee on the Bay's western edge.[528] The treatment farm was primarily a grazing property with some cropping that also bred cattle and sheep on irrigated pastures. Once pumped to the farm the sewage was dispersed across pastures and crops by flood irrigation to filter down through the soil. After filtering, a system of drains discharged clear, nontoxic water into Port Phillip Bay.[529] By 1925, the farm was claimed by MMBW secretary George Gibbs as the most efficient and one

[521] Gibbs and Melbourne and Metropolitan Board of Works, *Water Supply and Sewerage Systems of the Melbourne and Metropolitan Board of Works: Compiled from Official Documents*, 54.
[522] Dingle and Rasmussen, 51-52; La Nauze and Melbourne and Metropolitan Board of Works, 127.
[523] Tony Dingle, "Thwaites, William (1853-1907)," *Australian Dictionary of Biography*, National Centre of Biography, Australian National University, accessed April 6, 2016, http://adb.anu.edu.au/biography/thwaites-william-8811.
[524] Ibid.
[525] La Nauze and Melbourne and Metropolitan Board of Works, 132-34.
[526] Gibbs and Melbourne and Metropolitan Board of Works, *Water Supply and Sewerage Systems of the Melbourne and Metropolitan Board of Works: Compiled from Official Documents*, 71.
[527] Ibid, 76-78.
[528] Ibid, 71-79.
[529] Ibid, 80-81.

of the least costly sewage purification systems in the world.[530] The farm, like water catchments, was closed to public access and land development since purchase by the MMBW in 1892.[531] Since that time the Werribee farm, now the Western Treatment Plant, has become an important biodiversity area with part of the site included within the Port Phillip Bay Ramsar Site.[532] The Ramsar classification is based on the Convention on Wetlands of International Importance, especially as Waterfowl Habitat.[533] The Port Phillip Bay site covers the western shoreline, opposite the treatment plant and includes salt marsh, tidal mudflats, mangroves, and various wetlands.[534]

In October 1891, the Board approved the sewerage scheme selected by Thwaites for construction.[535] The system would collect all domestic sewage including drainage from stables and cowhouses, and all liquid refuse that would not affect or damage the Board's sewers, pumping station machinery or treatment farm.[536] The rainfall collected on streets was not to enter the sewers, instead would flow directly into the Yarra River.[537] Once the scheme was approved, design and construction details work commenced. However, Melbourne's initial construction was based on limited investigation of its landscape, topography, geology and hydrology: this was to become a problem.[538] A design requirement to ensure underground sewerage systems work is that all levels of each component part are precisely co-ordinated and the height above sea level is known at every feature in the system.[539] A full and correct survey of Melbourne was necessary before construction commenced.[540] This would involve surveying 78,000 acres (31, 566 hectares), and 108,000 existing houses with enough detail to connect each home into the system.[541]

On the 17th August 1897, the All England Hotel in Port Melbourne became the first property connected. In just over five years since the turning of the first sod, Melbourne had a

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530 Ibid.
531 Dingle and Rasmussen, 53.
532 "Werribee and Avalon," Bird Life International, accessed February 6, 2018, http://datazone.birdlife.org/site/factsheet/werribee-and-avalon-iba-australia/text.
533 Francis and Chadwick, 32.
534 "Sites - Important Bird and Biodiversity Areas (Iba's) Werribee and Avalon," Bird Life Australia, accessed 6 February, 2017, http://www .birdlife.org/datazonelsi1efactsheet.php?id=23933.
535 La Nauze and Melbourne and Metropolitan Board of Works, 141.
536 Gibbs and Melbourne and Metropolitan Board of Works., *Water Supply and Sewerage Systems of the Melbourne and Metropolitan Board of Works: Compiled from Official Documents*, 54.
537 Ibid.
538 Dingle and Rasmussen, 53.
539 Ibid.
540 Ibid.
541 Ibid.

fully functioning sewerage system.[542] In February 1898, the sluice gate on the main sewer at Melbourne's Australia Wharf downstream on the Yarra was raised, allowing sewage to flow from the city to Werribee Farm for treatment.[543] Once the bulk of sewerage ceased flowing across the urban fabric into the rivers, creeks and low-lying areas, the Melbourne *Age* (1905) reported that the 'sewering of the city, in carrying off the scourings from the streets and factories… has done a great deal towards purifying the river'.[544]

By 1907, the Melbourne Metropolitan Board of Works (MMBW) controlled an area consisting of 20 cities, towns, boroughs, and four shires covering an area of 90,821 acres (386 square kilometres) with an estimated population as of December 1907, of 530,000.[545] At the same time 91,272 houses had been connected to the sewerage network that consisted of 2,331 miles (kilometres) of mains, sewers and drains connected to the pumping station.[546] The top image in figure 31 shows a typical MMBW plan for household sewage connections into the street mains. The lower image is the former Spotswood Pumping Station along the western bank of the Yarra. In 1960, the station's capacity was exceeded due to the growth of Melbourne's suburbs during the decades following the Second World War. In addition, corrosion of the wrought-iron, rising mains led the MMBW to decommission the station in September 1965.[547]

With much of Melbourne connected to the system, the MMBW was left with the question of managing the city's waterways. The Board's founding act of 1891 (page 115), made it responsible for the bed and banks of the Yarra, and all other public rivers, creeks and watercourses within the metropolis.[548] However, the decision to construct a separate sewerage system, excluding stormwater collection, had not been considered by the original authors of the legislation, therefore no clear distinction had been established between sewers and drains.[549]

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[542] Ibid, 78-79.
[543] Ibid, 79.
[544] "Melbourne, Monday 23rd October, 1905," *Age*, October 23, 1905.
[545]E. T. Drake, "Victorian Year Book 1907-8," ed. Office of the Government Statist (Melbourne, Victoria: Victorian State Government, 1907-1908), 251.
[546] Ibid, 254.
[547] Melbourne Water Corporation, *Melbourne Sewerage System – Nineteenth Century Scheme* (Melbourne: Melbourne Water Corporation, 2014), 17.
[548] Melbourne Metropolitan Board of Works, 1.
[549] Dingle, 153-54.

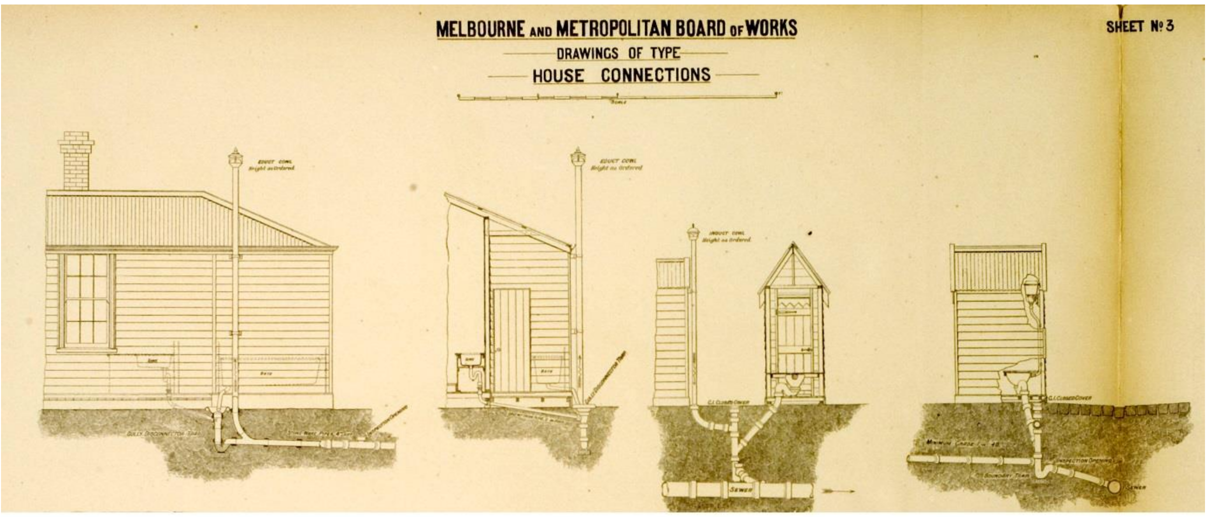

Figure 31. Detail for house connections into sewerage only system. Spotswood pumping station beside the Yarra. Sources: PROV, VPRS 8609/P20, Unit 332 – Author photo (2015).

The design of Melbourne’s sewerage system was arguably decades ahead of other large cities at that time and sewerage systems constructed in the United Kingdom since 1945 are separate systems, with many North American cities built separate systems after the 1920s.[550] However, when compared with other Australian capital cities, it was Adelaide, South Australia, where the first metropolitan-wide sewerage system was constructed that excluded surface drainage.[551] Adelaide’s system utilised a treatment farm with the treated effluent discharged into the ocean.[552] Similar to the system that would be later constructed in Melbourne, the first properties were connected in 1882, nine years before the creation of the

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[550] David Butler and John W. Davies, *Urban Drainage*, 3rd ed. (London: Spon Press, 2011), 20; Joel A. Tarr, “The Separate Vs. Combined Sewer Problem: A Case Study in Urban Technology Design Choice,” *Journal of Urban History* 5, no. 3 (1979): 335.
[551] Marianna Hammerton, *Water South Australia: A History of the Engineering and Water Supply Department* (Netley, S.A.:Wakefield Press, 1986), 39.
[552] Ibid.

MMBW.[553] In comparison, although construction of sewers commenced in Sydney, New South Wales, from the 1860s, Coward *Out of Sight: Sydney's Environmental History 1851-1981* reported that as late as the early 1970s, 80 percent of the city's industrial and domestic waste was being discharged into the sea via four ocean outfalls.[554]

Combined systems were primarily designed to discharge both sewage and rainwater into a receiving watercourse as rapidly as possible. They were not originally developed to include treatment of wastewater.[555] Both combined and separate sewers are based on the centralised water carriage waste removal system.[556] This type of system consists of construction of a coordinated system of conduits and channels utilising water to convey sewage waste away from the source to a central disposal locality.[557] The principle of the water carriage system was to keep sewage diluted and flowing thus providing a self-cleaning motion to the conduit.[558] In London, the combined sewerage system utilised rivers and watercourses as conduits for the collection and transport of sewage and stormwater resulting in many of London's sewers being built along the lines of watercourses since covered over and lost from the surface.[559] In Melbourne, many of the creeks and tributaries that may have been covered as combined sewers remained open to the surface. Lacking definitions and legislation about the management of Melbourne's watercourses, the MMBW largely ignored the city's rivers and creeks for the first two decades of the 20th century, instead focussing on extending sewers and constructing water supply infrastructure.[560]

Though an engineered solution, the sewerage system allowed the city to retain many of its creeks and tributaries to flow across the surface of its urban fabric. As previously discussed, many smaller creeks were erased from the surface by continuing suburban development. However, many more were left open as a direct result of the separate sewerage system. Many of Melbourne's flowing surface creeks are now valued as corridors of remnant

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553 La Nauze and Melbourne and Metropolitan Board of Works, 108.
554 Dan Coward, *Out of Sight: Sydney's Environmental History 1851-1981* (Canberra: Dept. of Economic History, Australian National University, 1988), 138.
555 L Heip, Bellers, R, and Poppe, E, "The Collection and Transport of Wastewater," in *Decentralised Sanitation and Reuse: Concepts, Systems and Implementation*, ed. Gatze Lettinga, P. N. L. Lens, and Grietje Zeeman (London: IWA Publishing, 2001), 100.
556 S. Burian et al., "Urban Wastewater Management in the United States: Past, Present, and Future," *Journal of Urban Technology* 7, no. 3 (2000): 37.
557 Ibid.
558 C. Hamlin, "Chadwick,Edwin and the Engineers, 1842-1854 - Systems and Antisystems in the Pipe-and-Brick Sewers War," *Technology and Culture* 33, no. 4 (1992): 262-63.
559 Richard Trench and Ellis Hillman, *London under London*, New ed. (London: J. Murray, 1993), 72.
560 Dingle, 154.

vegetation, habitat for fauna, providers of urban eco-services, recreational areas, trails and cycle routes and patches of urban ecology.

Conclusion

This chapter highlighted the problems the European urban development of Melbourne created for the area's waterways, and the problems in supplying the city with vital services for the health, well-being and sustained survival of city's growing population. All these needs involved the direct and indirect use, abuse and modification to the watercourses. The results provided Melbourne with a best-case practice, decades ahead of many other cities globally, at the time. The problems the planners and developers of early Melbourne sought to solve have rarely been assessed on an historical basis and it is rare that government bodies have acknowledged these problems. Despite a lack of record keeping, the urban environmental history of Elizabeth Street has been developed, illustrating the story of how one creek became a drain. With the surprise of significant floods once every few decades, as evident in the 1881 flood, illustrated in figure 32, the creek proves how Melbourne's urban environmental history effects on quality of life in a section of the city originally laid out as a regimented grid.

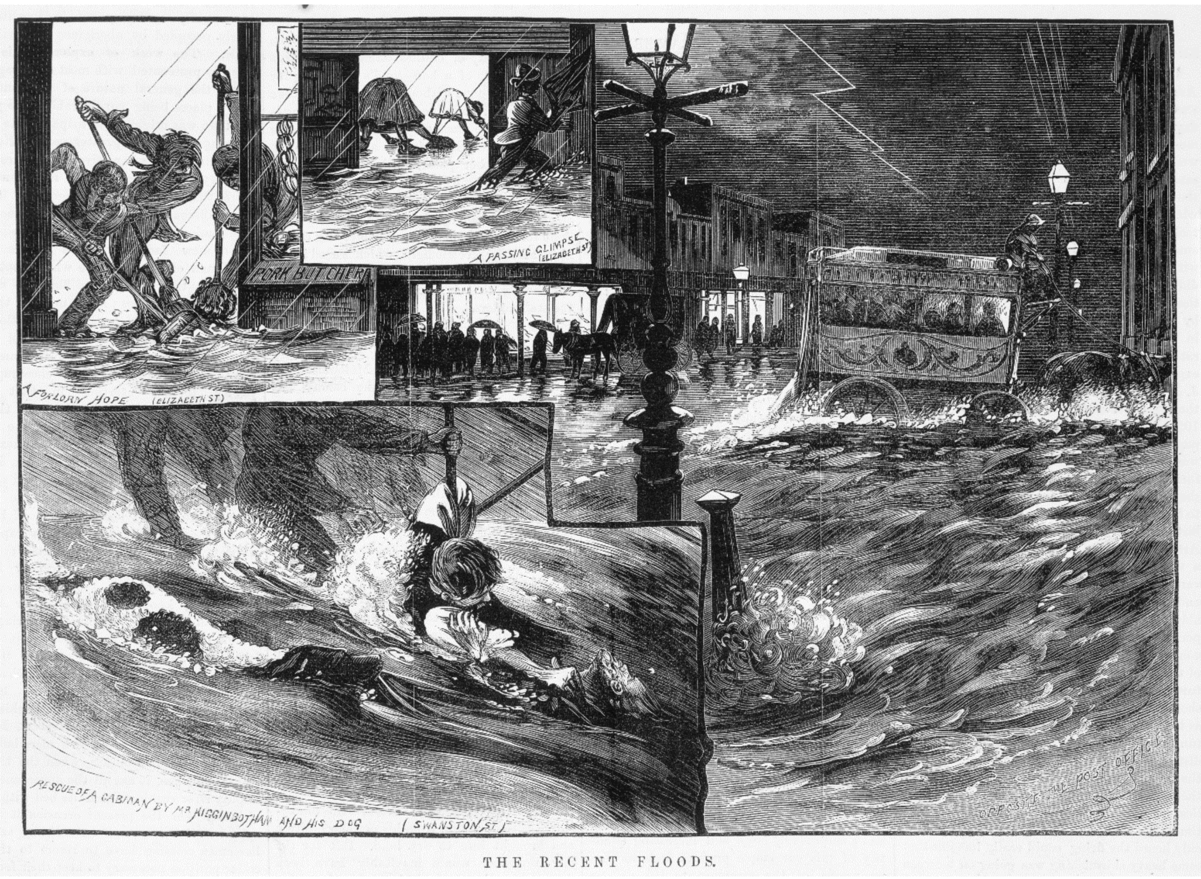

Figure 32. The flood along Elizabeth Street in November 1881. The nuisance resurfaces. Source: SLV http://handle.slv.vic.gov.au/10381/132465

Chapter Five: Influences changing the management of Melbourne's urban watercourses 1890s to mid-20th century

> [T]he rapid growth of the city and the Metropolis is creating unsatisfactory conditions, which require immediate attention, and that it is therefore necessary to further regulate development on modern scientific lines.[1]

Introduction

At the beginning of the twentieth century as Melbourne and suburbs were being progressively connected to the sewerage system, rivers, their tributaries and remaining wetlands were becoming less polluted. Engineers and planners began using newspapers to express ideas regarding Melbourne's watercourses as more than mere open sewers and nuisances. In 1904, William Thwaites (see chapter four, page 146-47) designer and supervisor of construction for most of Melbourne's separate sewerage system stated:

> The Yarra Yarra, to the average inhabitant of modern Melbourne, is not by any means associated with beauty, although its usefulness may have been apparent, chiefly, however, as the common sewer of the metropolis.[2]

Two decades later similar sentiments were voiced by surveyor and town planner Saxil Tuxen who also served as a commissioner for the Melbourne Metropolitan Town Planning Commission (MTPC). Tuxen wrote an article, 'What We Might Do with the Yarra' published in the Melbourne *Herald*, in which he asked his readers:

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[1] Victoria Metropolitan Town Planning Commission, *Plan of General Development, Melbourne: Report of the Metropolitan Town Planning Commission* (Melbourne: H.J. Green, Govt. Printer, 1929), 1.
[2] "Lake Ivanhoe" a Proposed Beauty Spot. Health, Utility, Recreation. Damming the Yarra," *Herald*, September 6, 1904, 3.

> Do you realise what a wonderful city Nature… has given to us, not for our use merely, but as a trust for prosperity, to use, to enjoy, to hand on enhanced by whatever of invention, of art, of hard work each generation can give? The original planners did their work well. Generous provision of park-land; ample streets; excellent situation by a waterway that comes almost into the heart of the city….[3]

The above quotes illustrate changing attitudes regarding roles for Melbourne's watercourses early in the twentieth century. During this period, many city authorities were also redefining how rivers and any tributaries still open to the surface were being treated, used and 'fitted' into ever-changing global urban fabrics. Boston's Fens and River-way, designed and constructed during the late 19th century by landscape architect Fredric Law Olmstead, Sr. (see chapter two, page 42) combined environmental engineering with the 'Picturesque' landscape ideology and the symmetry of European boulevards to create an urban parkland system. The design addressed water quality, flooding, and recreation while utilising principals of ecology with engineering, resulting in Olmstead's ideas becoming highly influential. New uses and roles, evident in Olmstead's work, evolved to encompass perceptions developing from modern empirical scientific methods regarding urban water management, public health and sanitation, engineering, and planning. The decision to construct a sewerage-only system in Melbourne was based on the region's rainfall and climatic conditions. This shows willingness amongst local engineers to consider Melbourne's natural environmental conditions and implications on their design and use of the area's waterways. The engineering of the eastern city reaches of the Yarra, from Princes Bridge for a distance upstream of two kilometres (1.2 miles) for flood control, between 1896 and 1901, although purely an engineered solution also included landscaping of the designed riverbanks, providing the city centre with its first riverside parkland and boulevards. These projects could be viewed as major stepping-stones towards Melbourne beginning to firstly consider, and then develop modern scientific town planning approaches towards its watercourses within the context of the ongoing development of the urban fabric. The design of the 'Modern City' placed nature and natural systems (such as waterways) as a focus of contemplation and leisure.[4]

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[3] Saxil Tuxen, "What We Might Do with the Yarra," *Herald*, November 27, 1926, 17.
[4] Gandy, "Rethinking Urban Metabolism: Water, Space and the Modern City," 366.

During the first 75 years of Melbourne's urban development, the fundamental uses and roles of the city's watercourses were established. Uses, identified in the previous chapter, included provision of potable water to city dwellers, shipping routes connecting Melbourne with the outside world, and use as open sewers and stormwater and drainage channels. The decision to construct a separate sewerage system saved the city's watercourses from becoming combined sewers. Commonly watercourses used as combined sewers were covered and buried. This was effective insofar as it controlled odours and flooding, and improved flow rates to prevent silting and blockages. Additionally, the end of the section of Yarra undergoing realignment and enlargement for flood management was developed as a picturesque boulevard for recreational activities. This started the first tentative establishment of Melbourne's rivers as aesthetic landscape features, promoted for their beauty and recreational use, a major change in perception.

Developing suburbs had used the tributaries of the Yarra, Maribyrnong, and Plenty Rivers as open sewers, drains, and rubbish dumps; their riparian zones and flood plains supplied flat land for constructing recreational facilities. Many were still open sewers for suburbs yet to be connected to the sewerage system; some had their banks and riparian zones quarried, and some became sources for irrigation. For a city only 65 years old, by 1900 Melbourne had already dramatically altered kilometres of its waterways by a range of management approaches. These included: re-design, engineering, diversion, placement into barrel drains, filling and reclamation of the land, '(de-)snagging' and removal of rock barriers, from streambeds.

The MMBW, founded in 1891, was entrusted with the management of all public rivers and creeks flowing within Melbourne's metropolitan area, their banks and streambeds. However, it would be thirty years before legislation was enacted for its management of watercourses. This legislation resulted in the MMBW strongly defining use and management of Melbourne's waterways for most of the 20th century. The creation of the MTPC in 1922 and its work in the planning of the city's waterways also affected significantly on perception of watercourses and their re-design. Approaches to urban watercourses by both the MMBW and MTPC were heavily grounded in modern scientific ideas about public sanitation and health, town planning and hard engineering. Based upon the modern engineering approach to water and hydrology, significant legislation introduced in 1926 defining the MMBW's management of waterways had profound and dramatic consequences, many of which underpin contemporary management and use of Melbourne's watercourses.

Two ideals conflicted during this period. One perceived the watercourses as valuable natural assets to be nurtured and integrated into the urban fabric. The other saw them as a stormwater drain network, vital in flood alleviation. This chapter examines these ideals and their historical context.

Urban water management

Melbourne's urban water management history closely parallels approaches examined by Brown, Keath and Wong in their *Urban water management in cities*. This work, already canvassed in chapter two, is applied here to illustrate the evolution of Melbourne's urban water systems from the 1850s to the 1950s. Brown et al propose Australian cities transitioned approaches to urban water management through six typologies. The first two of these included the 'Water Supply City' and the 'Sewered City'.[5] The water supply city is the first stage in the development of a modern urban water city, focussing on the effective provision of safe, secure, and reliable potable water supplies for a growing urban population. The 'Sewered City' stage in Australia appeared during the mid-to-late 19th century. By this time rational engineering communities had been well established between Australia and the United Kingdom, as public health concerns focussing on the epidemic outbreaks of cholera and typhoid in Europe, and typhoid in Australia, were of most concern to urban communities and government.[6] The 'Sewered City' phase involved the construction of sewerage systems (such as Melbourne's) to collect, transport and dispose of sewage to locations outside cities. In the case of Melbourne and Werribee, there appears to be no published data about the quality of the treated effluent discharged into the bay during the early 20th century. This may be the result of the widely understood model for sewage disposal by engineers, governments and the public at the time. For example, many coastal cities were discharging their combined sewers into oceans: an article in Hobart's *Mercury* (1912) reported on the success of the cities of Blackpool and Belfast in discharging sewage offshore.[7] During the sanitary dark ages spanning, the 15th to 19th centuries, sewage and manure were valued as fertiliser, collected in urban cesspits and sold to farmers and there was a well-developed knowledge that sewage

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[5] Brown, Keath, and Wong, 850-51.
[6] Ibid, 852.
[7] "Land Filtration," *Hobart Mercury*, November 26, 1912, 7.

and manure were valuable resources as fertiliser for agriculture.[8] The idea of modern sanitation and cities, in which sewage and waste had become deemed hazards to public health, was at odds with this perception.[9] Within this context, the Werribee Farm could be considered a compromise between the two understandings. One aspect of Werribee Farm that did attract public and media attention during the farm's first decades was public annoyance. Newspapers reported odours emitted from the farm experienced at distances of 13 kilometres (8 miles) away.[10] The smell emitted from Werribee has continued to be notorious.

The third typology concerned with urban water management is the 'Drained City' focussing on the management of stormwater and flooding for expanding urban fabrics. This resulted in many urban watercourses piped and buried or channelized, for the efficient and swift removal of stormwater from the urban fabric. Brown et al suggest the drained city phase developed in Australia after the Second World War.[11] Melbourne entered this stage earlier for two reasons. The city and suburbs were continuing to experience frequent, severe flooding; and the decision to construct a separate sewerage system, excluding stormwater, had not been considered by the original authors of the legislation for the founding act of the MMBW. Although the act entrusted the MMBW with the management of all public rivers and creeks, the legislation made no clear distinction between what constituted sewers and drains.[12] By 1900, 30,000 properties in the Melbourne metropolis were connected to the sewerage system.[13] With significantly less sewage flowing across the urban fabric to enter the Yarra, the river's condition was markedly better. Indeed, the overall general sanitary condition of Melbourne had improved: it was no longer 'Smellbourne' (page 50).[14] However, this left the MMBW with the question; how should the rivers, creeks and smaller tributaries be managed?

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[8] P.F Cooper, "Historical Aspects of Wastewater Treatment " in *Decentralised Sanitation and Reuse: Concepts, Systems and Implementation*, ed. Gatze Lettinga, P. Lens, and Grietje Zeeman (London: IWA Publishing, 2001), 14; Matthew Gandy, *Emancipatory City? Paradoxes and Possibilities* (London: SAGE Publications Ltd., 2004), 182; Loforano, 5272.
[9] Gandy, *Emancipatory City? Paradoxes and Possibilities*, 182.
[10] "Werribee Farm. Protests at Geelong. Opposition to Extension," *Age*, December 2, 1926, 12.
[11] Brown, Keath, and Wong, 852.
[12] Dingle and Rasmussen, 53-154; Melbourne Metropolitan Board of Works, 21.
[13] Dingle and Rasmussen, 102.
[14] Ibid, 105.

Melbourne's rivers and creeks from 1900 to mid-century: Floods and main drains

By the early 1900s, the sewering of central Melbourne and its inner suburbs was well advanced. Flows of raw sewage and waste entering the Yarra and its main tributaries within the greater metropolitan area had decreased.[15] The *Age* (1905) reported:

> The sewering of the city, in carrying off the scourings from the streets and factories, instead of having that refuse shot into the Yarra, has done a great deal towards purifying the river, with the result that the atmosphere of the whole city is much purer… [16]

Modern urban sewerage systems were entirely engineered solutions, designed to address problems of public sanitation and urban pollution.[17] Combined sewers had become a widely accepted approach to public sanitation management during the 19th century and many cities were covering urban waterways as components of combined sewer systems. Figure 34, the City of Vancouver, Canada, shows all the city's lost watercourses, many buried as combined sewers during the 19th and 20th centuries.[18] In 1992 Landscape Architect Moura Quayle, conducted a project exploring Vancouver's urban fabric for buried streams, estimating 90 per cent of the city's streams had been covered and buried.[19] Figure 33 maps the buried streams, shown in blue.

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[15] "Editorial," *Age*, October 23, 1905, 6.
[16] Ibid.
[17] Shannon and De Meulder, 5.
[18] D. Fass, *Historical Walking Tour of Gibson Creek through Kensington–Cedar Cottage*, (Vancouver: Kensington-Cedar Cottage City Plan Committee, 2009), 1-25, http://www.vcn.bc.ca/gibbys/docs/GFS_09Nov_Booklet.pdf.
[19] R Sarti, "Navigating the Main Streams beneath Vancouver: Landscape Architect Discovers Beds Paved," *The Vancouver Sun*, February 11, 1992, B8.

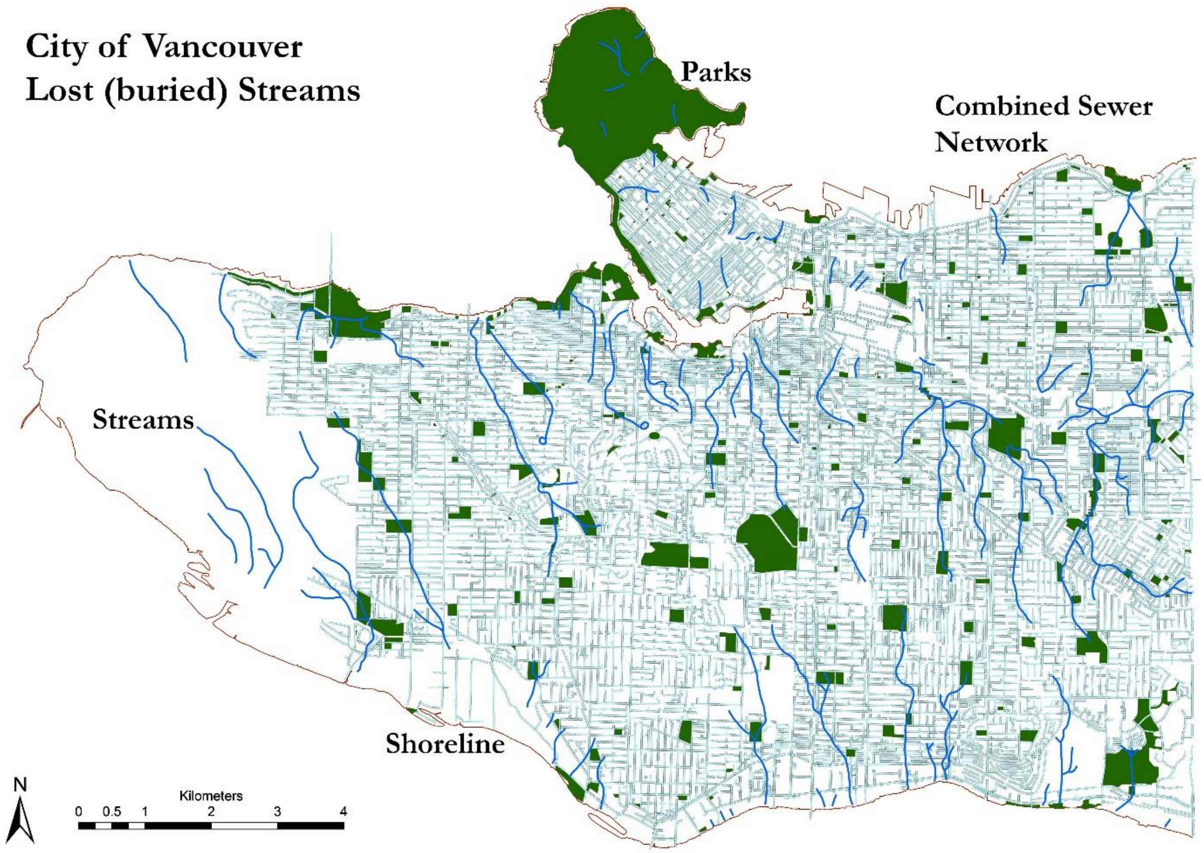

Figure 33. City of Vancouver buried streams in relation to combined sewer mains.

In Melbourne, however the Yarra and its many tributaries, neither covered nor buried, posed a question for the city and the Board of Works of how best to manage these unpredictable features, often in flood, as they became increasingly surrounded by the expanding urban fabric.[20] E.W. Cole’s Tramway map of Melbourne (figure 35) shows the main rivers and creeks flowing across the urban fabric in 1900. Compared with Hoddle’s mapping of the region’s major river and tributaries in 1840 (figure 36), there appears more, smaller tributaries on Hoddle’s map than Cole’s. This discrepancy may indicate by 1900 the extent to which many smaller tributaries had been buried during the late 1800s or placed into barrel drains such as Elizabeth Street Creek. During the nineteenth century creeks around Melbourne were often placed into barrel drains to control odour from sewage flows, (miasmas), prevent flooding or to simply ‘clean-up’ unsightly creeks that were used for refuse dumping by residents.[21]

[20] Dingle and Rasmussen, 153-54.
[21] Senior, 413.

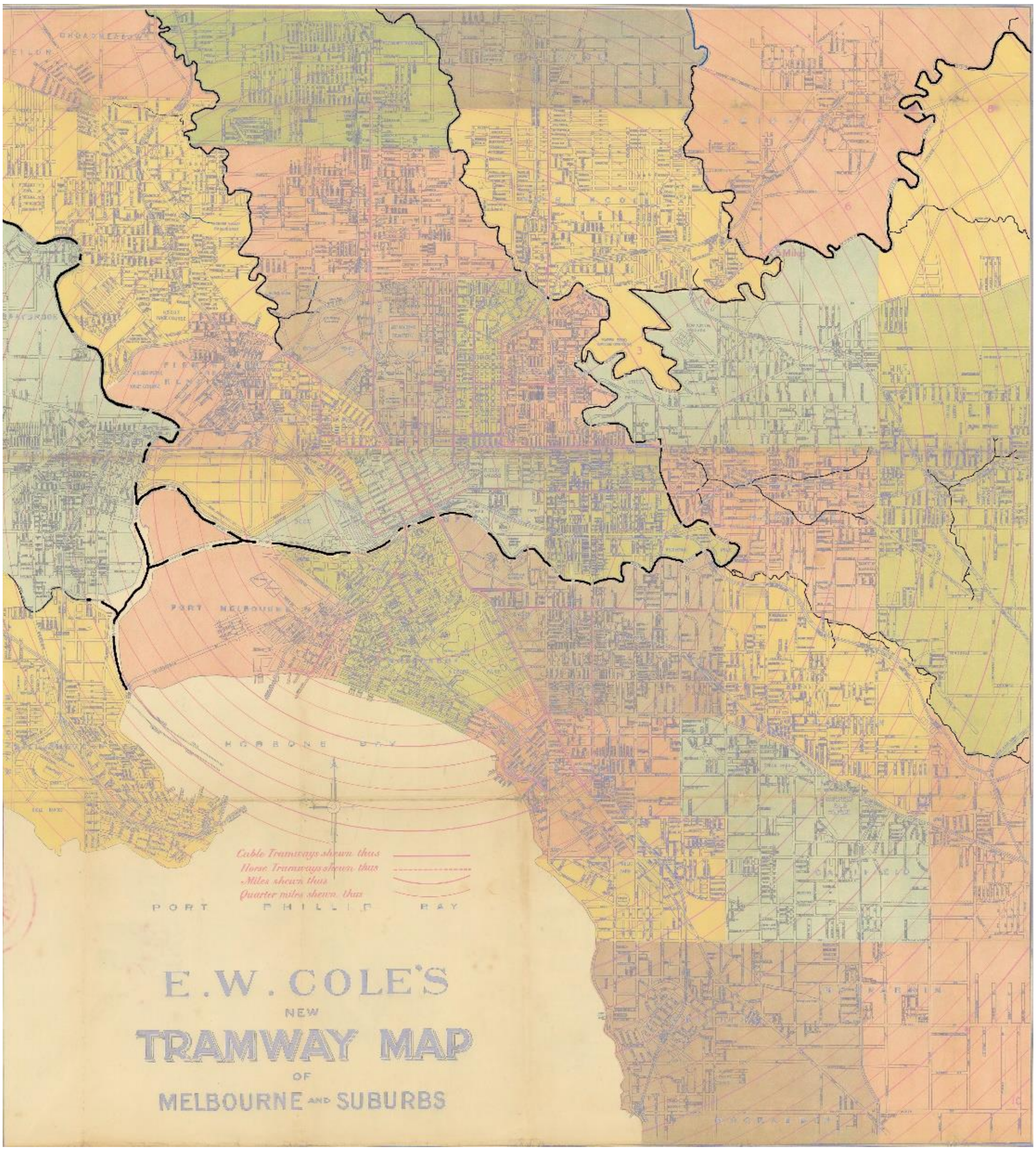

Figure 34. Melbourne's surface watercourses in 1900 - highlighted in black. Source: SLV http://handle.slv.vic.gov.au/10381/141066

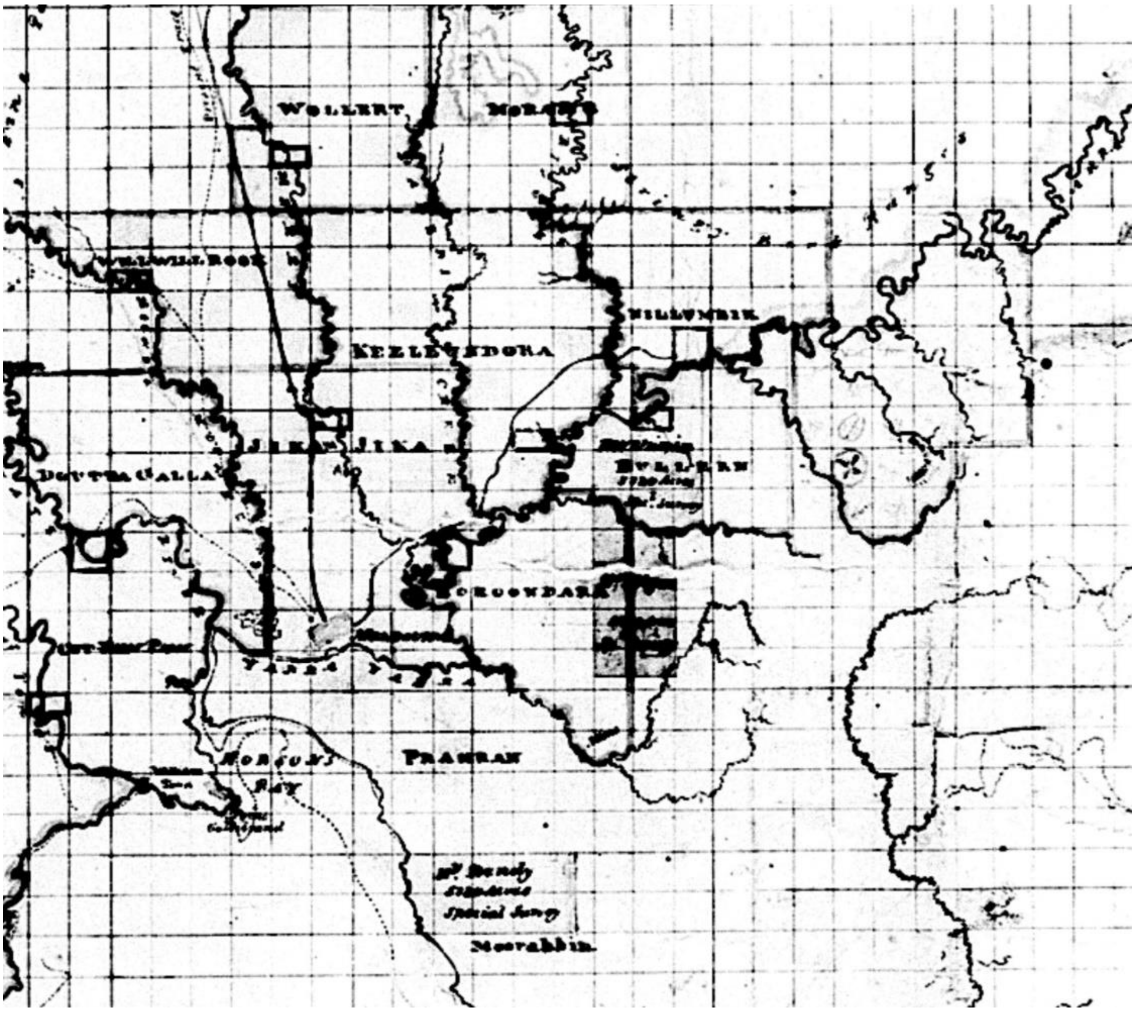

Figure 35. Hoddle's 1840 survey map of watercourses across the Melbourne region. Source: SLV (Victoria. Dept. of Crown Lands and Survey) http://search.slv.vic.gov.au/MAIN:Everything:SLV_VOYAGER2563112

By 1900 Melbourne’s rivers and creeks remained perceived as flooding nuisances by many of the population. From 1901 to 1954 the Yarra experienced a further 25 significant floods ranging from 300 to 850 cubic metre per second flows.[22] Image 36 is a photograph of the April 1901 flood level along the Yarra in the suburb of Abbotsford, with the flood levels on the Yarra within the Greater Melbourne area from 1900 to 1955 listed in table four.

[22] Lacey, 243-44.

Table 4. Floods on the Yarra in the Greater Melbourne region from 1900 to 1955

Date	Peck flow – (cumecs) Cubic metres per second
1901 - April	650
1904 – August	325
1911 - March	300
1911 – June	470
1916 – September	510
1918 – September	470
1920 - October	475
1920 – November	430
1923 – October	850
1924 – August	610
1924 - October	330
1930 – December	355
1934 – October	420
1935 – May	430
1937 – October	570
1939 – August	325
1946 - February	340
1952 – July	710
1952 – December	470
1953 – October	405
1954 – November	490

Table 4. Floods on the Yarra River in Greater Melbourne - 1900 to 1955. Source: Lacey 2004, pages 255-256.

Figure 36. Yarra in flood at Abbotsford, April 1901. Source: SLV H92.200/406

The problem of intermittent flooding not only created havoc and destruction across Melbourne, it was also one of reasons for the MMBW's unwillingness to accept responsibility for the city's rivers, tributaries and drainage. The original 1891 founding Act for the MMBW stated:

> All the bed soil and banks of the River Yarra Yarra and of all other public rivers and creeks and watercourses within the metropolis…become vested in the Board upon trust for the purposes respectively of supplying water…of providing for the sewerage and drainage of the metropolis and the commerce and recreation of the inhabitants of the metropolis…[23]

[23] Melbourne Metropolitan Board of Works, *An act*, 21.

Yet, for the first thirty years of its existence, the MMBW denied responsibility for surface drainage and the Yarra flowing within the Melbourne metropolitan area. Despite several attempts to clarify and define what constituted 'drainage' during the first decades of the 20th century, the MMBW remained reluctant to engage with the process, due to unease regarding liability issues.[24] Melbourne had developed during the 19th century with little restriction regarding the construction of housing and buildings on floodplains and areas of land subject to intermittent flooding. Following the 1870s, Melbourne's suburbs expanded at a significant rate.[25] Houses were built on all available land regardless of previous uses. This included former wetlands (swamps) and refuse dumps, low-lying areas, land subject to flooding and locations where hospital waste and night soil had been dumped.[26] The *Argus* (1878) highlighted the problem during March when low lying sections of South Melbourne along the Yarra were flooded; 'During the last few years a very large number of small wooden or brick cottages have been erected on the low-lying land… and some hundreds of these houses were flooded…to depths varying from 3ft to 6ft…' (0.9 -1.8 metres).[27] In 1936 following recurring flooding, South Melbourne council resolved to borrow a sum of £10,000 for the reclamation of low lying land near Montague railway station subject to flooding.[28] The contour plan of the area (Figure 37) indicates little elevation between the affected land and the Yarra.

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[24] Dingle and Rasmussen, 154.
[25] Ibid, 38.
[26] Ibid.
[27] "The Floods," *Argus*, March 18, 1878, 5.
[28] "Reclamation and Housing of Low Lying Areas," *Shepparton Advertiser*, January 27, 1936, 5.

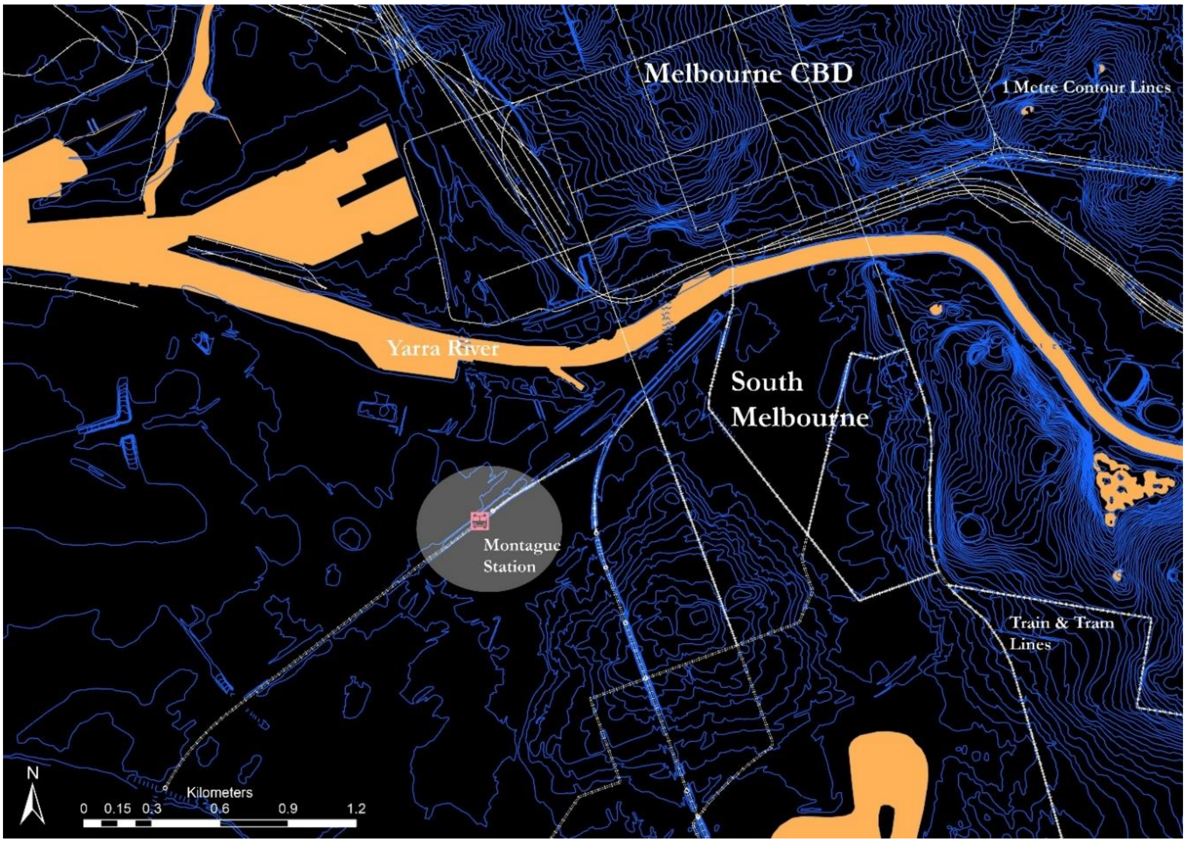

Figure 37. Contour plan, South Melbourne and the area surrounding Montague Railway Station.

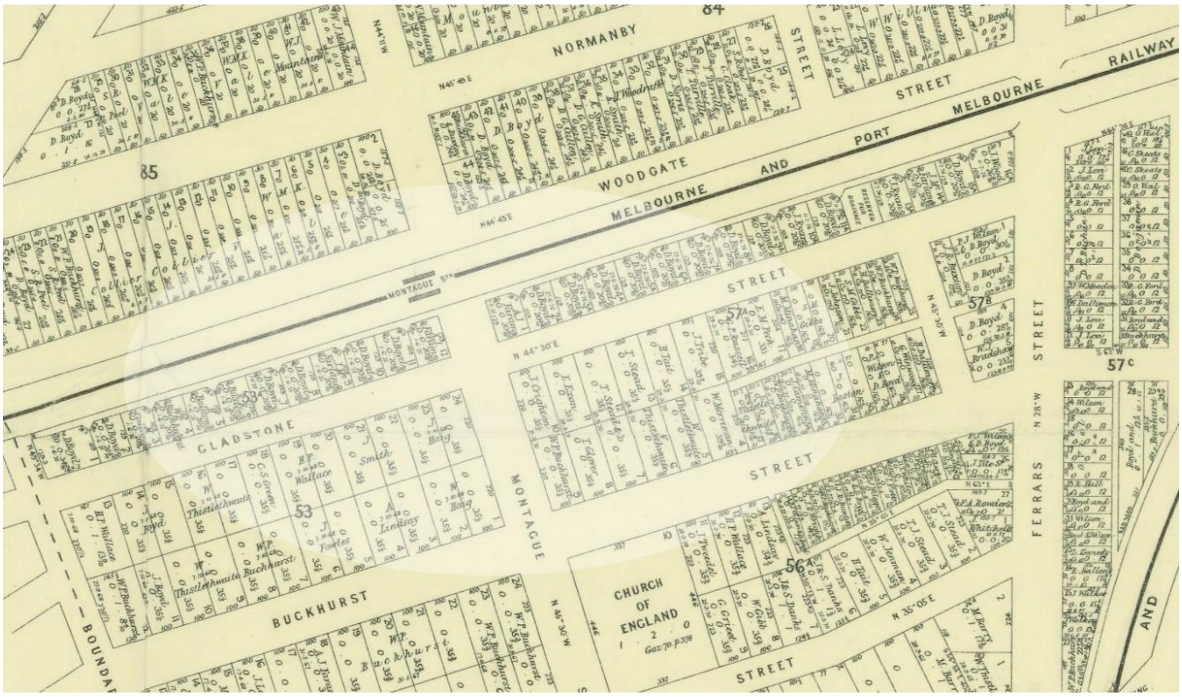

Figure 38. Map of the area in 1881 showing houses that were demolished, and the land reclaimed over 1936-39. Source: SLV http://handle.slv.vic.gov.au/10381/117425

Due to the low elevation of the area, under the right conditions of the wind and tide, water banked up from the Yarra flooding sections of Montague and Gladstone Streets, as shown on the MMBW map in figure 38. The flooding was further intensified during heavy rains resulting in the inundation of housing.[29] The reclamation project involved the demolition of 21 sub-standard cottages with the land including roads, raised 18 inches (0.46 metres) well above the flood level.[30] This was the first stage of the South Melbourne Council's Montague Housing Scheme, providing 18 modern brick worker's cottages.[31] It was not reported if the reclamation work had successfully alleviated flooding. Instead the main reported outcome concerned criticism from the government Housing Board regarding expenditure. The cost of the project was £12,157; the council sold the reclaimed land for £2160, resulting in a loss of £9997; the Board was concerned that the loss was necessarily subsidised by ratepayers.[32] A similar problem existed in low-lying Kensington to the west of the city, its eastern boundary bordered by Moonee Ponds Creek. Following years of flooding along the creek the *Age* (1934) published a letter from Thomas Murray, a resident of nearby North Melbourne. Murray suggested 'that the houses should be evacuated and turned into a park'.[33] Due to increasing public agitation and criticism of government response to the flooding victims of Kensington and the issue of compensation, the *Age* (1934) reported an interview with the Minister of Health, Sir Stanley Argyle. He claimed being not sure why, when or by whom the houses were built, and remarked that under the Health Act of 1890 residential buildings should not be built on land declared liable to flooding.[34] In October 1934, the *Age* further reported on the Kensington flood issue with comments from the chair of the Health Commission, Dr Edward Robertson.[35] Robertson also maintained the flood-affected area should be reclaimed or the houses removed and rebuilding prohibited quoting, like Argyle, the Health Act; he reported buildings constructed on such land after 1890 could be removed without owners or residents receiving compensation.[36] The MMBW's reluctance to manage rivers, tributaries and drainage was well founded, as many parts of Melbourne's

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[29] "Gladstone St. Reclamation Scheme Road to Success Paved with Difficulties - South Melbouren Council's Splendid Effort," *Record,* January 28, 1939, 8.
[30] "Community Housing Schemes. Board's Criticism. Many Anomalies Cited," *Age,* November 5, 1937, 13; "In the Suburbs. Housing Scheme. Provision for 18 Homes at Montague," *Age,* March 19, 1936, 13.
[31] "Houses for Workers at South Melbourne," *Age,* June 8, 1937, 10.
[32] "Community Housing Schemes. Board's Criticism. Many Anomalies Cited," 13.
[33] "Kensington Floods," *Age*, October 31, 1934, 16.
[34] "Kensington Floods. Compensation for Damage. Government Will Not Pay," *Age,* January 8, 1934, 10.
[35] "Kensington Floods. Who Is to Blame? Government Repudiation," *Age,* October 27, 1934, 22.
[36] Ibid, 10.

low-lying suburbs were liable to continual flooding of significant scale due to the very nature of Melbourne's topography, rainfall and climate.[37]

The flooding problem was not only a matter of liability for the MMBW. Many buildings constructed on flood-prone land created a problem for Melbourne's sewerage system infrastructure.[38] During floods, water that rose above the level of domestic sewerage fittings flowed into the sewer, with the additional amounts of water filling the system.[39] The larger flows entering the pumping station at Spotswood, not designed to pump such amounts, pushed the plant to capacity, placing the entire system in danger of failure. In addition, the treatment farm at Werribee became overloaded with floodwater, resulting in overflows mixed with raw sewage discharging into Port Phillip Bay.[40] As a solution to these issues, the MMBW proposed all urban municipalities prohibit construction on flood-prone land, a proposal that failed to evince a response. It then proposed all sewerage fittings be located at least two feet (0.7 metres) above the level of 1916 flood. This reached between 30 and 45 feet (10.6 and 13.7 metres) about the normal level of the Yarra. [41]

The proposal was retrospective and involved expensive alterations for residents on low-lying land and large properties owned by the Melbourne City Council.[42] These included the City Abattoirs, (see chapter four, page 108) constructed on flat land bordered by the Maribyrnong River, shown in figure 39. Due to strong objections raised by the council and residents, the proposal was dropped.[43]

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[37] Brown, Keath, and Wong, 852; Dingle, 155.
[38] Dingle and Rasmussen, 155.
[39] Ibid, 154.
[40] Ibid.
[41] Ibid.
[42] "Sewerage and Flood Level," *Register*, July 1, 1920, 5.
[43] Dingle and Rasmussen, 154.

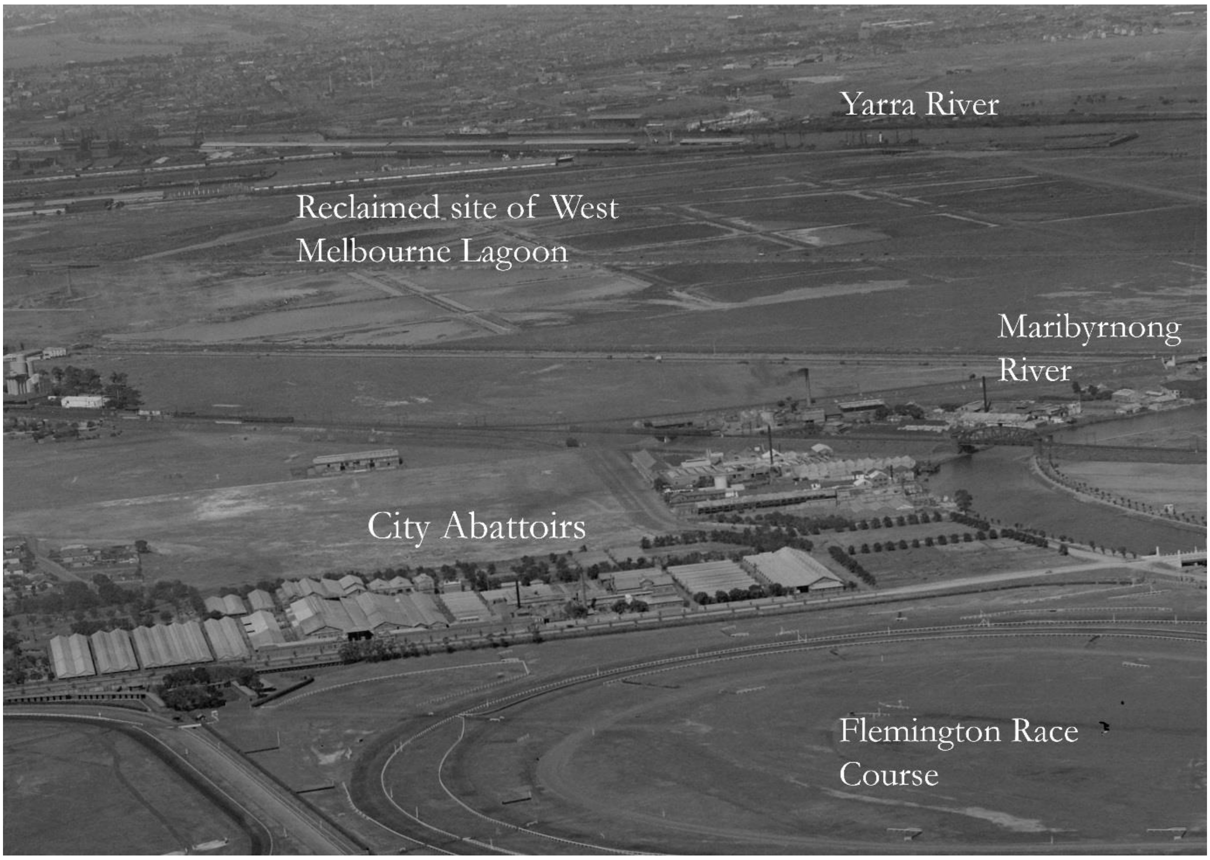

Figure 39. City Abattoirs in relation to flood prone land along Maribyrnong River. Source: SLV H91.160/1580

The design capacities of stormwater drainage systems constructed by local councils added to Melbourne's flooding problem. Prior to 1923 stormwater drainage was the responsibility of municipalities.[44] This resulted in a range of drainage systems designed to manage varying capacities and amounts of rainfall per hour as detailed in table five.[45] This may have affected the scale of floods and spread of inundation into neighbouring suburbs.

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[44] E.F. Borrie, "The Sewerage and Main Drainage Systems of Melbourne," *The Journal of the Institution of Engineers, Australia* 7 (1934): 385.
[45] "Capacity of Drains," *Prahran Telegraph*, November 4, 1911, 4.

Table 5. Designed drain capacities for inner suburban councils in 1911.

Council	Inches - per hour	Millimetres – per hour
Hawthorn	1/2	12.7
Collingwood	3/4	19
St Kilda	3/8 to 3/4	9.5 to 19
Caulfield	2/3 to 3/4	16.9 to 19
Prahan	1/3 to 3/4	8.5 to 19
Malvern	1/3 to 1	8.5 to 25
Camberwell	1 and 1/2	38

Table 5. Designed drain capacities for maximum rainfall amounts per hour. Source: Prahan Telegraph (1911), page 4.

By the early 1920s, it was widely recognised that rivers, tributaries and drainage required an integrated metropolitan-wide approach. Meanwhile periodic flooding and pollution of the city's watercourses continued to be problematic and pressure remained on relevant bodies to address the issue in the form of legislation.[46]

The *1923 Metropolitan Drainage and Rivers Act*: Rivers and creeks defined as Main Drains

In October 1923, the *Metropolitan Drainage and Rivers Act* passed into legislation, giving the MMBW all responsibility for metropolitan rivers, tributaries, watercourses and main drains.[47] The act also provided the Board with powers to make regulations regarding pollution prevention on metropolitan watercourses; control of bathing; regulation of all river traffic, (outside the area managed by the Harbour Trust) including boat races and regattas, and drowning prevention management. This included all vessels being required to carry

[46] Dingle and Rasmussen, 154.
[47] Ibid.; "Drainage and Rivers Act. Anomalies Discovered. Board of Works in Control," *Argus*, January 3, 1924, 6.

lifebuoys and providing life belts for the public along riverbanks.[48] The MMBW perceived the act as ambiguous with anomalies regarding definitions and exposure to liability for flooding.[49] The act was clear however in classifying rivers and creeks as main drains, stating:

> "Main Drain" means any drain creek or water-course (or portion thereof) within the metropolis declared to be a main drain pursuant of this Act, whether the same is natural or artificial or on above or below the surface of the ground and whether the same is constructed or used or is to be constructed or used for carrying off surface or storm water flowing through two or more municipal districts.[50]

The act also allowed for the modification of waterways under the guise of 'river improvement works', which included:

> Widening deepening and diverting any such rivers creeks or water-courses and altering the course thereof;
> The cleansing of or the preventing or minimizing the pollution of any such rivers creeks or water-courses;
> The improvement of navigation and the improvement of the flow of water therein;
> The prevention of and defence against flooding from the waters thereof;
> The construction of locks barrages and levees;
> The formation of ornamental lakes;
> The formation of the banks, the planting and ornamentation thereof, and the erection thereon of buildings wharves or jetties;
> The laying down and construction of roads carriage drives and footways on or along or near to the banks;
> The erection of bridges;
> The establishment of ferries; and generally, the improvement and beautification of such rivers creeks or water-courses and the banks thereof.[51]

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48 Ibid, 6.
49 Dingle and Rasmussen, 154-155.
50 *An Act to Make Further and Better Provision with Respect to Main Drains and Main Drainage Works and Certain Rivers Creeks and Watercourses within the Metropolis and for Other Purposes*, (23 October, 1923), 29.
51 Ibid, 30.

'Improvements' often led to ecological destruction of stream biology and increased erosion of the stream-bed and banks.[52]

It could be argued the *1923 Drainage and Rivers Act* was the origin of the formal classification of Melbourne's watercourses into a separate urban system. As discussed on pages 152 and 156, the MMBW was reluctant to take responsibility for watercourses as knowledge was limited to their management as combined sewers only, and their unpredictability for flooding. The MMBW feared being held liable for damage and destruction to property and infrastructure caused by floods. It could also be assumed the classification of the larger watercourses as main drains provided the engineers of the MMBW with a level of certainty as to the type of system they were to manage, and provided cues for how to management it. Rivers and streams were likened to large drains and could be managed as such with engineering solutions. Indeed, this turned out to be the case as once initial concerns the 1923 act were solved, a numbering system was developed that provided the larger watercourses with an identification number within a system defined as Main Drains (see page 180). Engineering solutions applied to many watercourses following enactment of the legislation included structures such as weirs, rock lining, and channel modifications to allow the safe, swift, drainage of the urban fabric. Additionally, having a section of the MMBW responsible for main drains also sat logically with their other areas of responsibility; the water supply and sewerage systems. However, in the first three years following the introduction of the 1923 act, the MMBW struggled with implementation due to ambiguities within the legislation. [53]

The Board opined that the *Metropolitan Drainage and Rivers Act* included no clear definition of the differences between main drainage works and main drains. Nor did it outline what constituted a main drain, as opposed to a normal drain remaining the responsibility of municipalities; the possibility of its work along river and creek banks being subject to compensation claims from stream-bank landowners; its liability for flood control as without clearly defined responsibilities the Board considered a possibility existed for unlimited flood compensation claims.[54] The size and scale of floods the MMBW should be responsible for had not been established. As discussed on page 144, prior to the 1923 Act local

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[52] S. Treadwell et al., "Wood and Other Aquatic Habitat," in *Principles for Riparian Lands Management*, eds. S. Lovett and P. Price (Canberra Land & Water Australia, 2007), 129.
[53] "Drainage and Rivers Act. Anomalies Discovered. Board of Works in Control," 6.
[54] Ibid.

municipalities controlled all stormwater drainage in situ.[55] The Board wanted a limit placed on how much rainfall per hour it should be liable to accommodate.[56] Responsibility for gullies formed or enlarged by erosion created by subdivision was also questioned by the Board.[57] Further confusion developed over the terms of the act regarding the scope of the MMBW's 'beautification' works along river and creek banks: the Act failed to define the exact portion of river and creek banks under MMBW jurisdiction.[58] The MMBW delayed all drainage work early in 1924 while conducting a survey of Melbourne's watercourses to determine which constituted 'main drains'.[59] Meanwhile flooding continued to be a concern. Melbourne's topology and climate ensured it was difficult to drain and flooding continued despite improvement works.[60] The MMBW appointed two assistant engineers, one for main drainage and the other for rivers and streams, and a river officer for waterway traffic on the Yarra above the ports.[61] Successive work involved dredging and widening works on both the Yarra and Maribyrnong rivers in conjunction with beaching the banks to control erosion.[62] Labelled as river improvement works, in 1925 alone, 3000 snags were removed from the Yarra.[63]

In late 1926, *An Act to Amend the Metropolitan Drainage and Rivers Act 1923* was introduced, clarifying:

> 'Main drainage works' means works within the metropolis (other than main drains) for the prevention of or defence against flooding by surface or storm water.

Regarding the interpretation of river improvements, the act stated: -

> in the interpretation of River improvement "River works" after the words "The formation of the banks" there shall be inserted the words "(including the forming sloping beaching pitching piling and altering of the banks and of any land abutting thereon or adjacent thereto)".

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[55] Borrie, 385.
[56] Dingle and Rasmussen, 155.
[57] "Metropolitan Main Drains Act-Amending Legislation Desired," *Sunshine Advocate,* May 9, 1925, 3.
[58] "Yarra Beautification. Defining Board's Powers," *Argus,* September 16, 1925, 31.
[59] "Main Drains and Streams," *Argus,* March 6, 1924, 14.
[60] Ibid, 155-56.
[61] Ibid.
[62] Ibid, 155.
[63] "Snags in the Yarra," *Argus,* September 10, 1925, 13.

Regarding the interpretation of main drains: -

> "(a) that any then existing drain creek or water-course (or portion thereof) within the metropolis shall be a main drain under and for the purposes of this Act; or
>
> (b) that any new main drain within the metropolis proposed to be constructed under this Act shall be a main drain under and for the purposes of this Act.
>
> (2) Every such notice shall describe the course of and contents of specify the points of commencement and termination of every then existing drain creek or water-course (or portion thereof) or any proposed new main drain to which the same relates".[64]

When the MMBW was required to declare a watercourse or drain as a *main drain*, the Act specified a notice must be published in the Government Gazette stating: -

> (a) 'that any then existing drain creek or water-course (or portion thereof) within the metropolis shall be a main drain under and for the purposes of this Act; or
>
> (b) that any new main drain within the metropolis proposed to be constructed under this Act shall be a main drain under and for the purposes of this Act.
>
> (2) Every such notice shall describe the course of and contents of specify the points of commencement and termination of every then existing drain creek or water-course (or portion thereof) or any proposed new main drain to which the same relates.'[65]

Further amendments defined a main drain as draining an area of 150 acres (61 hectares).[66] From that point onwards whenever a main drain was constructed, or a watercourse declared a main drain, a notice was placed in the Victorian Government Gazette. For example, a notice in the *Government Gazette* dated 4th April 1928 (reproduced in figure 40) declared Melville

[64] *An Act to Amend the Metropolitan Drainage and Rivers Act 1923*, (December 21, 1926), 46-47.
[65] Ibid, 49.
[66] Dingle and Rasmussen, 156.

Creek, a tributary of the Moonee Ponds Creek, a main drain under the responsibility of the MMBW. By the late 1960s, the Melville flowed entirely within a barrel drain.[67]

Metropolitan Drainage and Rivers Acts.

MELBOURNE AND METROPOLITAN BOARD OF WORKS.

Notice declaring that an existing drain and watercourse within the Cities of Brunswick and Coburg, and a proposed new drain within the City of Brunswick, both of which are within the metropolis, shall be and be deemed to be main drains, and that an area within the Cities of Brunswick and Coburg, and within the metropolis, shall be a Watershed Area (No. 13).

MELBOURNE and Metropolitan Board of Works, under the powers conferred upon it by the *Metropolitan Drainage and Rivers Act* 1926, and otherwise, doth by this notice declare—

(1) That the existing drain and watercourse (or portion thereof, within the metropolis, as the same is defined and described hereunder—

(2) That the new main drain within the metropolis, as the same is defined and described hereunder, and which it is proposed to construct under the *Metropolitan Drainage and Rivers Act* 1923, as amended by the *Metropolitan Drainage and Rivers Act* 1926—

shall be main drains, and each of them shall be a main drain; and

(3) That the area the outer boundaries of which are described hereunder shall be a Watershed Area under and for the purposes of the said Metropolitan Drainage and Rivers Acts.

Figure 40. Melville Creek declared a Main Drain. Source: Victorian Government Gazette (1928) page 1124.

In addition to declaring watercourses as main drains, the MMBW also provided each drain with a specific identification number, as illustrated by a section from the 1955 drainage record plan (figure 41) using the Merri Creek as an example.

[67] Leigh and Melbourne Metropolitan Board of Works, 91.

Figure 41. Merri Creek Main Drain Number 4420. MMBW drainage record plan 1955. Source: SLV http://handle.slv.vic.gov.au/10381/115237

At least two main drain-numbering systems were devised since 1923 when the MMBW commenced managing Melbourne's watercourses.[68] The system numbered all main drains as projects within the range 4000 to 5500. The Melbourne metropolitan area was divided into basins, for example the Moonee Ponds Creek - basin number three. An example of a full number is the Merri Creek 4420 that specifies:

4 shows that it is a drain or watercourse

4 shows the basin number – i.e. Merri Creek

20 shows a precise section along the creek

The middle numbers 42 give the drainage area number, while tributaries of the main branch are indicated by the last number, in this case 0, the lower main channel.[69]

In 1928-29, the Board continued flood control works along the Yarra. At Richmond, 3.6 kilometres (2.2 miles) upstream from the city, the Richmond Quarry cut was undertaken, and Herring Island created (see chapter six, page 224). The cut went through disused quarries allowing the river to split at its natural bend and flow through the old quarries as well as the

[68] H. Hughes, *Notes on Main Drainage Practice* (Melbourne: Melbourne Metropolitan Board of Works, 1964), i.
[69] Ibid, 3-4.

original bed. Levee banks were widened and lined with pitches for between 2-3 kilometres (1.2-1.8 miles) to aid with flood control and erosion.[70]

Figure 42.Herring Island, 1933. Source: SLV H91.160/1684

A major problem to planning and construction of drainage projects was once again the lack of vital data.[71] As in 1891 when approval was given by the MMBW for construction of the sewerage system (see chapter four, page 145), the lack of data about the area's topography, hydrology, geology and landscape was hampering the design and construction of drainage projects. All existing drains had to be surveyed, as did all riverbeds, stream and creek beds.[72] The lack of reliable rainfall and runoff data also hampered drainage design. The existing rainfall data was only recorded over twenty-four-hour periods being therefore of

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[70] Melbourne Metropolitan Board of Works, *The First 75 Years: A Review of the Activities of the Board of Works, 1891-1966* (Melbourne: Melbourne Metropolitn Board of Works, 1967), 9.
[71] Dingle and Rasmussen, 156.
[72] Ibid.

little use for designing drainage systems able to manage brief intense summer storms. Consequently, a rainfall gauge network was created.[73] Drains were constructed to allow for an average of the greatest rainfall liable to fall once every ten years. However, as illustrated in table 5, page 172, many were not large enough to conduct this amount. In addition, structural design standards had to be developed for the construction of drainage and river infrastructure.[74] Progress was slow due to the large amount of data collection, research and design required for the complete metropolitan area. The MTPC was, perhaps unfairly, frequently critical of what it perceived as the Board’s slowness in constructing drainage works.[75] W Creek flowing through Melbourne’s eastern suburbs was one of the first to be undergrounded with the new design standards. Figure 43 showing the transformation of the creek into an underground barrel drain during the 1920s-30s.

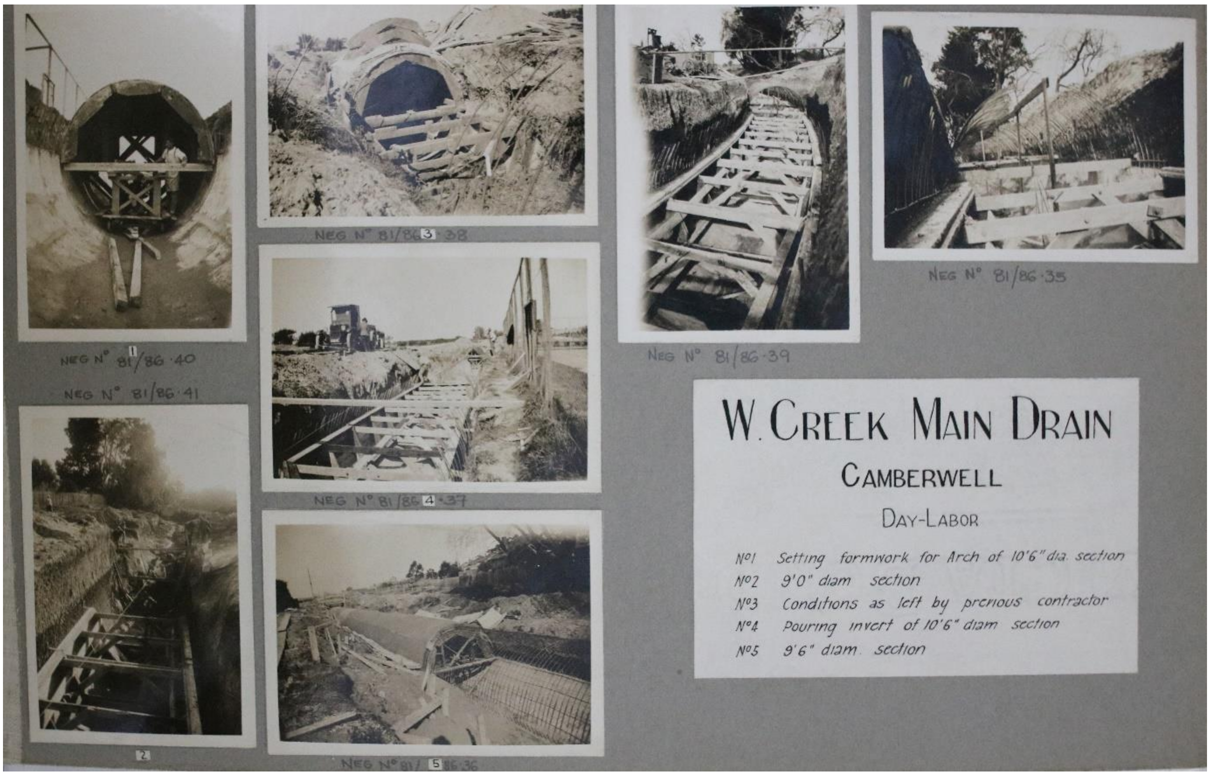

Figure 43. W Creek in Melbourne's eastern suburbs undergrounded during 1920s-1930s. Source: PROV, VPRS 8609/P32, Unit 7, PA17

[73] Ibid.
[74] Ibid.
[75] Robert Freestone and Max Grubb, “The Melbourne Metropolitan Town Planning Commission, 1922-30,” *Journal of Australian Studies* 22, no. 57 (1998): 132; Dingle and Rasmussen, 156-57.

Since the 1923 *Metropolitan Drainage and Rivers Act* was enacted all Melbourne's watercourses and drains classified as Main Drains have continually been the responsibility of the MMBW and from 1991, its corporatised form, Melbourne Water Corporation.[76] Although (at the time of writing) currently responsible for stream beds, banks, and land within 20 metres (66 feet) of watercourses, a range of other agencies, organisations, and private bodies also have various responsibilities relating to land use, planning, management, and use of watercourses and their environs.[77] To illustrate the bureaucracy involved with the management of Melbourne's watercourses, those involved with the Merri Creek as included in the *Merri Creek and Environs Strategy 2009-2014* (2009) are listed in table six.

Table 6. List of authorities, organisations, and their main responsibilities regarding the management and protection of the Merri Creek.

Agency, Organisation, or other stakeholders	Main Responsibilities
Private land owners	
Includes government agencies and private individuals and businesses	Avoid causing or contributing to land degradation Conserve soil, protect water, control and eradicate prohibited weeds Prevent spread of pest animals and eradicate as practical
Australian Government	
Department of the Environment, Water, Heritage and the Arts	Administers Environment Protection and Biodiversity conservation Water watch program – citizen science program for monitoring the health of watercourses
State Government	
Department of Environment, Land, Water and Planning	An array of roles including: land management, environmental flows, land-use planning and policy, river health policy and planning, flora and fauna management, land protection-weeds and pest animals
Port Phillip and Western Port Catchment Management Authority	Integrated catchment management – water quality, weed and pest animal management programs, overall catchment-wide management, coordination of stakeholder partnerships
Melbourne Water Corporation	Responsible for bed and banks of watercourses within 20 metres of a stream course Caretaker of river health

[76] Ibid, 153-54; Viggers, Lindenmayer, and Weaver, 87-88.
[77] Merri Creek Management Committee, 20-27.

	Responsible for drainage, rivers and floodplain management, improvement works, protection, restoration, research, planning, overall management of streams and banks
Parks Victoria	Management of State controlled parks, reserves, and other significant sites of vegetation and conservation Planning and implementation of new parks, and conservation reserves
Environmental Protection Authority	Regulatory role for long-term water quality, protection policies, issuing licenses discharges into watercourses, investigation of pollution incidents and enforces protection policies, emergency pollution management, auditing and reporting of environmental conditions
VicRoads	Manages major highways and reserves for future roads, manages Principal bicycle network linking into watercourse trail systems, planning and management of freeway and major roads runoff into watercourses
Victorian Planning Authority	Long-term strategic planning for urban growth, housing, public transport, employment, and public space
Sustainability Victoria	Waste management, recycling, anti-litter campaigns, resource use sustainability, and energy conservation
Local Government	
Range of local councils within the Merri Creek catchment area	Open space management and maintenance, provision of amenities, development of council land and crown lands they manage, responsible for smaller watercourses in catchments of less than 60 hectares (148 acres), manage street-scale stormwater systems, develop stormwater management plans, revegetation programs along watercourses, statuary planning
Utility services management	
Victorian Rail Track (VicTrack)	Owns and manages rail reservation land in various cations along the creek corridor
Yarra Valley Water	Manages sewage treatment plants along the creek, manages water mains and trunk sewers located along the creek corridor
AusNet	Manages high voltage power transmission towers, lines and underground power lines along the Merri Creek Valley
AGL Energy Limited	Manages underground high-pressure gas lines located within various places along the creek corridor
Merri Creek Management Committee (MCMC)	
Incorporated association-members include local councils of: Darebin, Hume,	Vegetation management, community education, water quality monitoring, environmental, strategic and statutory planning advice, development of large

Mitchell, Moreland, Whittlesea, Yarra – located along sections of the creek corridor Community groups include: Friends of Merri and Wallan Creeks	knowledge base of watercourses and the entire Merri Creek and tributaries catchment region
Friends of Merri Creek	
Voluntary incorporated association including a range of key-sub groups: Friends of: Edgars and Malcom Creeks, Friends of Merri Grasslands, Friends of Edwards Lake, Merri and Edgars Creek Confluence Area Restoration Group	Local environmental advocate for the creek and its conservation Conduct a range of activities including: planting-revegetation, public talks and walks, litter collection Participation on the MCMC Committee of Management with six members on committee

Table 6. Contemporary agencies, organisations, groups and individuals responsible for managing the Merri Creek and catchment. Source: Merri Creek Management Committee (2009), pages 20-27.

The planning of Melbourne and its effects on watercourses – prior and post creation of Metropolitan Town Planning Commission

> We have in the Yarra a priceless possession, if we only wake up to the best way to utilise it…Just as there are two sides to city life, work and pleasure, so our river stands ready to minister to both of them with its utility and beauty.[78]

The above quote from Tuxen's 1926 article summarises the change in attitude to urban watercourses during the early decades of the 20th century. Their roles and requirements firmly established during the 19th century as utilities (for water-supply, shipping channels, port infrastructure and stormwater drains), urban watercourses were now identified as important landscape features, valued for their visual beauty, as recreation resources providing atheistic qualities within built environments. This view arose from the growing town

[78] Salix Tuxon, "What We Might Do with the Yarra," *Herald*, November 27, 1926, 17.

planning movement, which espoused the need for scientifically planned cities that allowed for future growth, improved living conditions and avoided the mistakes clear in many larger cities.[79]

However, 26 years prior to Tuxen's publication of his thoughts on the Yarra, the river was supporting other roles and uses, occurring just 12 kilometres (8 miles) upstream from the city. At Dights Falls, the Yarra had been stocked with several species of fish by the Abbotsford Anglers Society. In 1900 at a meeting between the society and Collingwood Council, the society reported pollution had destroyed its valuable fish stocks.[80] The Society's president reported recently seeing 11 dead dogs, a dead horse, and other pollution discharging from Abbotsford's main (Reilly Street) drain. He also believed the river was losing its reputation as an area of beauty.[81] The choice of site to stock fish was remarkable as the Reilly Street drain was notorious for its heavily polluted greyish-black flows containing all types of refuse draining from three suburbs, Melbourne's General Cemetery, and noxious industries including abattoirs (see chapter six, page 246).[82] In addition, pollution flowing down the Merri Creek included the sewage (before the sewerage system was extended too many outer suburbs) and waste from a range of northern suburbs and industries, including drainage from the Pentridge Stockade.[83] Despite the pollution, the Deep Rock Swimming Club had been established in 1906 a further 0.3 kilometres (0.19 miles) upstream, on the Yarra.[84] As the club developed, a concrete swimming basin was constructed into the riverbank, with later additions including dressing pavilions, floodlights, social clubrooms, and toilet facilities, with a diving tower completed in 1939.[85] Aiming to teach swimming and lifesaving, the club soon became renowned for its aquatic carnivals.[86] Such events featured athletic, canoe, swimming, and diving events.[87] The highlight of the club was the carnival of 1918 when an audience close to 60,000 watched Alick Wickham, a tramway employee from Sydney, dive from a 205

[79] John Sulman, *An Introduction to the Study of Town Planning in Australia* (Sydney: William Applegate Gullick, Govt. Printer, 1921), xv-xvi; Victoria Metropolitan Town Planning Commission, *First Report* (Melbourne: Government Printer, 1925), 1.
[80] "Pollution of the Yarra River. A Grievous Condition of Things," *Argus*, December 11, 1900, 7.
[81] Ibid.
[82] "The Pollution of the Yarra," *Argus*, April 30, 1887, 13.
[83] "The Drainage of the Pentridge Stockade. Alledged Pollution of the Merri Creek," *Argus* March 15, 1895, 7.
[84] Heritage Council Victoria, *Deep Rock Swimming Club Site* (Melbourne Heritage Council of Victoria, 2016), accessed June 17, 2016, http://vhd.heritagecouncil.vic.gov.au/places/103865/download-report.
[85] Ibid.
[86] "Deep Rock Club," *Weekly Times*, November 16, 1918, 20; "Deep Rock Henley. Canoe Events Contested," *Age*, April 18, 1921, 10.
[87] "Deep Rock Henley," *Age*, March 21, 1921, 13.

feet, 9 inches (62.7 metres) platform, setting an Australian high diving record.[88] The club became a major social venue and thrived into the 1930s when its long decline commenced due to floods, bush fire and the outbreak of World War Two.[89] Following several attempts at revival, the club was abandoned during the late 1950s due to a general decline in using the rivers for swimming and boating and the rise of personal travel created by the car providing easier access to other swimming facilities.[90] Dights Falls, first seen by Europeans in 1803, was described by the expedition led by Charles Grimes (see chapter four, page 62) as 'a freestone, the strata on edge' being a hard-resistant strip of sandstone.[91] Between 4.5 and 1 million years ago, active volcanoes to the north of Melbourne produced lava flows that extended south along the creek valleys.[92] Dights Falls lay at the intersection or junction of the basalt lava flows and the underlying sedimentary rock.[93] Following the basalt flows, the Yarra was confined to flowing along the edge of the basalt, its flow eroding the softer sandstone sediments.[94] In 1838 John Dight, a millwright and engineer from New South Wales, purchased the block of land bordering the falls, deciding it was suitable for construction of a water-powered mill, with construction of a brick mill commencing in 1840 on the river's western flood plain opposite the falls.[95] The mill was one of the first to be built in the Port Phillip region and the first on the Yarra, although it did not produce flour until 1843.[96] Due to significantly fluctuating water levels on the Yarra, the Dights requested permission in 1841from the Superintendent of the Port Phillip District to construct a weir across the falls to ensure a reliable and consistent supply of water to the mill.[97] By 1843, permission had been granted and the first rock weir was constructed.[98] The weir and mill wheel evident in the 1875 photograph of figure 44. The mill produced flour intermittently until 1909 when it was destroyed by fire and the remaining mill buildings demolished, after

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[88] W. Corbett, "Alick Wickham's Sensational Dive," *Referee*, April 17, 1918, 14; "Deep Rock Carnival. Wickham's Diving Feat," *Argus*, March 25, 1918 4.
[89] Heritage Council Victoria, *Deep Rock Swimming Club Site*.
[90] Ibid.
[91] James Fleming and John Currey, *A Journal of Grimes' Survey: The Cumberland in Port Phillip January-February 1803* (Malvern, Vic.: Banks Society Publications, 2002), 27.
[92] I. F. Clark et al., *Victorian Geology Excursion Guide*, 1st ed. (Canberra: Australian Academy of Science in conjunction with the Geological Society of Australia (Victorian Division), 1988), 379.
[93] Ibid, 378.
[94] Ibid, 379.
[95] W. Lewis Jones, Peggy Jones, and Flour Millers' Council of Victoria, *The Flour Mills of Victoria 1840-1990: An Historical Record* (Victoria: Flour Millers' Council of Victoria, 1990), 28-29; ibid.
[96] Ibid, 28.
[97] Ibid, 29.
[98] Ibid.

which the site was filled and levelled.[99] From 1893 when the MMBW was entrusted with responsibility for all watercourses and their banks, it issued leases for the operation of the mill.[100]

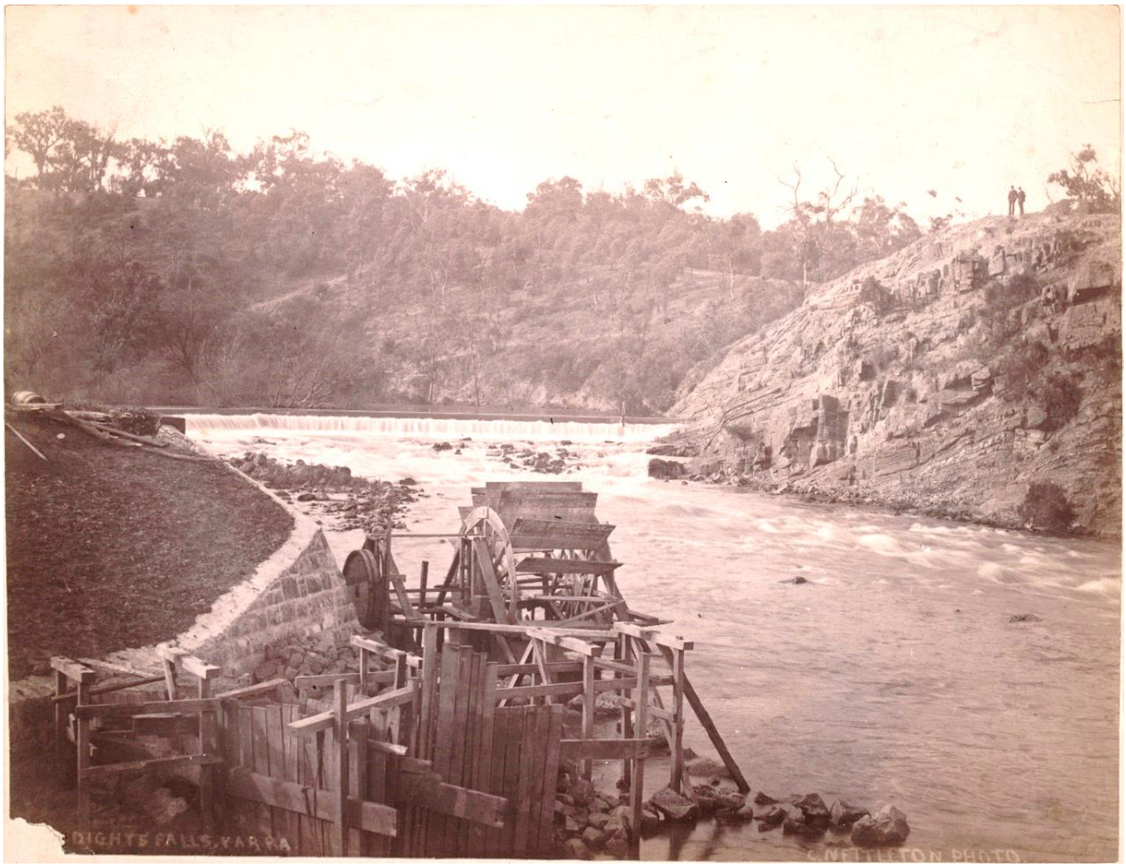

Figure 44. Dights Falls, c.a. 1875. Source: SLV H4546

Frank Stapley – a Melbourne City Councillor and sometime Lord Mayor – was an early advocate of town planning (page 195).[101] The expansion of Melbourne and creation of its inner suburbs throughout the 19th century was influenced by two factors. The first was location of fresh-water, topography, underlying geology and changes in rainfall patterns from west to east.[102] The second, as put forward by architect Robin Boyd, was the ill-considered

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[99] Ibid, 84.
[100] Heritage Council Victoria, *Dights Mill Site* (Melbourne: Heritage Council Victoria 2016), accessed June 17, 2016, http://vhd.heritagecouncil.vic.gov.au/places/2/download-report.
[101] "Scientific Town Planning," *Daily News*, September 13, 1920, 5.
[102] Presland, *The Place for a Village: How Nature Has Shaped the City of Melbourne*, 1-7.

and disinterested surveying and pegging of land.[103] This idea is clear in the way Melbourne's environs were surveyed and divided following the layout of the central city grid. The surrounding region was divided into mile-square (2.6 kilometre) sections composing of 640-acre blocks (259 hectares).[104] This was based on the section method of land subdivision and due to the scarcity of sustained surface water included a regulation declaring no one section could control both sides of a watercourse (see chapter four, page 114).[105] The sections were the basis for all subsequent land sales, with roads to be located on section lines. Village and town reserves were located on watercourses, at a recommended interval of five miles (8 kilometres).[106] Parishes consisted of one town or village at its centre. The 640-acre sections could be subdivided into eighths along each boundary, creating 64 sub-sections. Further subdivision of the sub-sections created a quarter acre allotment.[107] These were favoured in Australia for suburban residential development throughout the 19th and 20th centuries, its origin being Phillip's first plan for Sydney (page 142).[108] George Gibbs's 1838 model for Melbourne was surrounded by a ring of sections subdivided into vegetable and dairy farms practising intense agriculture that could be further subdivided without restriction.[109] Development of Melbourne's inner suburbs was based on surveyed lines and blocks.[110] Davison (1997) suggests the term 'suburb' had been popularised by landscape gardener/architect John Loudon in his publication *Suburban Garden and Villa Companion* (1838). Loudon advocates what he terms the enjoyments to be derived from a suburban residence, unconfined by close streets, uncontaminated by smoke from chimneystacks, free to experience vegetation and bird life in unconfined and generally unlimited space.[111] These ideals were to inspire Darling in planning Sydney's first suburb, Woolloomooloo.[112] Laid out initially as a picturesque sanctuary for the wealthy free settlers, the suburban ideal soon became so attractive to all classes that by the late 1830's estate agents were appealing to

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[103] Robin Boyd, *Australia's Home: Its Origins, Builders and Occupiers* (Carlton, Vic.: Melbourne University Press, 1987), 18-19.
[104] Lay, 13.
[105] Ibid, 15.
[106] Ibid, 13.
[107] Ibid, 19.
[108] G Davison, "Suburban Character," *People and Place* 7, no. 4 (1999): 26.
[109] Lay, 17.
[110] Ibid, 19.
[111] John C laudius Loudon, *The Suburban Gardener, and Villa Companion* (New York: Garland Publishing 1838).
[112] Davison, 12 ; "Sir Ralph Darling (1772-1858)," *Australian Dictionary of Biography*, National Centre of Biography, Australian National University, accessed March 8, 2016, http://adb.anu.edu.au/biography/darling-sir-ralph-1956/text2353

tradesmen in addition to the wealthy to acquire their own suburban estate. The suburban villa ideal mirrored the four great contemporary ideas of evangelicalism, sanitarianism, romanticism and class separation.[113] Evangelicalism promoted the family as central to religious and moral life with the suburban home a refuge from the vice and violence of the repulsive city area. The new science of public health, 'Sanitarianism', promoted the suburb as a clean healthy safe-haven away from the over-crowding, dirt and disease of the urban areas. The garden provided with the suburban home was emphasised by Romanticism as a private refuge from the urban built environment, where people could experience and reflect on the quiet beauty of nature. The suburb was also quickly developing into a zone of exclusive middle-class residences offering a safe separation away from the other classes.[114]

While this preference for the suburban ideal was transforming Australia into the world's first suburban nation, late 19th century Australian culture was awash with myths and legends.[115] Although many Australians were increasingly suburban and enjoying exotic picturesque private garden sanctuaries away from polluted cities, the rural mythology of the Bushman, the large-scale pastoralist, and the great Australian bush saturated all levels of Australian culture. In the 1880s and 90s a group of artists referred to as Australian Impressionists (also known as the Heidelberg School) and their landscape paintings of the Yarra Valley on the north-east fringe of Melbourne portrayed Australian culture through images of pastoral and bush myths that became influential visions of Australian identity.[116] Rural mythology was thus set against the backdrop of one of the most highly urbanised societies: two-thirds of Australia's population in 1891 resided in cities and towns.[117] The Impressionists painted with their backs to encroaching suburbia.[118] One, Arthur Streeton, writing to colleague Tom Roberts, described lying on a hill in Eaglemont (adjacent to Heidelberg) of "… pastoral dreamy loveliness…""[119] Streeton's painting *Near Heidelberg* (1890) is of an area poised for sub-division. Speculators already owned much of the land

113 Ibid.
114 Davison, 12.
115 Aidan Davison, "Stuck in a Cul-De-Sac? Suburban History and Urban Sustainability in Australia," *Urban Policy and Research* 24, no. 2 (2006); Leigh Astbury, *City Bushmen: The Heidelberg School and the Rural Mythology* (Melbounre: Oxford University Press, 1985), 2-4.
116 "Australian Impressionism," National Gallery of Victoria, accessed October 25, 2016, http://www.ngv.vic.gov.au/australianimpressionism/education/insights_intro.html; Chris. McAuliffe, *Art and Suburbia* (Roseville Eas, NSW: Craftsman House, 1996), 46.
117 Leigh Astbury, *City Bushmen: The Heidelberg School and the Rural Mythology* (Melbourne: Oxford University Press, 1985), 2.
118 McAuliffe, 46.
119 Ibid.

were awaiting improvement of the rail link to the city.[120] Watercourses such as that depicted in Roberts' painting *A Quiet Day on the Darebin Creek* (1885), figure 45, would soon become little more than open sewers, public health risks and flooding hazards for life and property. Yet the image of the bush still lingered on in the country's identity.

Figure 45. A quiet day on the Darebin Creek. Source: National Gallery of Australia NGA 69.4

These paintings also give insight into the landscape history and past ecology of the Yarra Valley and its watercourses. Gaynor and McLean (2008) suggest landscape paintings reflect changes to the landscape through comparisons of flora compositions and prevalence of large trees.[121] The landscape depicted along the Darebin Creek in figure 18 illustrates a site void of any large trees or diversity of riparian vegetation. Evidence of subdivision for agriculture is illustrated by the 1840 map of surveyed lands of the Melbourne region. The blocks shown in

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[120] Ibid.
[121] Gaynor and McLean, 187.

dark red tint had been sold, suggesting by the time of Roberts painting, the land had been grazed or farmed for 45 years.

By the 1920s, the outcome of such unplanned or regulated suburban development was evident across Melbourne's suburbs. Problems included outer suburban development outpacing expansion of the sewerage system; significant periodic flooding across the region; automobile congestion; uncontrolled subdivision; inadequate provision of parks and reserves; and no formal land zoning.[122] The *Age* reported comments from ophthalmologist Sir James Barrett, (Chairman of the National Parks Association and President of the Town Planning and Playgrounds association) who argued the planning mistakes made in Melbourne's suburbs would require hundreds of thousands of pounds to rectify.[123]

One of the more enthusiastic advocates for improving central Melbourne was accountant Francis Edwin Dixon.[124] Dixon began a campaign in 1923 to promote a scheme entailing diversion of the entire lower reach of the Yarra from the city via a new channel cut through the Botanical Gardens at a point where the elevation reached 20 metres above river level, as illustrated in figure 47. The channel would then traverse back onto the lower contours to flow across Henley Park (now Albert Park Lake) to discharge at the eastern shore of Hobsons Bay in St. Kilda.[125] Dixon's scheme, shown in figure 46, was one of the more ambitious proposals of early 20th century Melbourne, illustrating how urban watercourses were perceived as being expandable commodities, designable, and readily constructed features of the urban fabric. His scheme was proposed as a solution to Melbourne's traffic congestion from vehicles entering the central city area. Dixon argued if the Yarra was removed, all the main north-south roads of the grid could seamlessly cross into South Melbourne and thus the city could be expanded, improving traffic flows.[126]

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[122] "Scientific Town Planning," 5; Dingle and Rasmussen, 151; "Metropolitan Problems. Melbourne's Haphazard Growth," *Age,* June 23, 1926, 12.
[123] S. Murray-Smith, "Barrett, Sir James William (1862–1945)," *Australian Dictionary of Biography*, Centre of Biography, Australian National University, accessed 10 June, http://adb.anu.edu.au/biography/barrett-sir-james-william-64; "Town Planning. Mistakes in Melbourne," *Age* July 1, 1924, 11.
[124] "Obituary," *Age,* May 31, 1944, 3.
[125] F. E. Dixon, *Planning Melbourne for Posterity: A Profitable Post-War Proposal Meeting Every Need / by F.E. Dixon* (Melbourne: F.E. Dixon, 1944), 3.
[126] Ibid.

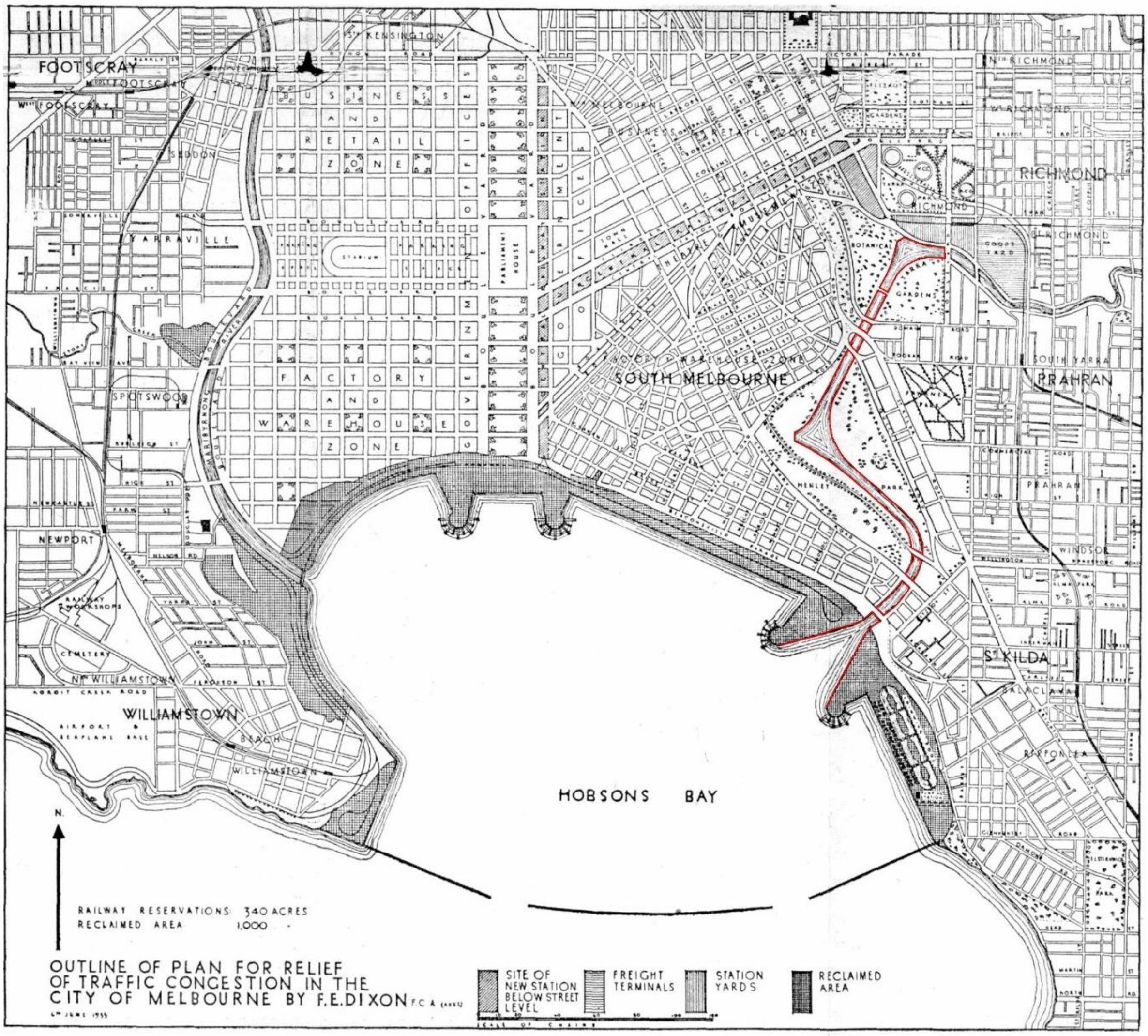

Figure 46. Dixon's plan for realigning the Yarra - the new river course marked in red. Source: Dixon (1944).

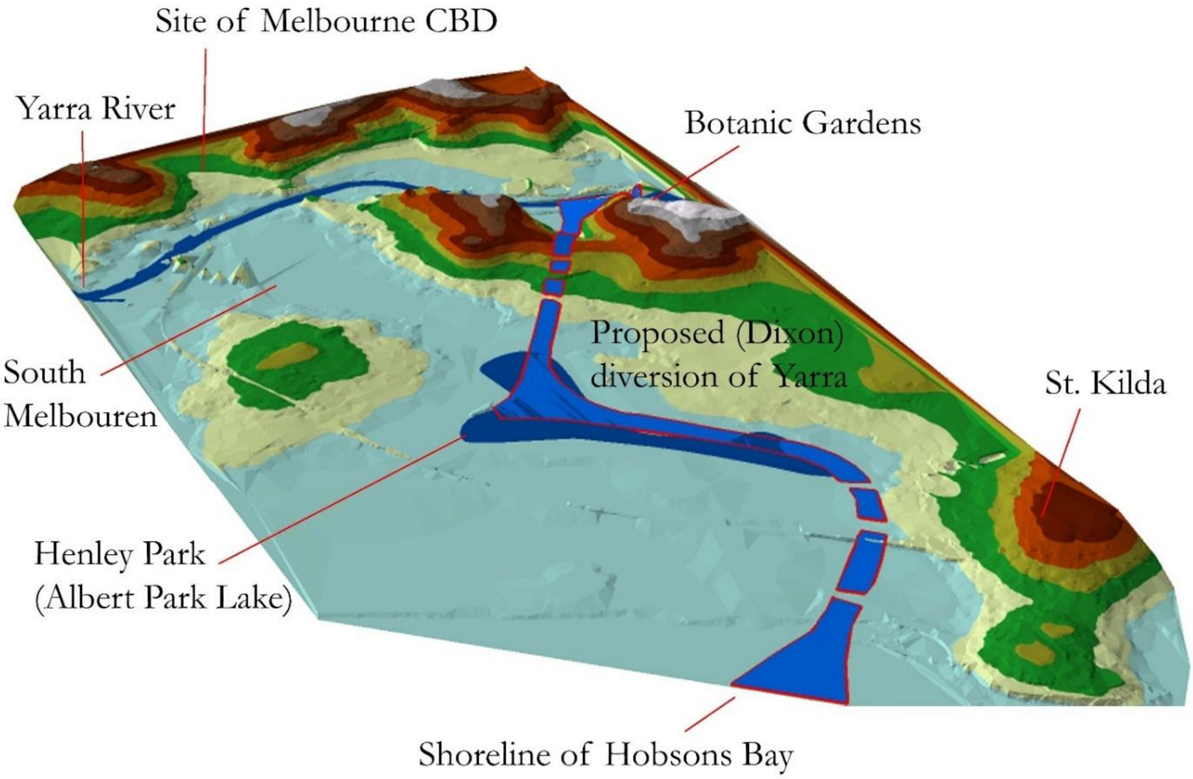

Figure 47. Model of Dixon's proposed scheme cutting through the ridge and Botanical Gardens.

As modern urbanism used empirical science to resolve London's sanitary condition and sewage problems of the 19th century, scientific planning was recommended to improve the living conditions of Melbourne's residents.[127]

Modern town planning emerged in Australia after 1900 from concern over dismal living conditions experienced by the urban working class, and utilitarian form lacking quality public open spaces prevalent in Australian cities.[128] International developments in planning introduced the creatively planned city based upon order, symmetry, formality and harmony, with potential to improve health, efficiency and beauty of urban environments.[129] The early evolution of planning in Australia was dominated by ideas from Britain, including the

[127] "Scientific Town Planning", 5.
[128] Leonie Sandercock, *Property, Politics, and Urban Planning: A History of Australian City Planning, 1890-1990*, 2nd ed. (New Brunswick: Transaction Publishers, 1990) 55-58; Robert Freestone and Australian Heritage Council., *Urban Nation: Australia's Planning Heritage* (Collingwood, Vic.: CSIRO Publishing, 2010), 14; Robert Freestone, "The Americanization of Australian Planning," *Journal of Planning History* 3, no. 3 (2004): 191.
[129] Freestone and Australian Heritage Council., 14.

'garden city' movement founded by Ebenezer Howard.[130] The 'garden city' was self-contained including residential, industrial and agricultural sections.[131] The concept was designed as a solution in addressing the overpopulated, unhealthy conditions of large cities such as London.[132]

Frank Stapley, a staunch advocate for town planning, became chair of the Metropolitan Town Planning Commission (MTPC) in 1922.[133] Like the sewering of Melbourne during the 1890s, the introduction of town, planning measures also required considerable time and debate. The *Daily News* (1920) reported the Melbourne City Council had requested the state government three years previously for the introduction of a Town Planning Bill; the request was ignored. Lord Mayor Stapley argued the current improvements to Melbourne and its suburbs were unsatisfactory and wasteful. He espoused the benefits of the City Plan Commission's report for St. Louis (USA) published in June 1919, stating:

> It is the function of the city plan and particularly the zone plan scientifically so to promote the natural processes, and so to curb and direct the artificial processes of growth that the city may become a place… where healthful living conditions… may be enjoyed.[134]

In 1922, a bill was introduced to the Victorian parliament for the creation of the MTPC, consisting of nine members to investigate and report on the current urban development and conditions of Melbourne, including river improvements.[135] From the outset, the MTPC was significantly influenced by planning practice in the United States, as is evident from its collection of planning reports, numbering more than 20, from various North America cities, and subscriptions to American planning journals including *American City* and *National*

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[130] Ibid.
[131] Ewart Gladstone Culpin, *The Garden City Movement up-to-Date*, (Florence: Taylor and Francis, 2015), http://UNIMELB.eblib.com.au/patron/FullRecord.aspx?p=1983443. 70.
[132] Ibid.
[133] D. Dunstan, "Stapley, Frank (1858-1944)," *Australian Dictionary of Biography*, National Centre of Biography, Australian National University, accessed May 20, 2016, http://adb.anu.edu.au/biography/stapley-frank-8628/text15075.
[134] "Scientific Town Planning", 5.
[135] "Town Planning. Bill before Parliment. Metropoltian Planning Commission Proposed," *Age* November 2, 1922, 9; "The Victorian Town-Planning Commission," *Daily News,* January 18, 1923, 7; "Town Planning. First Meeting of Commission," *Argus,* March 29, 1923, 9.

Municipal Review.[136] Stapley toured North America at least once during the period while commissioner Tuxen toured 65 towns and cities that had projects featured in *The American City* journal.[137] Tuxen's article from 1926 (page 159) compared the current condition and public attitudes towards the Yarra with urban watercourses observed during his visits to North American cities. He stated:

> After the Yarra traverses another mile of mingled charm and ugliness, Nature being responsible for one and man the other, Studley Park is reached, and from that point for miles the river twists through an enormous permanent reservation which has the bad luck to be in Australia instead of America. Were it in the latter country, it would be advertised so widely folk would come from far countries to see a national park whose nearest point was but two miles away from the heart of a great metropolis.[138]

In 1925, the MTPC released its first report, setting the themes for later work that included planning for and treatment of watercourses and shorelines. Although the topic was only briefly discussed, (eight lines of text) the commission opposed private control of all riverbanks and foreshores which, it opined, should be prohibited or restored to the community.[139] The MTPC's approach was similar to Thwaites' 1907 proposal (page 158). Thwaites argued that excluding Port Phillip Bay, Melbourne had not developed any 'water pleasure resorts' and the development of the tree-lined boulevard along the Yarra from Princess Bridge to below the Botanical Gardens (page 219-21) demonstrated beautification would improve the river to the people's benefit.[140] He also expressed regret that land bordering the river was under private ownership, prohibiting public access and the construction of roads. River foreshores, he believed, should be reacquired by the government, allowing construction of further ornamental drives.[141] The idea gained popularity through a scheme proposed in 1910 for the government to buy back Yarra land to form 'pleasant

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[136] Freestone and Grubb, 138; J. Brian McLoughlin, *Shaping Melbourne's Future?: Town Planning, the State and Civil Society* (Oakleigh, Vic.: Cambridge University Press, 1992), 33.
[137] Freestone, 195; D. Nichols, "Tuxen, Saxil (1885–1975)," *Australian Dictionary of Biography*, Centre of Biography, Australian National University, accessed June 6, http://adb.anu.edu.au/biography/tuxen-saxil-14890.
[138] Tuxon, 17.
[139] Metropolitan Town Planning Commission, *First Report*, 51-52.
[140] "New Pleasure Resorts,"*Argus,* February 22, 1907, 5.
[141] Ibid.

promenades and roadways' along the river's banks.[142] The MTPC proposed a comprehensive boulevard treatment for the Yarra in 1926.[143] The top image in figure 48 shows the MTPC's 1929 proposal, while the bottom image shows the sections that were constructed. A Merri scheme also proposed by the MTPC included boulevards or 'picturesque drives' along both banks, connecting with the Yarra's boulevard and another course along Gardiners Creek.[144]

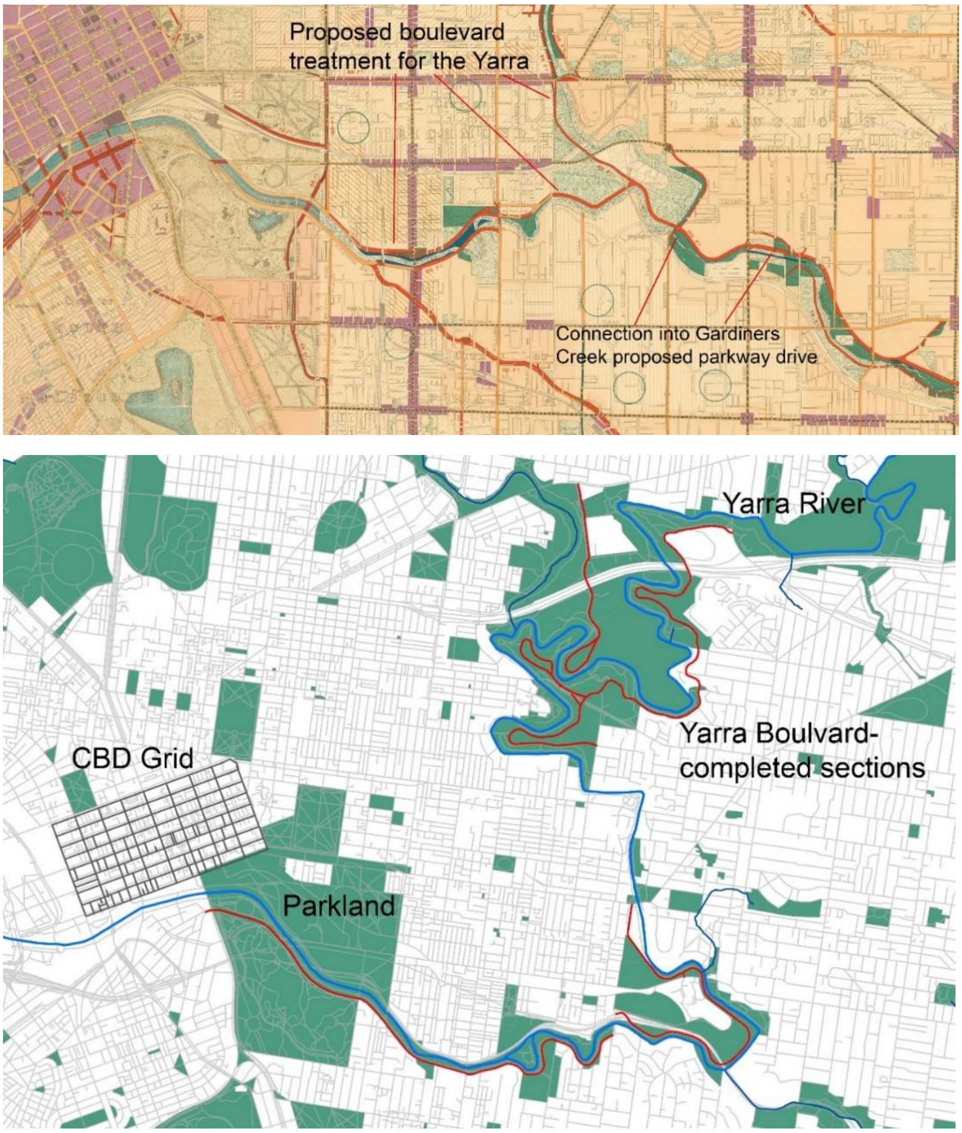

Figure 48.The MTPC's proposed boulevard plan (above) and completed sections (below in red) on crown-land. Source: SLV http://handle.siv.vic.gov.au/10381/182740

[142] "Latest Yarra Scheme. State to Buy Back Land Which It Should Have Held," *Geelong Advertiser*, February 28, 1910, 4.
[143] "Improving the Yarra. Boulevard Proposals," *Argus*, September 16, 1926, 19.
[144] "Merri Creek Scheme," *Age*, July 30, 1926, 5.

In 1929, the MTPC published its *Plan of General Development Melbourne,* the first comprehensive metropolitan plan for an Australian city, that included major sections on land use zoning, transportation and open space.[145] Soon after its release, the MTPC received an abundance of letters from many cities globally, requesting a copy of the plan.[146] These included: County of Los Angeles; Hiroshima City Planning Commission; Vienna; City of Edinburgh; Iowa Town Planning Association; The City Planning Board of St. Paul-Minnesota; City of Chicago; Wellington City Council; Chicago Plan Commission; and City of Lewiston,-Idaho.[147] The request from the City of Hiroshima coincided with the city's creation in April 1929 from the merging of seven municipalities, making it the seventh largest city in Japan.[148]

The report featured Melbourne's watercourses under three separate sections; roads, main drainage and the park system. The first reference to watercourses was under the subheading 'Roads', regarding communications. The MTPC believed Melbourne's network of main watercourses, converging in a radial direction towards the inner suburbs, severely disrupted the road system. Due to their winding courses, steep banks (making the land unsuitable for development) and the streams physically forming municipal boundaries, the adjacent street networks were chaotic.[149] As much of the land immediately adjacent to rivers and creeks was deemed of no value for building, the MTPC considered it a cheap solution. Radial supplementary roads and additional creek crossings could connect streets between various municipalities.[150] Connecting irregular street networks along watercourse banks would also create continuous routes throughout the suburbs.[151] Watercourses also featured in the MTPC's proposals under the sub-heading of Main Drainage in the section on Public Utilities. The MTPC reiterated the Metropolitan Drainage and Rivers Acts of 1923 and 1926, using watercourses as main drains and supported the MMBW's responsibilities for drainage and improvement. The MTPC further restated its own policy on reserving watercourses and

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[145] Freestone and Grubb, 134.
[146] PROV, VA 3131 Metropolitan Town Planning Commission, VPRS 10284/P0000
Printed copy of reports, correspondence about distribution, Unit 5, letters requesting copy of Plan of General Development
[147] Ibid.
[148] "History of Hiroshima," City of Hiroshima, accessed June 12, 2016, http://www.city.hiroshima.lg.jp/www/contents/1263790328515/index.html.
[149] Metropolitan Town Planning Commission, *Plan of General Development, Melbourne: Report of the Metropolitan Town Planning Commission*, 52.
[150] Ibid.
[151] Ibid.

adjacent land as public property, promoting the idea of a zoning scheme to prevent development of areas that could not be readily drained into a common outlet. A major benefit of zoning, envisaged by the commission, related to the prediction of runoff and drainage flows. These would be easier to forecast for zones of similar development (residential) as opposed to areas of variable or mixed development that would be impossible to predict.[152]

The section of the plan specifically addressing watercourses was entitled 'The Park System'. This recommended the reservation of all main watercourses and adjacent land for public use be placed under public ownership.[153] Key factors included: lower values of land along watercourses; the suitability of floodplains for siting recreational sports ovals, with steep slopes being suitable for spectator vantage points. Reservation of floodplains prohibiting development that would otherwise be subject to flooding resulting in additional drainage and flood prevention work costs; the landscaping of watercourse surrounds enhancing what would otherwise be drainage canals into 'picturesque' parklands increasing property values of adjacent housing; increasing parkland would address Melbourne's lack of appropriately located parklands; proposed parkways would bring land under public control.[154] Figure 49 is the original 1929 plan for the proposed parks and parkway system along the main watercourses.

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[152] Ibid, 238.
[153] Ibid, 214.
[154] Ibid.

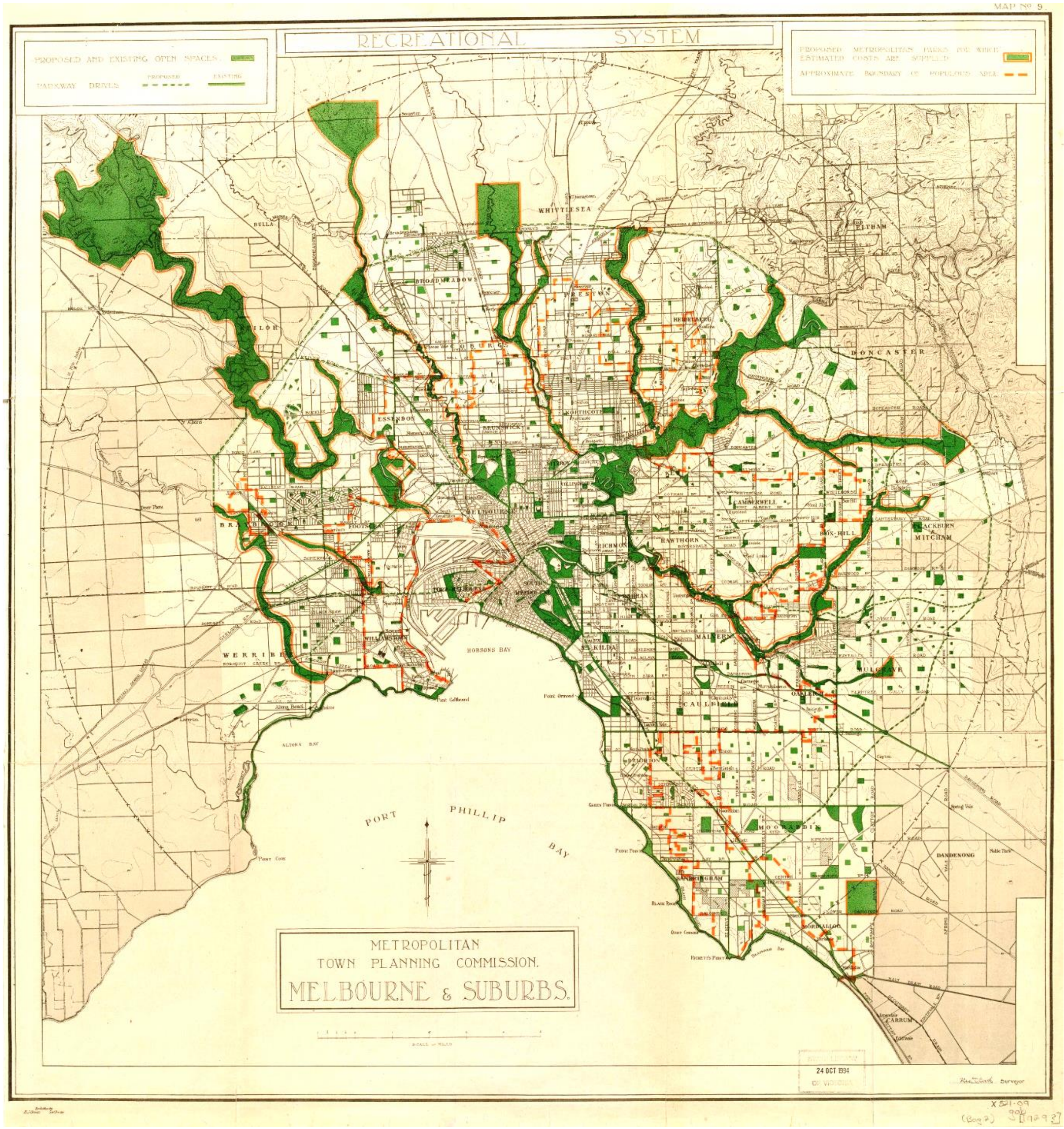

Figure 49. Existing and proposed park and parkway system, 1929. Source: SLV http://handle.slv.vic.gov.au/10381/382400

The parks plan additionally proposed more roads in the form of parkway drives. These would follow along all main watercourse valleys and connect existing and proposed parkland into network of parkways across Melbourne. These included parkways along: the Plenty River; Maribyrnong Valley; Rose Creek (now Steele Creek); Gardiner Valley; Scotchman’s Creek; Back Creek; Koonung Koonung Creek; Darebin Creek; Merri Creek; Moonee Ponds

Creek; Kororoit Creek; and Stony Creek.[155] Each watercourse would provide parkland of assorted sizes edged with a road along one or both sides.

As discussed above, the MTPC was influenced by developments in planning practice in North America, with the ideal of the parkway guiding the proposed park system along Melbourne's watercourses. This, defined by Miller, is a limited-access highway located in parks or along stretches of publicly owned land of substantial size reserved for public recreational purposes.[156] Traffic is limited to small passenger vehicles while prohibited to trucks and other commercial vehicles. The 1929 plan was to date the only attempt to integrate fully all of Melbourne's main watercourses into the urban fabric as an individual system designed for recreation, environmental preservation, stormwater and flood management, and a roadway network along picturesque watercourse valleys.

The MTPC's plan was introduced into the Victorian Parliament in December 1930, its concepts represented in a Town Planning Bill; however, the bill was deferred and lapsed.[157] Due primarily to political opposition by conservative parties, the plan was largely shelved, although a selection of road projects and various public works proposals were realised over succeeding decades.[158] In 1944, the proposed Town Planning Bill of 1930 was passed in the spirit of post-war reconstruction, responsibility for developing a new metropolitan-wide plan being passed to the MMBW (see chapter six, page 204).[159] Many of the 1929 plan's proposals including open space, watercourse valleys and roads, significantly influenced the development of the MMBW's 1954 planning scheme.[160] However, the MPTC's proposed network of picturesque parkway drives with sweeping aesthetic vistas of watercourses was to take on a complete new form under the MMBW, as examined in chapter six.

Conclusion

For the first half of the twentieth century, perceptions and uses of Melbourne's watercourses focussed around two main uses; main drains and parkland. As the city and suburbs were progressively connected to the sewerage system, the problem of managing

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[155] Ibid, 214-25.
[156] Spencer Jr. Miller, "History of the Modern Highway in the United States," in *Highways in Our National Life* ed. J Labatut and W Lane (New Jersy: Princeton University Press, 1950), 109.
[157] Freestone and Grubb, 140.
[158] Freestone and Australian Heritage Council., 18.
[159] Freestone and Grubb, 141.
[160] Ibid.

surface watercourses originally envisaged to be converted into underground combined sewers intensified for the MMBW. The answer arrived in the form of two opposing ideas. The rising Town Planning Movement of early 20th century allowed experts to imagine Melbourne's rivers and creeks as valuable aesthetic assets; the other was to transform watercourses into main drains, engineered for efficient storm-water management and flood alleviation. Enactment of the *1923 Rivers and Drains Act*, officially classified Melbourne's main watercourses as part of the main drain system. Hence, from that point onwards watercourses became a system similar to the water-supply and sewerage systems already managed by the MMBW. The management of watercourses as drains was to be achieved by widening and straightening of channels and removal of all obstructions from streambeds and banks. It also involved concrete lining of channels and placing many smaller tributaries into underground barrel drains. Although larger watercourses were transformed into main drains, and the park system shelved, Melbournites developed a taste for the MTPC's vision for the watercourses, as will be illustrated in proceeding chapters.

Chapter Six: Main Drains, Planning, Freeways and Watercourses

> With Route 23…it is one of the most essential of the future roads. Its location has been carefully chosen to minimise interference with playing fields along Gardiners Creek, and consequently its construction will involve covering Gardiner's Creek and Scotchman's Creek in places.[1]

Introduction

For four decades following World War Two, Melbourne's watercourses were managed as main drains. Watercourse beds and riparian zones were cleared of snags and indigenous vegetation, while sharp bends, shallow rocks and any obstructions perceived to slow or disrupt flood and drainage flows were removed. Many stream channels were formed into trapezoid-shaped earthen or concrete-lined channels to aid with flood alleviation. Numerous watercourses also had engineered structures, including steps and weirs, to control erosion and improve flow velocities, constructed within streambeds and along banks. However, flooding, erosion, and pollution continued to degrade watercourses, as riparian areas and floodplains were perceived as useful sites for expansion of industry, housing, and infrastructure.[2] These sites were also viewed as convenient, cheap places to dump spoil from excavations, resulting in many former stream courses, wetlands and billabongs (oxbow lakes) being filled.[3] The photograph on the left in figure 50, show step weirs and a retaining wall along a section of Gardiners Creek. The photo to the right shows bank erosion along a section of Moonee Ponds Creek.

[1] Melbourne Metropolitan Board of Works, *Melbourne Metropolitan Planning Scheme 1954* (Melbourne: Melbourne Metropolitan Board of Works, 1954), 100.
[2] Senior, 413.
[3] Ibid.

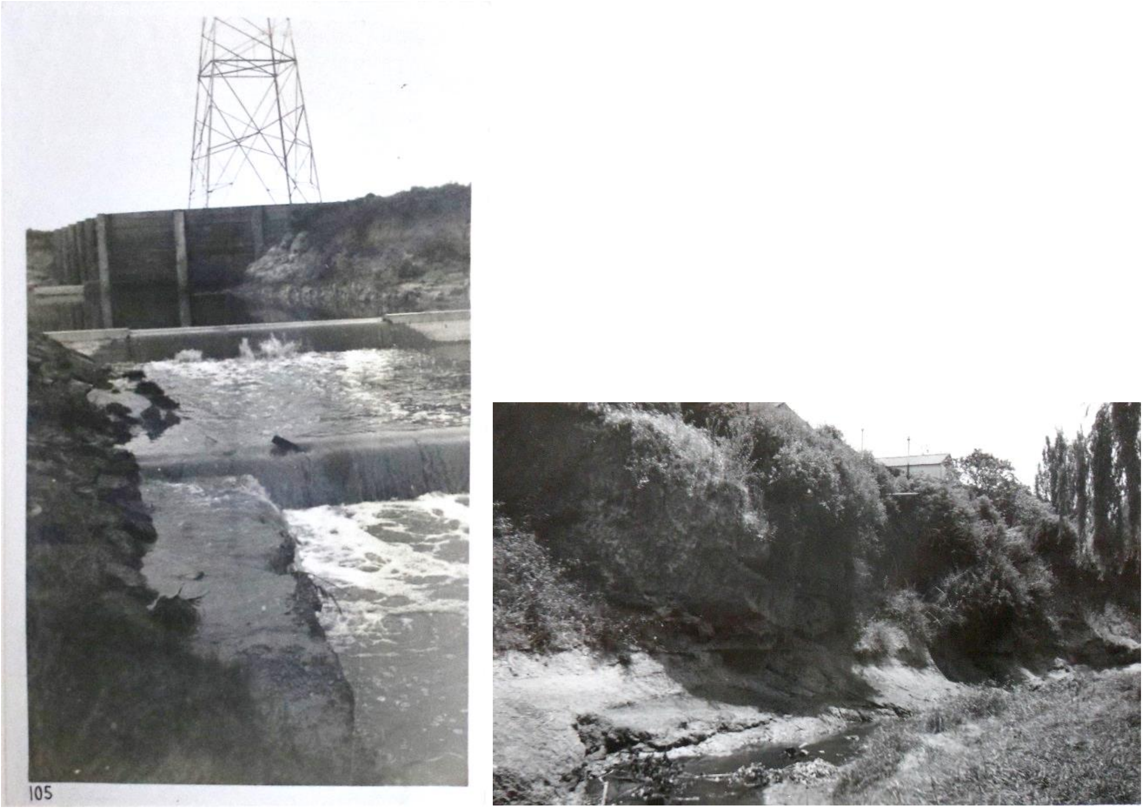

Figure 50. A section of Gardiners Creek, c.a. 1940s, with weirs, and timber retaining wall to control erosion. Moonee Ponds Creek bank erosion in 1955. Source: PROV, VPRS 8609/P32, Unit 7, PA17

By the 1950s, the lower reaches of Melbourne's rivers and creeks (main drains) were the MMBW's most neglected area of operations. This was largely due to ongoing impacts created by the Great Depression and World War Two including shortages in labour and materials.[4] Rapid post-war development of the outer suburbs was resulting in additional drainage flows into watercourses leading to flooding in older suburbs downstream.[5] The dramatic spread of suburban development had also resulted in over 20,000 properties not connected to the sewerage system, and greater use of septic tanks.[6] Seepage from septics and grey or sullage water from kitchens, bathrooms and laundries, was collected by stormwater drainage systems and discharged into creeks.[7] The city's watercourses were perceived as unhealthy and hazardous.[8] In addition to pollution and flooding, suburban expansion was also

[4] Dingle and Rasmussen, 216-17.
[5] Ibid, 217.
[6] Ibid, 215.
[7] Brown, Clarke, and Monash University Facility of Advancing Water Biofiltration, 15; Leigh and Melbourne Metropolitan Board of Works, 94.
[8] Senior, 413-14.

creating significant traffic problems.[9] In 1949 Victoria's government passed the *Town and Country Planning Act (Metropolitan Area)* giving the MMBW responsibility for preparing a planning scheme for Melbourne.[10] The MMBW reserved the watercourse valleys for sections of an arterial road network.[11] From the late 1950s, freeways were deemed the solution to traffic congestion and a viable method of improving travel times between the suburbs and city. The use and modification of Melbourne's watercourses as main drains, accepted practice by this time would soon be joined by using stream banks, beds, and floodplains as locations for freeway construction.

Main Drains: concrete lining and undergrounding continues

As flooding continued and pollution from household septic tanks and sullage-entered Melbourne's watercourses, the MMBW responded with what was considered in many instances to be the only viable solution, concrete-lining larger creek channels and undergrounding smaller tributaries.[12] One of the MMBW's representatives, Councillor R. W. Sylvester claimed in September 1952 that the illegal connection of stormwater pipes into the sewerage system was causing the MMBW to pump millions of gallons of stormwater from the sewers each year.[13] The MMBW's Drainage Record Plan from June 1955 (figure 51) illustrates the number of watercourses that had been designated main drains. It also illustrates underground main drains, many of which were smaller surface (perhaps ephemeral or seasonal) tributaries. Surface flowing watercourses (main drains) are illustrated in blue, with undergrounded ones displayed in red.

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[9] Melbourne and Metropolitan Board of Works., *Melbourne Metropolitan Planning Scheme 1954: Surveys and Analysis* (Melbourne: Melbourne Metropolitan Board of Works, 1954), 167.
[10] Dingle and Rasmussen, 231-35.
[11] Melbourne Metropolitan Board of Works, 97-100.
[12] Dingle and Rasmussen, 307-08.
[13] "M.M.B.W. Has Ambitious Plans for Sewerage," *Record,* September 12, 1952, 5.

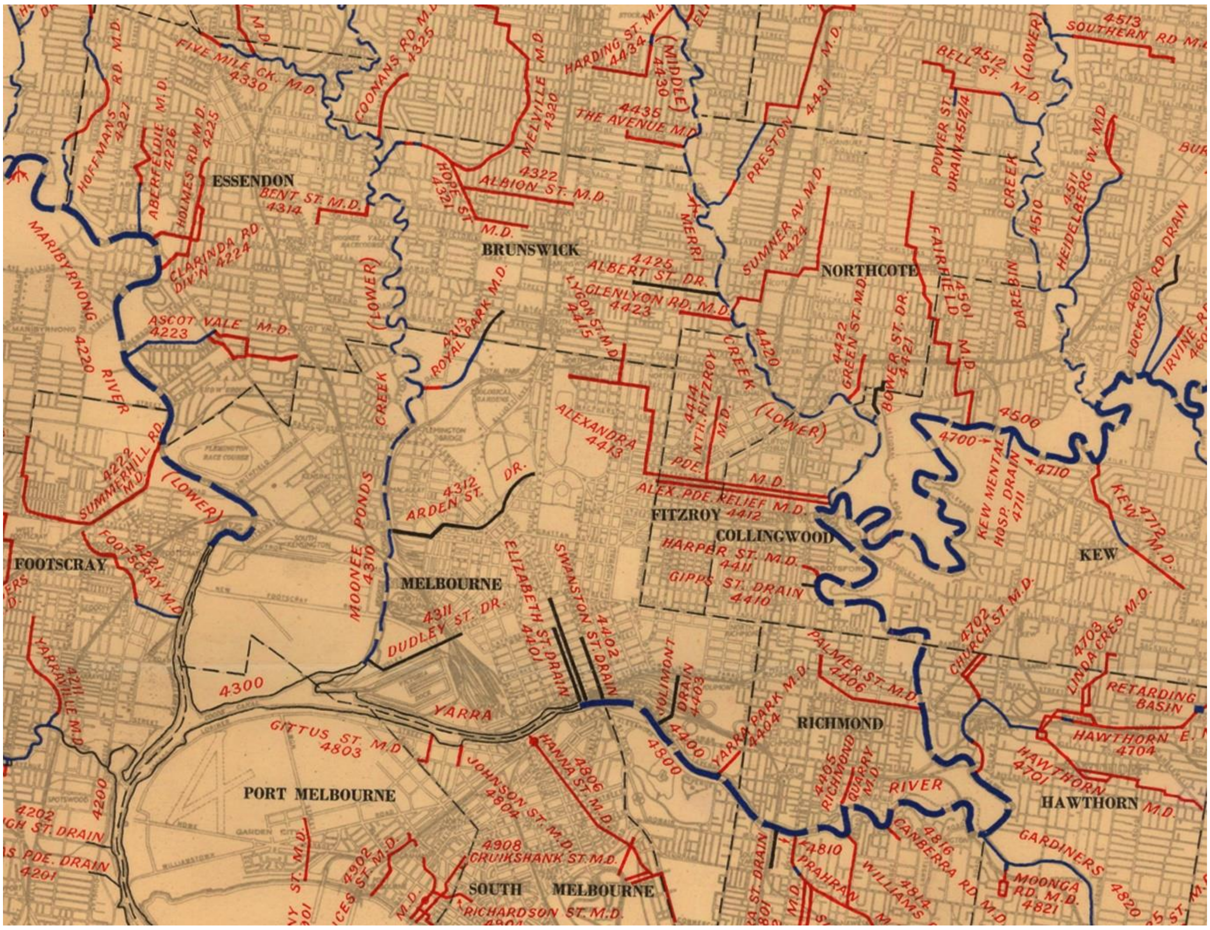

Figure 51. Section of 1955 Drainage Record of main drains. Many underground drains were surface tributaries. Source: SLV http://handle.slv.vic.gov.au/10381/115237

Articles similar to one published in the *Sunshine Advocate* (1954) became common: it claimed analysis showed Kororoit Creek contained gross pollution from either human or animal origin.[14] Although the MMBW and local council declared the creek free of effluent from a nearby explosives manufacturing plant, wastewater and seepage from septic tanks of unsewered housing estates was cited as the possible cause, making the creek unsafe for swimming. A local councillor reported that despite warnings, people had been swimming in the creek all summer.[15]

The Kororoit and neighbouring Stony Creek, both flowing through Melbourne’s western suburbs, (see figure 52) give an example of how the MMBW was managing and responding to major flooding problems on many of Melbourne’s watercourses during the 1950s-1990s.

[14] “Creek Not Suitable for Swimming,” *Sunshine Advocate*, April 2, 1954, 1.
[15] Ibid.

Stony Creek saw a series of devastating floods affecting the low-lying southern area of the working-class suburb of Sunshine. Four years after a severe flood in April 1950, the MMBW announced the approval of a large-scale drainage project.[16] This involved undergrounding 1.1 kilometres (two thirds of a mile) of Stony Creek, flowing through Sunshine's main business district, and construction of 0.5 kilometre (one third of a mile) of an open cut channel to divert flood flows into the Kororoit to the south.[17] Stony Creek is the final tributary of the Yarra, flowing into the river from the north-west, 2.4 kilometres (1.5 miles) from its mouth at Hobsons Bay via the Stony Creek Backwash.[18] The creek rises in grasslands to flow nine kilometres (5.6 miles) across basalt plains, now Melbourne's western suburbs, through residential and industrial areas. The neighbouring Kororoit, to the south, flows from the outer north-west suburbs, in a southeast direction across the western basalt plains and suburbs, and directly into Port Phillip Bay.[19]

[16] "Big Diversion Drainage Job Approved by MMBW," *Sunshine Advocate*, March 12, 1954, 1.
[17] Ibid.
[18] Presland, *The Place for a Village: How Nature Has Shaped the City of Melbourne*, 96.
[19] Melbourne's Living Museum of the West, *Kororoit Creek* (Footscray: Melbourne's Living Museum of the West, 1986), accessed November 2, 2017, 1,https://www.livingmuseum.org.au/publications/DLdownload_pdf/kororoit_creek.pdf.,

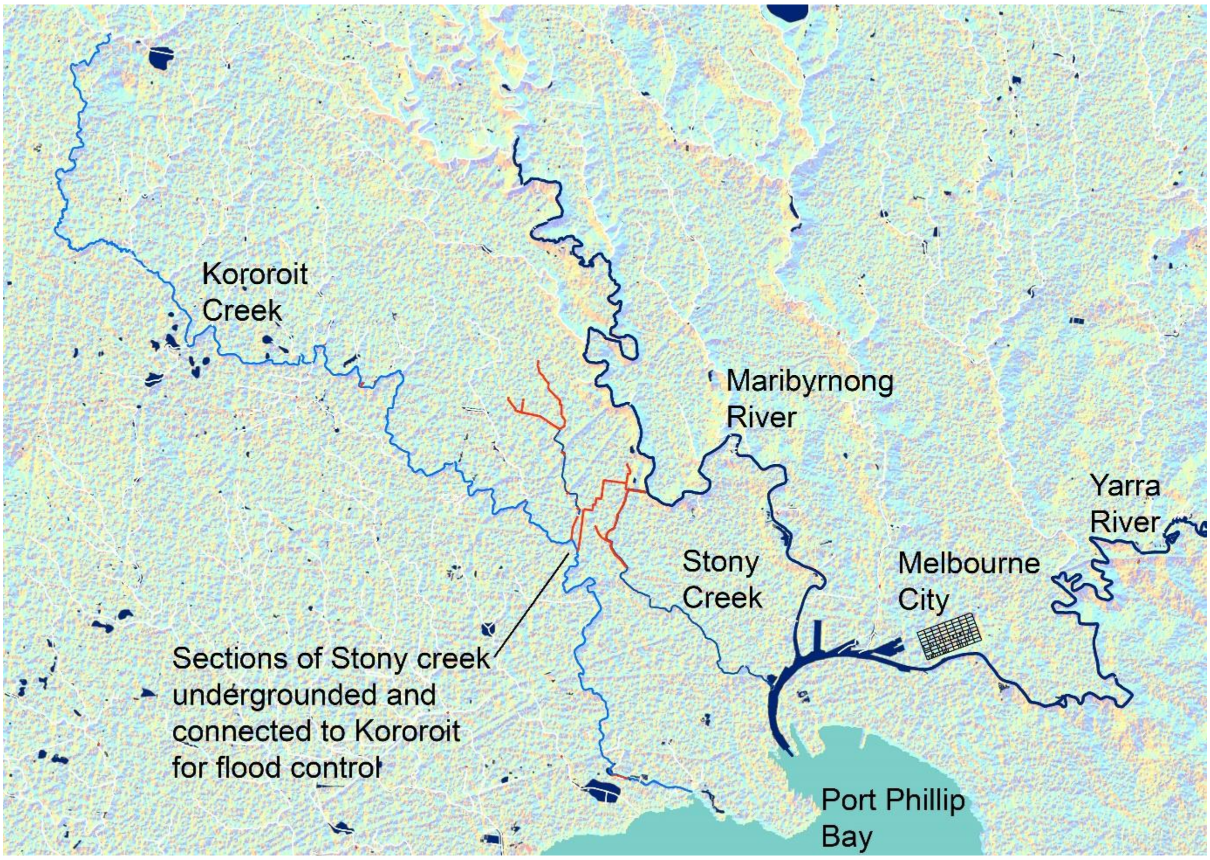

Figure 52. Stony and Kororoit Creeks.

By 1980, sections of twelve of Melbourne's creeks had been lined with either concrete or bluestone pitches, or a combination of both.[20] In addition, 23 surface main drains had been similarly lined.[21] Many had originally existed as smaller tributaries, headwater streams, or seasonal and ephemeral flows. In managing pollution and flooding, and providing flood alleviation works, the MMBW commonly modified streambeds of creeks and smaller tributaries. This was done to increase channel capacity by creating a variety of lined, partially lined or earthen, trapezoid shaped channels, shown in figures 53, 54, and 55. Figure 56 shows underground main drains, in red, with many being former surface tributaries. Concrete-lined creek channels are shown in grey, with constructed connector channels in yellow. Connectors transfer flood flows between the creeks.[22] Construction of trapezoid channels results in straightening of meanders, restriction of floodwaters to floodplains, and loss of natural stream functions.[23]

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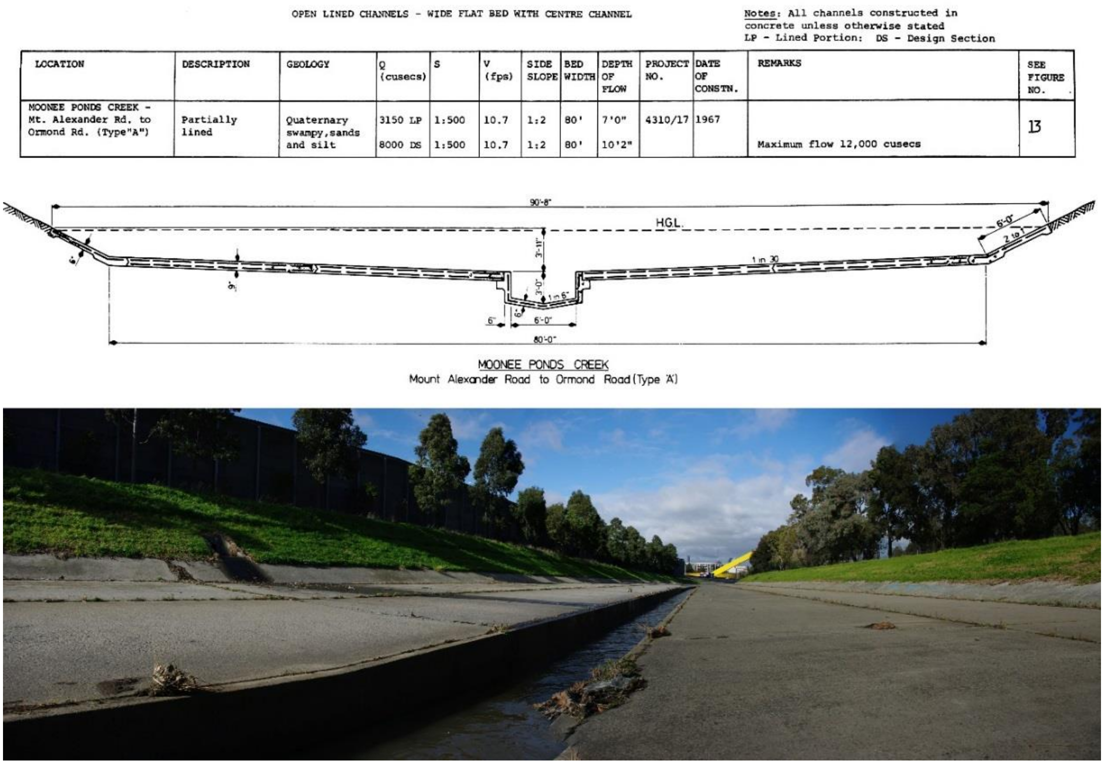
[20] Main Drainage Division, *Design Details of Open Lined Channels* (Melbourne Metropolitan Board of Works 1980), 1-7.
[21] Ibid.
[22] Merri Creek Management Committee, 46.
[23] Ibid.

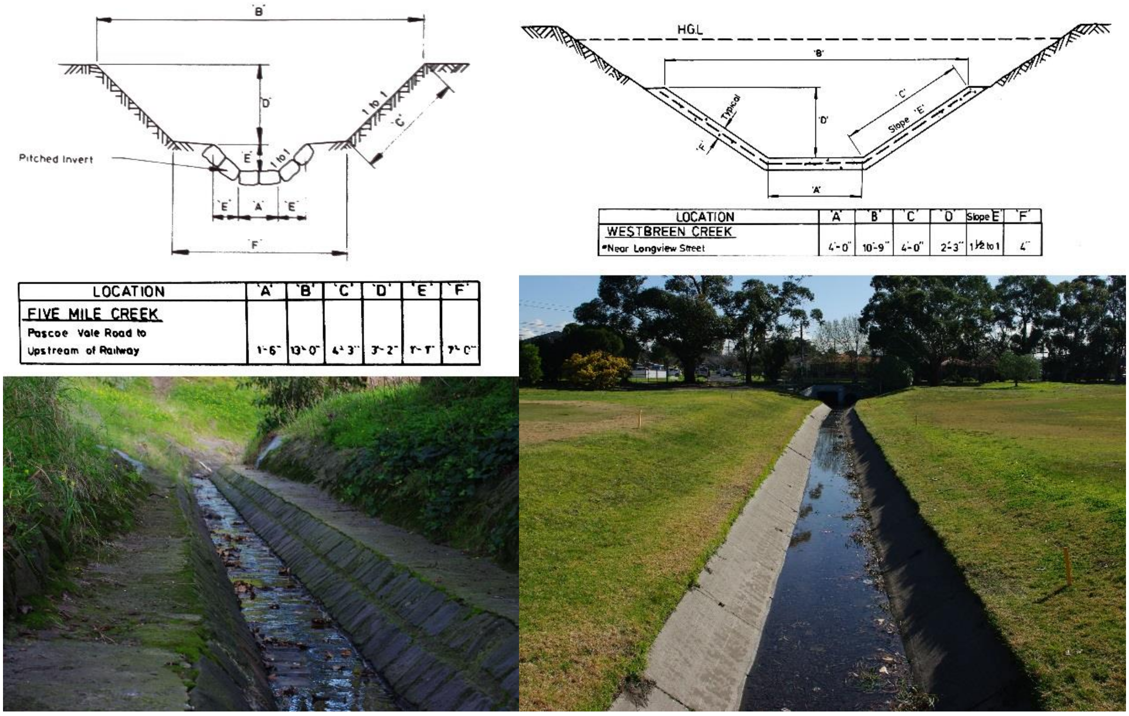


OPEN LINED CHANNELS - WIDE FLAT BED WITH CENTRE CHANNEL

Notes: All channels constructed in concrete unless otherwise stated
LP - Lined Portion: DS - Design Section

LOCATION	DESCRIPTION	GEOLOGY	Q (cusecs)	S	V (fps)	SIDE SLOPE	BED WIDTH	DEPTH OF FLOW	PROJECT NO.	DATE OF CONSTN.	REMARKS	SEE FIGURE NO.
MOONEE PONDS CREEK - Mt. Alexander Rd. to Ormond Rd. (Type"A")	Partially lined	Quaternary swampy, sands and silt	3150 LP 8000 DS	1:500 1:500	10.7 10.7	1:2 1:2	80' 80'	7'0" 10'2"	4310/17	1967	Maximum flow 12,000 cusecs	13

Figure 53. Section Moonee Ponds Creek realigned for the freeway. Source: MMBW (1980) and Author photo (2016)



LOCATION	'A'	'B'	'C'	'D'	Slope 'E'	'F'
WESTBREEN CREEK *Near Longview Street	4'-0"	10'-9"	4'-0"	2'-3"	1½ to 1	4"

LOCATION	'A'	'B'	'C'	'D'	'E'	'F'
FIVE MILE CREEK Pascoe Vale Road to Upstream of Railway	1'-6"	13'-0"	4'-3"	3'-2"	1'-1"	7'-0"

Figure 54. Examples of MMBW 20th century lined channels. Five Mile and Westbreen Creeks. Source: MMBW (1980) Author photos (2017)

Figure 55. Examples of earthen trapezoid channels designed by the MMBW. From top left, Merri Creek; Ruffy Creek; Darebin Creek, and bottom right, Koonung Creek. Source: Author photos (2017)

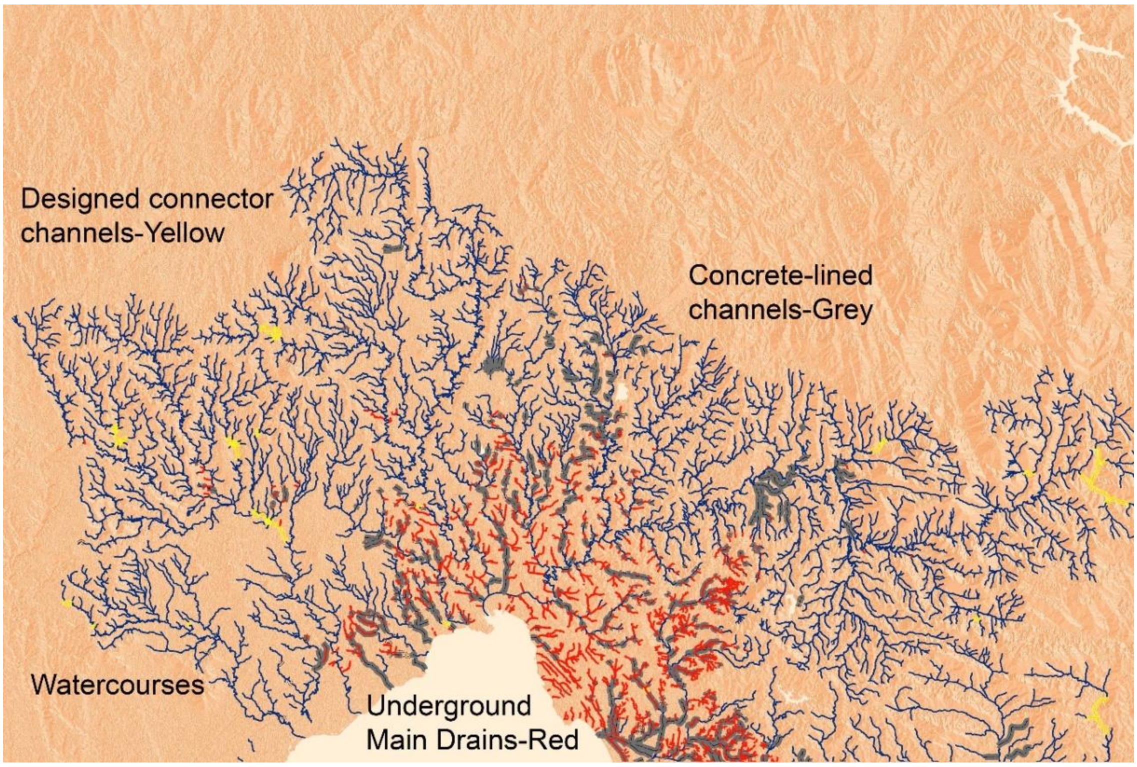


Figure 56. Melbourne's underground main drains, concrete-lined watercourses and constructed connector channels that transfer flood flows between creeks.

Melbourne's planning in the 1950s: Town planning or planning for road networks?

When the MMBW was selected in 1949 to produce a plan for Melbourne, it set up a Town Planning Committee with its engineer of sewerage Edwin Borrie in charge, assisted by an architect, engineer, surveyor and economist/sociologist.[24] A draft plan was released in 1954 for public consultation and implemented as an interim development order in 1955. Much later, in 1968, it was approved by the government.[25] Spencer (1995) lists the scheme's main objects as: to accommodate a projected population of 2.5 million to the east of the city; inclusion of a rural zone to control outward expansion; develop growth in suburban commercial centres; promote inner suburb redevelopment; improve accessibility between homes and employment centres; and to provide an efficient arterial road network.[26] Unlike the 1929 plan that proposed watercourses be preserved as an interconnected park system, the MMBW scheme recommended many watercourse valleys be reserved for future construction of arterial highways.[27]

Like similar industrialised cities globally, Melbourne was seeking solutions to significant traffic problems.[28] The MMBW's *Metropolitan Planning Scheme 1954* highlighted the increasing importance attached to road transport networks as a problem for both planning and future urban growth.

> Transport is undoubtedly one of the major factors in living today. Not only is it essential for mobility, but the money expended on it is reflected in the cost of food, clothing, housing, public utilities, recreational pursuits and practically everything necessary for our sustenance, convenience and comfort. [29]

To the MMBW, traffic problems and road provision were primarily economic issues. The outcome of Melbourne's rapid post-war suburban growth coupled with the rising status and dependency on motor vehicles for personal mobility and transportation of goods resulted

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[24] Dingle and Rasmussen, 235.
[25] R. D. Spencer, "The Development of Strategic Policy Planning in Victoria, Australia: A Review," *The Town Planning Review* 56, no. 1 (1985): 49.
[26] Ibid.
[27] Melbourne Metropolitan Board of Works, 97-100.
[28] Dingle and Rasmussen, 244.
[29] Melbourne and Metropolitan Board of Works, 167.

in roads and transport assuming an important role in city functions and population growth.[30] Similar views were promoted by Charles Bennett, Director of Planning for the City of Los Angeles (1941-1955), on visiting Melbourne in 1953.[31] Bennett had been invited by the TCPA to promote the freeway networks and the need for comprehensive planning.[32] Bennett spoke of 'the vital need for planning' with 'the coming of the automobile age… Our cities must be built round the necessity for the car.'[33] Bennett argued sprawling development of cities was inevitable (even desirable, in the context of threat of nuclear war), public transport was not an economically viable solution for servicing outer suburbs – the reason why 'the motor car is king.'[34] Following the planning scheme's release, the Chairman of the Country Roads Board, Donald Darwin, stated:

> We have much to learn from America where motor vehicular traffic has increased in the last 20 years…limited access freeways and elevated arterial routes through miles of urban areas are now some of the more spectacular endeavours to cope with the enormous flow of traffic. [35]

The Country Roads Board (CRB) was a state bureaucracy, similar to the MMBW, with responsibility for major highways beyond Melbourne's metropolitan boundary, in this case defined by the termination points of the urban tramway system.[36] A consequence of Melbourne's pursuit of the freeway ideal involved many city watercourses losing the aesthetic values acknowledged three decades previously by the MTPC, becoming regarded instead as road engineering problems. The 1954 planning scheme reflects the importance placed on transport through its proposed arterial roads system. Two forms of arterials were proposed: controlled access and free access roads.[37] Access was controlled by constructing

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[30] Dingle and Rasmussen, 242-43.
[31] Sue Ebury, *The Many Lives of Kenneth Myer*, Miegunyah Volumes Second Series (Carlton, Vic.: Miegunyah Press, 2008), 242; "City of Los Angeles Officials," City of Los Angeles, accessed July 20, 2016, https://cityclerk.lacity.org/ChronoLA/index.cfm?fuseaction=app.Faculties&organizationid=481&OfficeID=1093&ElectionID=69.
[32] Ebury, 243; "California Town Planner Says... Planned Cities Vital to Good Government," *Age,* August 3, 1953, 3.
[33] "California Town Planner Says... Planned Cities Vital to Good Government," 3.
[34] "Parking Lots City's Framework Car Is the King, American Expert Says," *Argus,* August 3, 1953, 2.
[35] D Darwin, "Better Roads Are Worth Paying For," *Age,* December 31, 1955, 2.
[36] Graeme Davison and Sheryl Yelland*, Car Wars: How the Car Won Our Hearts and Conquered Our Cities* (Crows Nest, N.S.W.: Allen & Unwin, 2004), 124.
[37] Melbourne Metropolitan Board of Works, 94.

service roads along main arterials for traffic to enter private property, with vehicles restricted to entering the main road only at certain points. Several of the proposed arterial roads would later be constructed as freeways, on land along watercourse valleys, recommended in the 1954 plan to be reserved specifically for future road construction. The proposed arterial roads, numbered routes one to twenty-eight, included four closely aligned with sections of watercourse routes, either along the stream bank or bed.[38] The routes are illustrated in figure 57 with the network of watercourses beneath. This shows the number of roads proposed directly along watercourses and their valleys. The MMBW argued locations of proposed routes had been chosen to avoid shopping centres, tram routes, and other areas of potential traffic congestion, minimising the number of intersections and providing roads with controlled access.[39] Due to the sprawling nature of Melbourne's suburbs the locations of some roads required entirely new routes, which the MMBW argued were available along various creek valleys where extensive areas of land remained undeveloped.[40] An example of the thinking around watercourses during the period is illustrated by the description of one proposed arterial: 'Route 21 follows the valleys of the River Yarra, Gardiner's Creek and Scotchman's Creek…It is located generally in open country so that controlled access will be possible along most of its route.'[41]

[38] Ibid, 94-97, 99-101.
[39] Ibid, 99.
[40] Ibid.
[41] Ibid, 100.

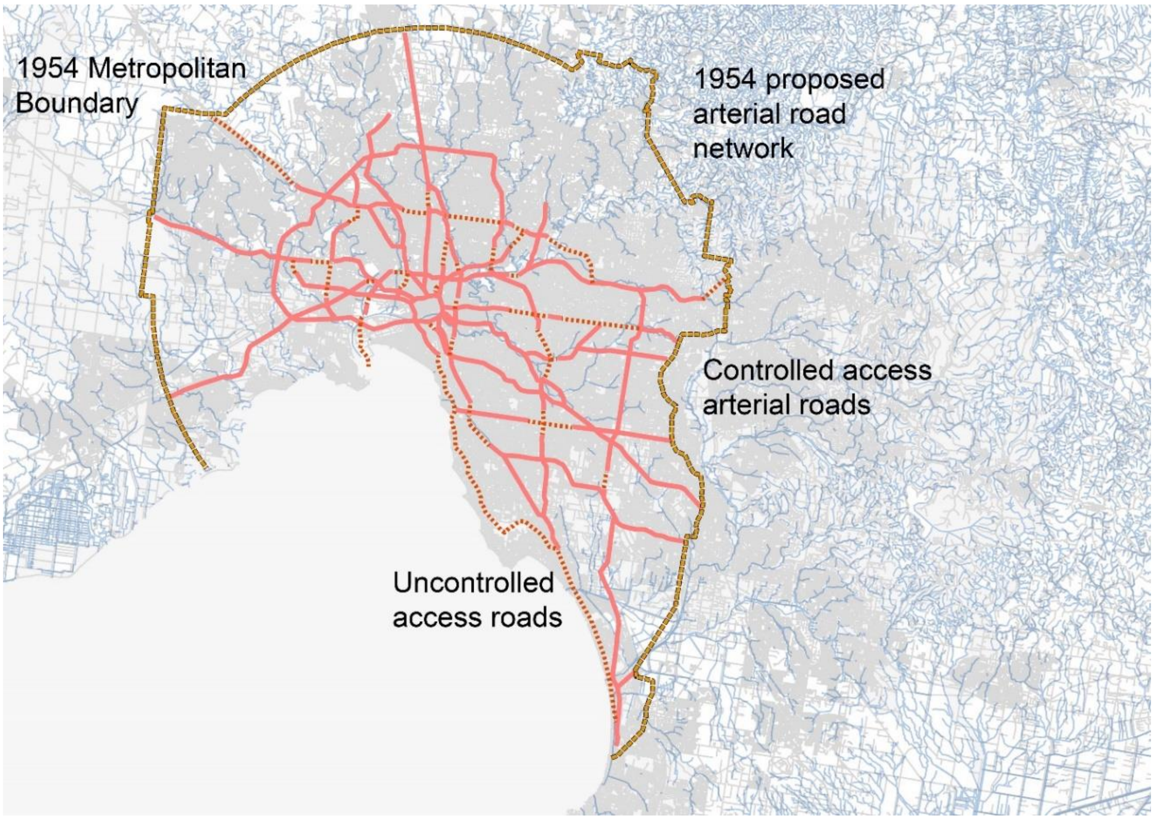

Figure 57. 1954 arterial network. All major watercourses within central Melbourne have arterial roads proposed along sections of their courses and valleys. Source: MMBW (1954).

In 1958 construction of Melbourne's first freeway was announced with arterial route 21 redesignated as a freeway and named the South-Eastern.[42] Its first stage was constructed along the northern bank of the Yarra River on land originally proposed by the MTPC as the location for a parkway drive.[43] Visually utilitarian, the freeway's design removed the attributes of leisure space, the picturesque and flowing water, all highly valued by the MTPC as demonstrated in its parkway system.[44] Figure 58 is a view of the area in 1945, a complete parkway, Alexandra Avenue following the left bank of the Yarra. Figure 59, for comparison, is the same view from 2017. The first stage of the freeway was constructed between the two road bridges, foreground and background along the right bank.

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[42] Lay, 211.
[43] Metropolitan Town Planning Commission, *Plan of General Development, Melbourne: Report of the Metropolitan Town Planning Commission*, 226-28.
[44] Ibid, 214-28.

Figure 58. Alexandra Avenue 1945. Source: SLV H91.160

Figure 59. The same view in 2017. The freeway follows the right bank. Source: Google Earth (2017).

In 1960 and 1963-64 the renowned Australian planner and engineer, Patrick Troy, was involved with the planning of the freeway as a transport highway engineer in the employ of the MMBW.[45] The proposed freeway, shown in figure 60, consisted of four-lanes (two in each direction), with elevated sections along the northern bank of the Yarra through the southern boundaries of the inner suburbs of Cremorne and Burnley, (at the time both part of the City of Richmond, a working-class suburb). The freeway's main aim was to relieve traffic congestion along the road routes entering the city from the southeast suburbs.[46]

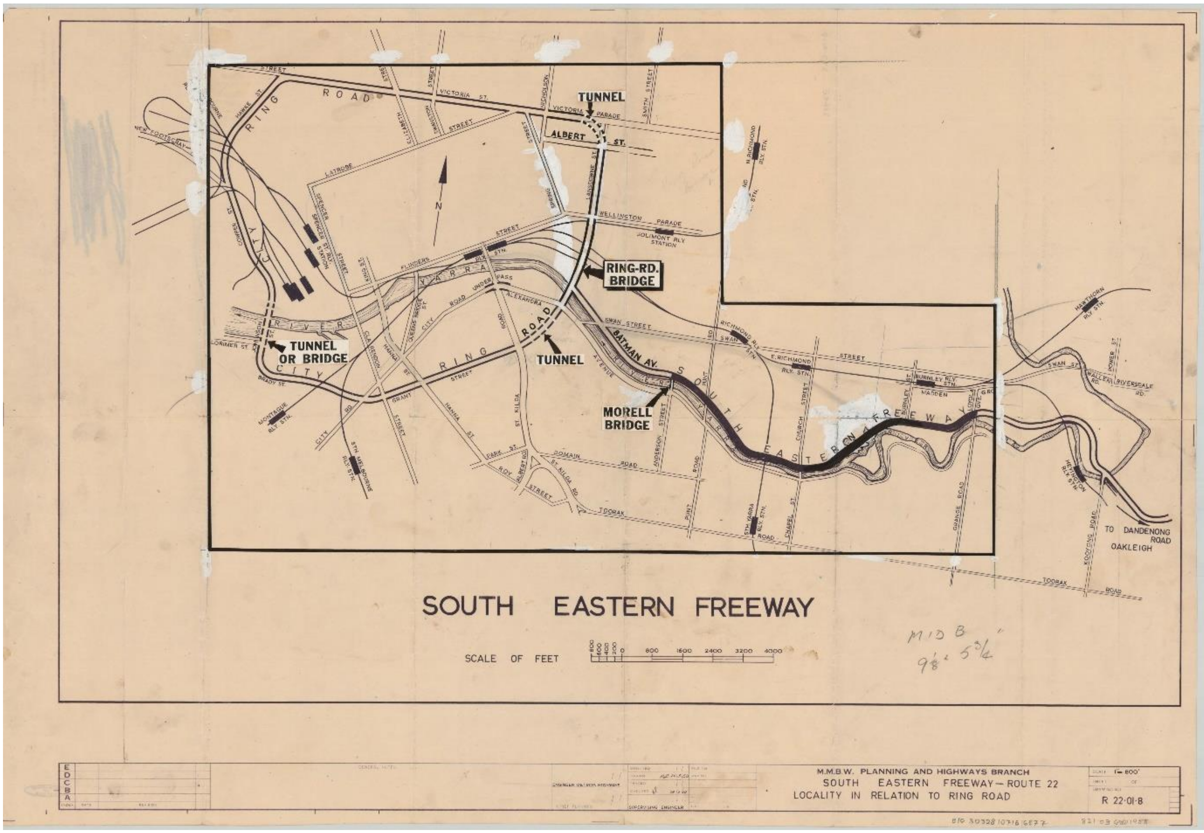

Figure 60.Route of the first stage, following the riverbank. Source: SLV http://handle.slv.vic.gov.au/10381/117432

That the planned route was minimally intrusive on private property justified use of the Yarra's bank.[47] Already contentious, as the above example shows, the use of private property

[45] Stuart Macintyre, "Patrick Troy: Public Good and the Intellectual," *Urban Policy & Research* 18, no. 2 (2000): 148-49.
[46] Dingle and Rasmussen, 244.
[47] Ibid.

for freeway construction in Melbourne became a major issue over the following decades for many stakeholders including public, governments and road construction authorities.[48] Public dissent regarding the construction of urban freeways initially centred on demolition of inner city neighbourhoods and housing. This also included quality of life issues for locals (for instance, the potential for children to be affected by the lead in automobile fumes), as successive state governments sought to solve Melbourne's traffic problems with a network of freeways surrounding and dissecting the city. For example, the *Metropolitan Transportation Plan* (1969), similarly to the arterial roads of the 1954 plan, proposed 494 kilometres (307 miles) of freeways involving large-scale demolition of houses and property.[49]

In Melbourne, public protest and dissidence against freeways only appeared after the city's first two freeways were completed. Stage one of the South-Eastern and the southern section of the Tullamarine, both constructed in watercourse valleys, and directly affecting on sections of stream courses, evoked little public protest. Opening the Tullamarine in February 1970, Premier Henry Bolte stated: 'It will make Melbourne one of the greatest cities in the world.'[50] The ideals of the freeway promised Melbourne a solution to its traffic flow problems, status on the world stage and the swift, efficient, uninterrupted movement of motor vehicles.[51] This utopian vision of freeways however was soon tarnished. As discussed above a major outcome of the *Melbourne Transportation Study* (1969) and proposed metropolitan-wide freeway network was the rise of public opposition to construction of freeways through neighbourhoods, across parklands and green belts and along stream valleys.[52] Public protest against freeway construction across and above Melbourne has a history spanning over forty years. The most recent protest was during the 2012 – 2015 period against the proposed East West Link Protect, involving the extension of the western end of the Eastern Freeway (Melbourne's third constructed freeway) to the western suburbs.[53] The project involved utilising sections of public parkland for road tunnel portals and covering further sections of the Moonee Ponds Creek with elevated roadways.[54]

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48 Davison and Yelland, 187-218.
49 Ibid, 187-204.
50 "'Freeway Makes Us Even'," *Sun News Pictorial,* Feburary 4, 1970, 19.
51 Davison and Yelland, 176-177.
52 Ibid, 187-238.
53 "Snap Protest Staged as East-West Drilling Begins in Clifton Hill," *Melbourne Times Weekly*, May 23, 2012, 5; Victorian Auditor-General, *East West Link Project*, (Melbourne: Victoria Auditor-General, 2015), 1-3.
54 E Daniels, "Technical Appendix E, East-West Link Eastern Section-Traffic Impact Assessment, " in *Report for Linking Melbourne Authority* (Melbourne GDH 2013), 72-74.

Melbourne's first freeway route: An historic path

Although the South-Eastern freeway was Melbourne's first freeway, it followed a route predating the city itself.[55]

The indigenous inhabitants of the Melbourne region before European urbanisation utilised the area's rivers and stream valleys to travel from Port Phillip Bay to further inland sites and resources (see chapter two, page 22).[56] As discussed in chapter four, the first thoroughfares created by European settlers outside Melbourne's grid were commonly stock routes, frequently following paths formed by indigenous people primarily following permanent rivers and creeks.[57] During the first years of Melbourne, paths along the Lower Yarra River were developed as riverside towpaths (1835-1840) used to haul shipping from the Yarra's mouth at Hobsons Bay to the turning basin and the city's first wharf, in front of the falls.[58] However the ancient practice of using watercourse banks as travel routes was challenged in 1837 when land was subdivided into blocks allowing water access to as many as possible, roads to be located at 90 degrees to watercourses, as stipulated in 1829 regulations introduced by Governor Darling (see chapter 4 page 114-15).[59] This pattern of subdivision may explain why Melbourne's ongoing development largely radiated out in an arc parallel to main watercourses. The use of watercourses for locating roads along either the banks or streambed involves major ecological, landscape and hydrological modification affecting stream banks, beds, riparian zones, and flood plains.[60]

Watercourses and roads: From the picturesque to the utilitarian

The 1829 ruling on watercourses was soon forgotten, as Melbourne rapidly developed. The next antecedent to the South Eastern freeway was development of the boulevards of the late 1890s alongside the Yarra. Commencing near Princes Bridge on the southeast corner of the original city grid, these low-lying areas, part of the Yarra's

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[55] Presland, *The Place for a Village: How Nature Has Shaped the City of Melbourne*; Lay, 29-32.
[56] Presland and Victoria Archaeological Survey, 13; Woiwod, 30.
[57] Lay, 29.
[58] Ibid, 1.
[59] Ibid, 12,15.
[60] Andreas Seiler, *Ecological Effects of Roads: A Review* (Sweden: Swedish University of Agricultural Sciences, 2001), 7-14.

floodplains, were often subjected to flooding. This is evident in photo, figure 61, of the width of the Yarra during the Great Flood of 1891.

Figure 61. The Great Flood of July 1891, the Yarra at Princess Bridge. Source: SLV H82.62

A major outcome of the flood on the Yarra in July 1891 was the decision to widen, deepen, and straighten 2.2 kilometres (1.36 miles) of the river between Princes Bridge and Richmond.[61] Commencing in 1896, the project included bypassing a significant bend in the river as illustrated in figure 62.[62]

[61] Beardsell, Beardsell, and Royal Society of Victoria, 39-40.
[62] "Upper Yarra Improvements: Boulevard Taverner," 36.

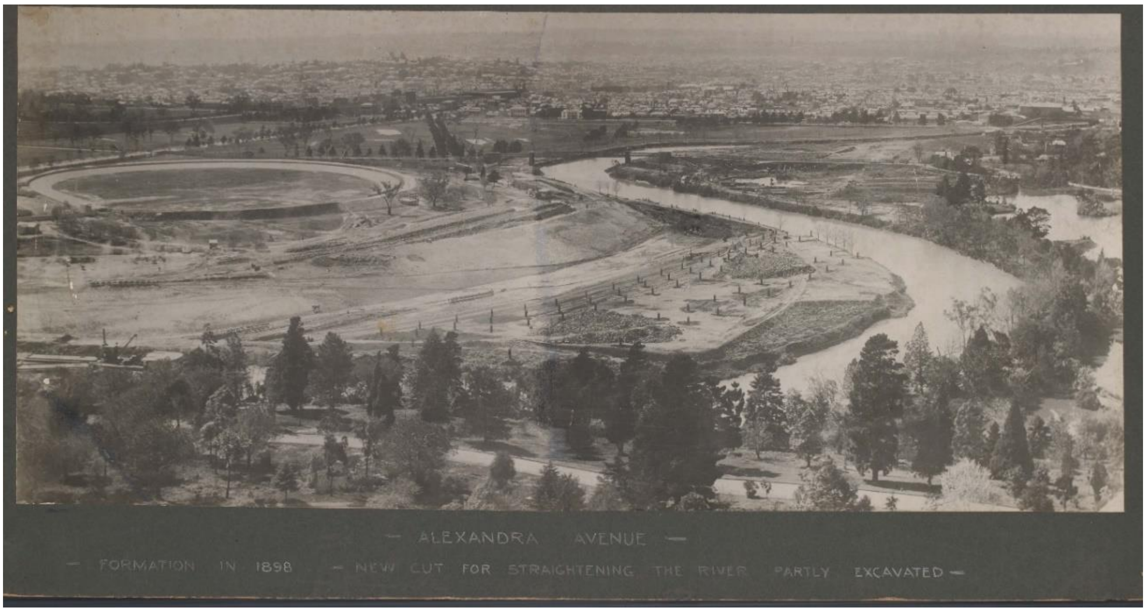

Figure 62. New Yarra bed c.a. 1887. Source: SLV H347

The *Age* (1897) suggested a reconstructed riverbank would provide the opportunity to move beyond the *'severely utilitarian engineering'* of what was considered a canal, to re-make this section of the river as a picturesque feature of riverine scenery for the city.[63] The chief engineer of the Public Works Department, Carlo Catani, who devised the scheme also proposed construction of a riverside highway from the city to Heidelberg, 34 kilometres (21 miles) upstream.[64] Catani's project has been only partially realised. In the original project spoil removed in river bed excavation was used to construct roadways along the banks divided by five rows of trees, defining a series of avenues including pedestrian and cycle paths, a carriage way and equestrian track, as evident in the photograph of figure 63.[65]

[63] "Yarra Improvements. The Present Position," *Age*, November 10, 1897, 7.
[64] "The Yarra Boulevard. Checks to the Catani Scheme. Whose Responsibility?," *Age*, December 31, 1932, 4.
[65] "Yarra Improvements," *Australasian*, November 13, 1897, 51.

Figure 63. The completed river alignment and avenues in 1917. Source: SLV H348

The truncated river bend was incorporated into the Botanical Gardens' ornamental lake system.[66] Proposed for recreation and improvement of the riverbanks, the first stage of the Boulevard, Alexandra Avenue, was opened in May 1901.[67] It was soon recognised as one of the city's landscapes that are more attractive. The *Mercury* (1908) stated 'the picturesque Alexandra-avenue, cannot but appeal forcibly to any stranger with the least appreciation of the beautiful.'[68] Similar boulevards were built on up-stream sections of the Yarra.[69] These were constructed between 1931 and 1933 as unemployment relief projects during the Great Depression, in several sections lining alternate banks of publicly owned land along sections of the Yarra River.[70] The impact of the Avenue's landscape was far reaching. In 1969, the opposition leader in the legislative council John Galbally called for the clean-up of the Yarra through Melbourne's central business district by stating 'This part of the Yarra is now so ugly…Why not extend Alexandra Av. Under Princess Bridge and Queen St. to clean the Yarra's north side?'[71] With the arrival of the motor vehicle early in the 20th century, it

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[66] E Almond, "A Garden of Views: Photographic Records of the Royal Botanical Gardens, 1860 to 1910 " *Victorian Historical Journal* 67, no. 1 (1996): 54.
[67] "Alexandra Avenue. Melbourne, Friday," *Examiner,* May 18, 1901, 11.
[68] "Melbourne's Decorations," *Mercury,* August 29, 1908, 5.
[69] Lay, 178.
[70] Metropolitan Town Planning Commission, *Plan of General Development, Melbourne: Report of the Metropolitan Town Planning Commission*, 214-15; Lay, 178-79.
[71] "Jetway Will Be Xmas Present," *Sun News Pictorial,* May 30, 1969, 11.

became an even more important route connecting the city with eastern and south-eastern suburbs. The MTPC's 1929 plan for Melbourne proposed continuing the road as the 'Yarra Boulevard' and extending it along the river upstream to Kew, 18 kilometres (11 miles), on a route closely resembling Catani's earlier scheme from 1896.[72] Additionally, the MTPC's proposal stipulated land between the river and Boulevard would become part of a park system and, where land was under private ownership, it should be re-acquired by government for public use.[73] To the MTPC the logical extension of the Yarra Boulevard and accompanying park system was the inclusion of all main river and creek valleys across metropolitan Melbourne, creating an interconnected system of public parks and roads or parkways.[74]

The history of the Yarra's (and Melbourne's) first scenic boulevard signifies the creation of new roles, uses, and changing form of integration into the urban fabric for main rivers and creeks.

The main concept in the parkway system was provision of a limited-access highway through parkland, linking passenger vehicle movement with recreational areas.[75] During the 1920s and 30s in North America, the parkway evolved into the divided highway, designed for high-speed travel over longer distances.[76] Further developments from Western Europe included the autobahn, constructed in 1935, connecting Frankfurt and Darmstadt, Germany.[77] Specifically designed for interurban travel, it resembled the autostrada, privately owned roads in Milan, Italy constructed between 1922 and 1930.[78] Both provided intersection-free two and four-lane highways and were early versions of the modern freeway system.[79] In Australia, the concept of the autobahn was not adopted until 1953 when the *Newcastle Sun* announced construction of the first autobahn in Australia, connecting the suburb of Freemantle, Perth with an oil-refinery 17.7 kilometres (11 miles) to the south in Kwinana, (a road now known as the Kwinana Freeway).[80] Previously the autobahn was rarely reported in Australia and then

[72] Metropolitan Town Planning Commission, *Plan of General Development, Melbourne: Report of the Metropolitan Town Planning Commission*, 215; "The Yarra Boulevard. Checks to the Catani Scheme. Whose Responsibility?", 4.
[73] *Plan of General Development, Melbourne: Report of the Metropolitan Town Planning Commission*, 215.
[74] Ibid, 115-16.
[75] Peter G. Rowe, *Making a Middle Landscape* (Cambridge, Mass.: MIT Press, 1991), 186-87.
[76] Ibid, 189.
[77] Ibid, 191.
[78] Ibid.
[79] Ibid.; Thomas Dunlap, "Planning the Autobahn before and after 1933," in *Driving Germany*, ed. Thomas Zeller, The Landscape of the German Autobahn, 1930-1970 (Berghahn Books, 2010), 48.
[80] ""Autobahn" for West Australia," *Newcastle Sun*, 30 July, 1953, 13.

only regarding the benefits of improved traffic flows and reduction in road accident tolls.[81] In February 1938, during her luncheon address to the Soroptimist Club in Sydney, entitled *Town Planning in the City of Sydney – or the lack of it,* planning advocate and architect Florence Taylor promoted the concept for Sydney.[82]

By the 1950s, divided highways struggled to cope with increasing traffic volumes in many urban centres globally.[83] The ideals of the parkway were reimagined to create a road system of utilitarian design, based on moving traffic as swiftly and efficiently as possible across the urban fabric, a move away from landscape principals to basic engineering.[84] The freeway was promoted as the solution to urban traffic congestion.[85]

Melbourne's first freeway: Cutting travel time by cutting watercourses

The first stage of the South-Eastern Freeway involved construction of 1.2 kilometres (0.73 miles) of roadway following the contour of the Yarra's engineered northern bank, two kilometres (1.2 miles) upstream from the city. This section of the river had previously been widened, deepened, and straightened with its bank lined in rock beaching and grass. Sections of the freeway include elevated overpasses spanning existing roads and a section of the Yarra opposite Herring (formerly Como) Island. In 1951, it was named for Victoria's Chief Justice Sir Edmund Herring who, as president of the Australian Boy Scouts Association, had organised the use of the island for scouts.[86] The island was formed over 1928-29 by the MMBW as part of flood control works and the Yarra's original course flows along the southern edge of the island. [87] The freeway also passed along the southern edge of the suburb of Richmond, bordered mostly by industrial sites, requiring minimal acquisition of private land.[88]

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[81] "Road Improvement," *Cains Post,* August 29, 1939, 8; "Modern Roads Reduce Motor Toll in Germany ", *Maitland Daily Mercury,* August 19, 1939, 8.
[82] Florence Taylor, "Town Planning in the City of Sydney – or the lack of it," *Construction and Real Estate Journal* (23 February 1938): 5.
[83] Rowe, 196.
[84] Ibid.
[85] Ibid, 195-97.
[86] Presland, *The Place for a Village: How Nature Has Shaped the City of Melbourne*, 109; "Scouts Take over Yarra's Herring Isle," *Argus* December 24, 1951, 3; ibid; Heritage Council Victoria, *Como House* (Melbourne: Heritage Council Victoria, 2008), accessed July 24, 2016, 3,http://vhd.heritagecouncil.vic.gov.au/places/1076/download-report.
[87] Beardsell, Beardsell, and Royal Society of Victoria, 38-39.
[88] "Beauty and Squalor, Along New Freeway," *Age*, December 27, 1961, 7; Macintyre, 149; Lay, 211.

In 1961 during construction of the South-Eastern, *The Age* reported 'motorists will catch a new vista of the Yarra, with its grassy banks framed by the skyline of the city ahead.'[89] The freeway opened in 1962 and after initial improvements to traffic flows, general traffic conditions in the area worsened.[90] Although the freeway's impact on traffic was measured, the effects upon the Yarra from the overshadowing infrastructure appear to have received little if any consideration. Dingle (1990) believes this was due to the first section bordering what was termed 'an ugly industrial area.'[91] This lack of concern was echoed by the *Age* (1962); 'The freeway will not be a serious challenge of the beauty of Alexandra Avenue on the southern side of the river, as its northern boundary is lined with grimy factories, storage yards and dilapidated backyards.'[92] Extension a further 4.7 kilometres (2.9 miles) was announced in 1965 continuing along the northern bank of the Yarra to its confluence with Gardiners Creek.[93] At this point, it would cross the river and follow the creek's alignment, on a section of elevated roadway.[94] In addition to greatly affecting the lower reach and confluence of Gardiners Creek this section also affected, the Yarra's streambed directly as it required straightening the river. The composite map below, (figure 64) with Ham (1852) as the base has been overlayed with the current route of the Yarra and Stage two of the South-Eastern Freeway to illustrate sections of the river diverted and straightened for construction.

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89 "Beauty and Squalor, Along New Freeway," 7.
90 Lay, 211.
91 T Dingle, "Melbourne and the Yarra: An Uneasy Relationship," *Historical Environment* 14, no. 3 (1999): 8.
92 "Beauty and Squalor, Along New Freeway," 7.
93 Lay, 211.
94 Ibid, 211-12.

Figure 64. Former and current course of the Yarra in relation to the freeway. Source : Base Map - SLV http://handle.slv.vic.gov.au/10381/1588

Additionally, Gardiners Creek valley would also be the site of a high voltage transmission line proposed to align the South Eastern to the extent some of the pylons supporting the transmission line were relocated to fit within the MMBWs siting of the freeway.[95] The SECV had established the easement 40 years previously for a transmission with shorter pylons, and had acquired additional land only months before the introduction of the *Cultural and Recreational Lands Bill 1963* was passed through state parliament.[96] The bill sought to protect land within the metropolitan area of Melbourne used for cultural and recreational activities from being compulsorily acquired for other uses, such as road corridors and service easements.[97]

Gardiners Creek flows south-west through the eastern suburbs of Melbourne, to join the Yarra as one of its largest tributaries along the southeast bank.[98] It was originally surveyed by Robert Hoddle in 1837 as Kooyong Koot Creek, the name used by the local indigenous people.[99] The tributary was a braided stream (a stream with many small

[95] "Freeway 'Placed' Pylons," *Sun News Pictorial*, January 4, 1964, 4.
[96] Ibid.
[97] *Cultural and Recreational Lands Act 1963* 7101.
[98] Presland, *The Place for a Village: How Nature Has Shaped the City of Melbourne*, 81.
[99] "The City of Malvern. An Entertaining History," *Age*, February 15, 1936, 7.

intertwining channels) flowing across a wide marshy floodplain covered with tea-tree scrub.[100] It was renamed after John Gardiner, one of a group of pastoralists who drove 300 sheep from Sydney to the Port Phillip region in 1836 and established a station adjacent to the creek.[101] Gardiners Creek traverses more than 25 kilometres (15.5 miles) from its headwaters upstream from Blackburn Lake (see chapter four, pages 90-2).[102] By the 1930s due to flood alleviation works carried out by the MMBW, including channel straightening and streambank vegetation clearance to promote swift, unobstructed removal of flood flows, the creek bed had eroded deeply into the underlying alluvial plain. In addition, earlier land clearing of the floodplain had removed the retarding properties of the floodplain and creek that slowed and dispersed floodwaters.[103] Consequently, the MMBW was required to construct ten retarding basins along the Gardiner's upper reaches to slow flood flows and reduce erosion.[104] As Melbourne's suburbs spread easterly along the creek valley, the floodplains were commonly used for refuse dumping, or reclaimed and developed for industry. For example, one section of the creek contained two channels, with one filled and used as part of a brick-manufacturing site.[105] Gardiners Creek covers a catchment area of 114 square kilometres (44 square miles), fed by a network of tributaries.[106] Many of these smaller tributaries have been placed either underground or filled, and the land developed, as evident in the map of Gardiners Creek in figure 65.

[100] David Helms, Stonnington (Vic.) Council, and Context Pty. Ltd., *Stonnington Thematic Environmental History* (Prahran, Vic: City of Stonnington, 2006), 22.
[101] "The City of Malvern. An Entertaining History," 7; Presland, *The Place for a Village: How Nature Has Shaped the City of Melbourne*, 81.
[102] "Blackburn Lake's History at a Glance," Blackburn Lake Sanctuary, accessed March 25, 2016, http://blackburnlakesanctuary.org/history.php; Presland, *The Place for a Village: How Nature Has Shaped the City of Melbourne*, 81.
[103] Helms, Stonnington (Vic.) Council and Context Pty Ltd, 22; T. S. Hall, *Victorian Hill and Dale: A Series of Geological Rambles* (Melbourne: T.C. Lothian, 1909), 49.
[104] Helms, Stonnington (Vic.) Council, and Context Pty Ltd, 22.
[105] Ibid.
[106] Presland, *The Place for a Village: How Nature Has Shaped the City of Melbourne*, 82.

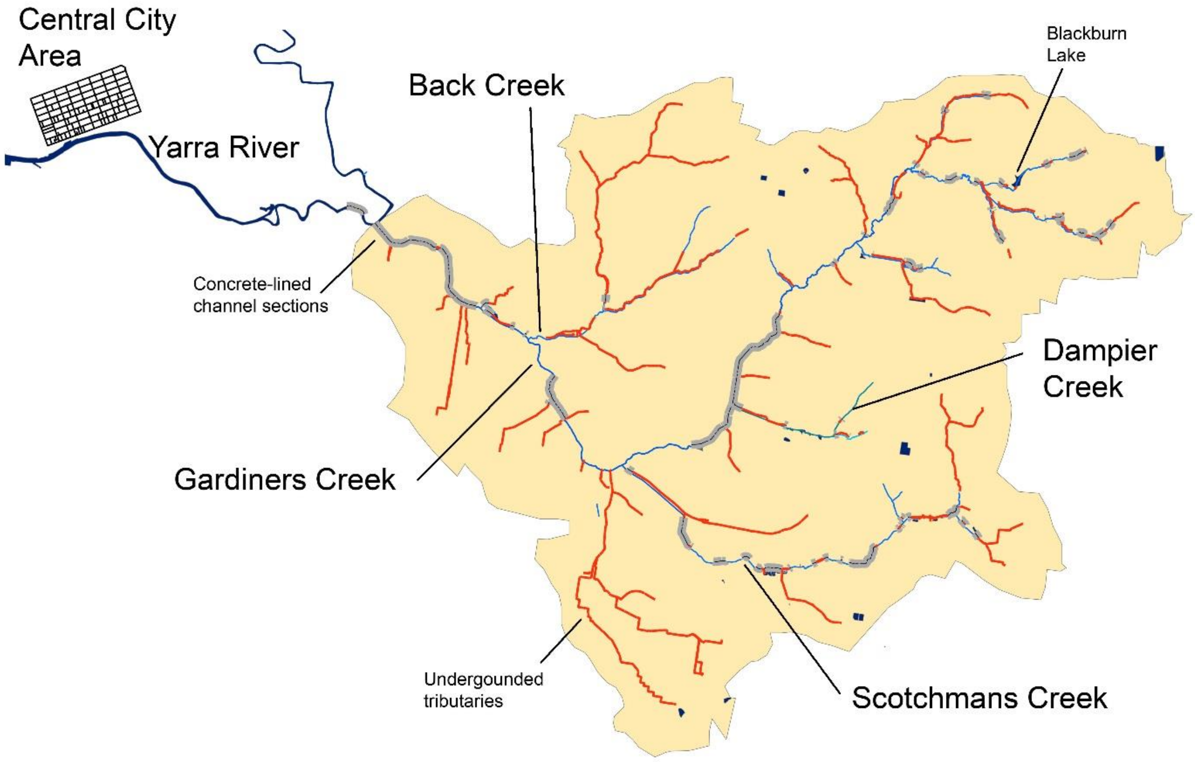

Figure 65. Gardiners Creek catchment.

One of the creek's main tributaries was Scotchmans Creek, flowing from the southeast.[107] Long sections of Scotchmans flows within an underground barrel drain having been progressively piped by the MMBW progressively throughout the 20th century, while open sections flow along bluestone pitcher or concrete-lined channels. Little information exists about the transformation of Scotchmans Creek into a heavily modified main drain. It is assumed this occurred as a solution to flooding, since the creek flows within a narrow corridor through several eastern suburbs. A large section of the creek's final reach before its confluence with Gardiners Creek was placed underground due to the construction of the South Eastern Arterial, and its upgrade to a freeway.

The decision to extend the freeway across the Yarra and along Gardiners Creek valley was not the first road proposal for the valley. In 1929, the MTPC, as with other main watercourses, proposed a parkway traversing 15 kilometres (9.5 miles) along the creek and

107 Ibid, 83.

encompassing 323 hectares (798 acres) of land that was subject to inundation.[108] Due to ongoing flooding, councils bordering Gardiners Creek purchased 104 hectares (256 acres) of land and developed a series of sporting ovals and recreational reserves.[109] The parkway was proposed to join into Scotchmans Creek, a tributary of the Gardiners flowing from the northeast, and create an interconnected series of parks along both valleys.[110] The 1954 planning scheme-reserved land along Gardiners and Scotchmans Creeks for a main arterial route, numbered *22/23*.[111]

From the outset, the 1965 extension proved unpopular, not because it traversed and covered the lower reach of Gardiners Creek, rather the impact of the freeway's route on land along the creek.[112] A large portion of the Gardiners floodplain had been developed as sporting fields by two of Melbourne's elite private schools and Victoria's international lawn tennis stadium, Kooyong Tennis Courts, managed by the Lawn Tennis Association of Victoria occupied a section of floodplain.[113] The impacts of the first stage of the South Eastern upon the Yarra and residents of Richmond had received minimal consideration from planners. However, the proposal to locate the road above the sports ovals of the schools, and across the boundary of the tennis stadium, was problematic.[114] A major campaign protesting the location for the freeway was instigated by staff of St Kevin's College, located along the southern bank of the final reach of the creek. In 1963, the college published its response to the MMBW's proposed route, arguing the freeway would severely affect the school's daily operation, future expansion plans, safety of students, and rob the school of significant land.[115] The report described the work of St Kevin's and adjacent Scotch College, across the creek, in developing the ovals and landscapes had resulted in a 'beautiful natural setting' that was rare so close to the city. However, the only reference made to Gardiners Creek concerned a remaining stand of indigenous trees, unique within the metropolitan area, which would be destroyed by construction of the freeway.[116] Consequently, the authors proposed an

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[108] Metropolitan Town Planning Commission, *Plan of General Development, Melbourne: Report of the Metropolitan Town Planning Commission*, 219.
[109] Ibid.
[110] Ibid.
[111] Lay, 211; Melbourne Metropolitan Board of Works, 100.
[112] Macintyre, 149.
[113] "Changes Still Can Be Ordered for Freeway Extension," *Age*, April 1, 1963, 3.
[114] Macintyre, 149.
[115] St. Kevin's College, *The South-Eastern Freeway Proposed Extension, Its Deficiencies and Inadequacies: An Appraisal of the Project and Recommendation for Its Review* (Toorak, Vic. : St. Kevin's College, 1963), 1-5.
[116] Ibid., 8.

alternative route that bypassed the schools, sports ovals and tennis stadium by traversing parklands and residential areas away from the creek. The route terminated back to the creek onto the original route upstream beyond the school.[117] The final route proved to be a compromise between the MMBW and the college that effectively covered the final reach and confluence of Gardiners Creek with an elevated roadway, opened in 1969.[118]

The South-Eastern was further extended along the Gardiners Creek valley, constructed over the period 1984-1988 as an arterial road, not a freeway.[119] This was due to widespread protest and opposition from residents. However, the road was designed for later conversion into a freeway, believed essential when traffic had dramatically increased to a point it was nicknamed the 'south-eastern carpark.'[120] It was opened as a freeway in 1997, following much of the route along Gardiners Creek valley as detailed in the 1954 planning scheme.[121]

Davison (2004) maintains this section of the freeway was the cause of one of the most intense and prolonged public protests over placing freeways along Melbourne's creek valleys.[122] The lower reach of Gardiners Creek was largely concrete-lined in the mid-1980s with sections of elevated roadway covering the streambed in several places. The first upstream reach of the creek along the proposed route of the 1984 section was jammed between a main railway line and a high voltage transmission line, its floodplains covered with an assortment of sports ovals, brick manufacturers, and industrial sites.[123] However, beyond this, flowing between residential developments, the creek was perceived by residents as providing a valued section of riparian parkland.[124] In 1984, the Gardiners Creek Valley Association published *Let It Be*, a six-page booklet summarising the recreational and conservation values of the creek and potential environmental impacts of the proposed road.[125] The association also highlighted the state government's conservation and environmental policy that stated watercourse valleys would not be used as locations for freeways.[126] The

[117] Ibid., 13.
[118] Dingle and Rasmussen, 255-56; Lay, 213.
[119] Ibid, 212.
[120] Sandra McKay, "More Cars Spend a Little Less Time on the Freeway," *Age*, July 8, 1997, 3.
[121] Lay, 212; Melbourne Metropolitan Board of Works, 100.
[122] Davison and Yelland, 233.
[123] Ibid, 234.
[124] Ibid.
[125] Gardiners Creek Valley Association, "Gardiners Creek Valley: Let It Be," (Melbourne: Gardiners Creek Valley Association, 1984), 1-3.
[126] Ibid, 3.

association strongly opposed the project and the overall use of watercourse valley for road or freeway routes, and the promotion of a private motor vehicle -based transport system.[127] The following quote from the booklet captures some of the passion towards Melbourne's Yarra expressed by Saxil Tuxen during the 1920s (see chapter five, page 158). The association described Gardiners Creek as 'a stream of great beauty':

> It is the habitat of water birds. It is a bustling little creek, flowing between trees presently attired in marvellous spring growth…In the Valley there are also sports grounds, a golf course, people walking, bicycles, dogs and dozens of children playing and adventuring. More leafy tracks and always the creek. To walk its length is an adventure which is about to be demolished to save car travellers no more than ten minutes….[128]

The proposed route was additionally located within a middleclass suburb, the area's sitting local conservative member residing within metres of the creek's picturesque landscape.[129] Wary of the freeway protests of the 1970s and possible damage to the government, the Country Roads Board conducted extensive analysis of every impact the road may have upon the creek's environment.[130] Alternative routes were offered by the road planners, in compromises that resulted in some losses of creek landscape and the demolition of various residential buildings.[131] In the MMBW's Main Drainage Division's activity report of 1981-82 the division reported due to changing the route of the road at least 2.3 kilometres (1.4 miles) of the creek bed required realignment, and to 'save space' would be undergrounded by covering with a parabolic arch.[132] Consequently, due to resident outrage, the section of the creek was concrete-lined, with only 90 metres (297 foot) beneath a major road crossing covered by an arch. Two comparison images of the confluence of the Yarra and Gardiners Creek, the top from 1875 and bottom from 2017 are shown in figure 66.

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[127] Ibid, 5-6.
[128] Ibid, 2.
[129] Davison and Yelland, 235-36.
[130] Ibid.
[131] Ibid, 236-37.
[132] Main Drainage Division - Melbourne Metropolitan Board of Works, *Main Drainge Division Activity Report* (Melbourne: Melbourne Metropolitan Board of Works, 1982), 12.

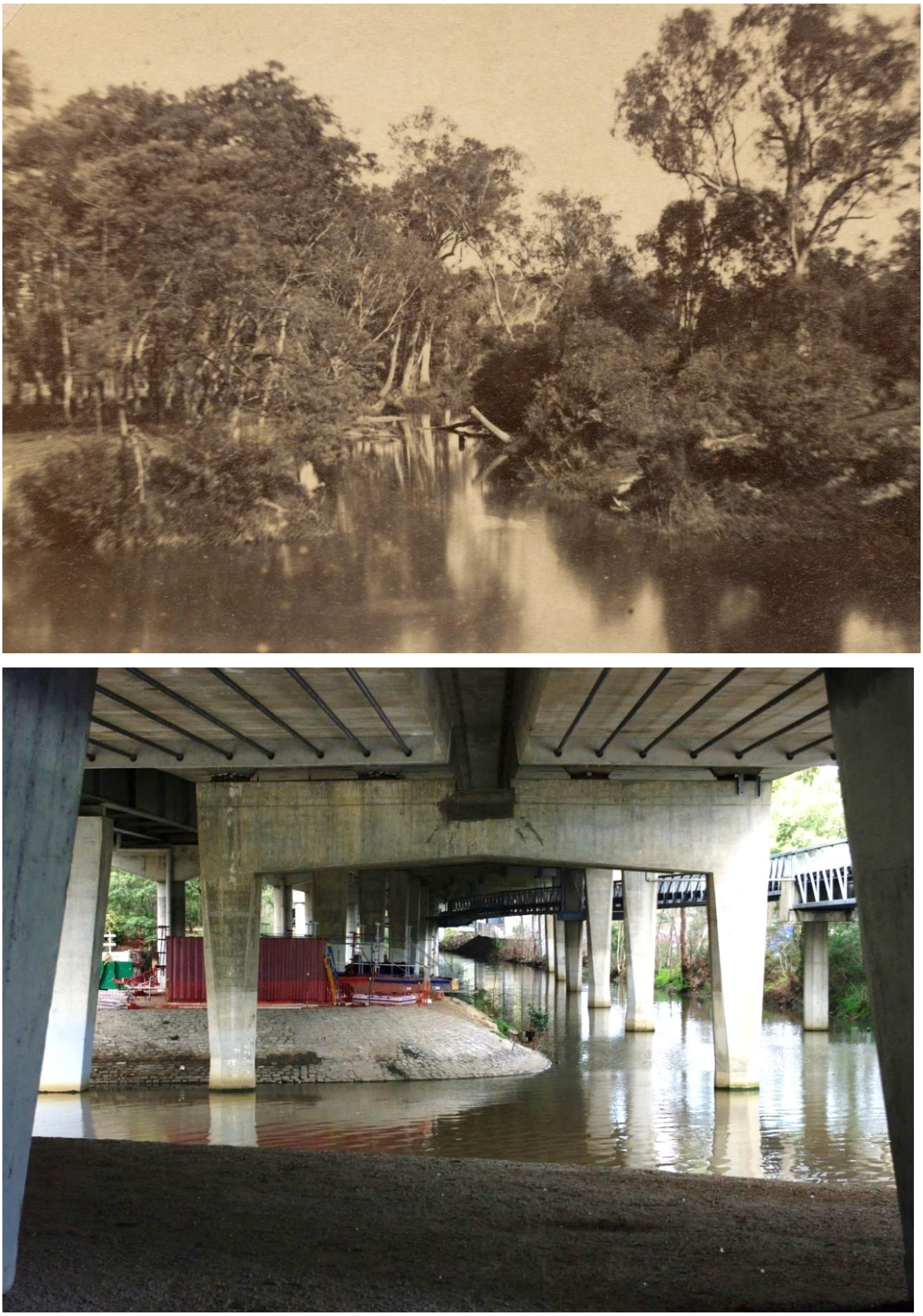

Figure 66. The confluence of Gardiners Creek and Yarra River in 1875 and 2017. Source: SLV H83.429 and Author photo (2017).

Watercourse valleys as easements: landscapes of infrastructure

Prior to the rise of modern urbanism, resources and landscapes vital for human survival were valued and viewed as material necessities tied to seasonal interactions between communities and the natural environment.[133] Since the advent of the modern city, these attributes have been replaced with centrally controlled engineered systems that extract and transport resources vital for life including water, food and energy, often hundreds of kilometres to urban centres.[134] Thus, the architecture of urban areas includes infrastructure required to supply resources and remove waste, stretching through and beyond urban centres in such a scale it is unable to be hidden, becoming an important visual component of urban fabrics.[135] The responsibility for design and construction of this infrastructure into the landscape is complex, often haphazardly implemented by a range of disciplines and authorities.[136] The construction, maintenance and ongoing expansion of Melbourne's infrastructure was no different with an array of stakeholders, government departments and private companies providing the city with varying systems of infrastructure since the city was founded by Europeans in 1835 (see chapter 4). In providing different service infrastructures, Melbourne's main watercourse valleys had been integrated into the urban fabric for use as service easements. In addition to being used as boundaries between municipalities, riparian zones and floodplains had become easements for sewerage trunk mains, while the actual streams, legislated, as 'main drains' for surface water, were managed and treated as such (see chapter five, page 174-80).[137] Other watercourses had parkland and recreational facilities placed on adjacent land, while Alexandra Avenue and the Yarra Boulevard became the city's intermittent scenic drives along several separate sections of the river.[138]

With the construction of stage one of the South-Eastern Freeway, a precedent was established for locating freeways along watercourse valleys. These freeways connected into the larger road network and provided links with the state-wide and national road network. An additional easement located along sections of several of Melbourne's watercourses contained

[133] Gary Strang, "Infrastructure as Landscape" *Places* 10, no. 3 (1996): 13.
12; Gandy, "Rethinking Urban Metabolism: Water, Space and the Modern City," 366.
[134] Strang, 13; Gandy, "Rethinking Urban Metabolism: Water, Space and the Modern City," 365-66.
[135] Strang, 12.
[136] Ibid.
[137] State Government of Victoria.
[138] Lay, 178.

high voltage electricity transmission lines, supplying electricity to terminal stations located within the urban fabric.

Following creation of the State Electricity Commission of Victoria (SECV) by the state government in 1919, a high voltage power transmission network commenced supply of electricity from a power generation scheme which by 1938 included coal powered stations, 159 kilometres (99 miles) east of Melbourne, a hydroelectricity system located in the north-east of the state and two stations in Melbourne.[139] The SECV developed a network of aboveground high voltage transmission lines consisting of steel towers (pylons) ranging in height from 30 to over 60 metres (98 to 197 feet) depending on the kilovolt rating of the line.[140] The pylons were located along easements surveyed and acquired by the SECV.[141] As Melbourne expanded the transmission lines also required extension, with new lines constructed crossing existing suburbs. In 1928, one of the first lines was proposed for construction along sections of Scotchmans and Gardiners Creeks and the Yarra, through a range of middle class eastern suburbs.[142] The proposal was met with strong opposition from residents with many expressing fears the new line would diminish the appearance of the suburbs it passed through.[143] Although the towers would be constructed along stream banks and riparian zones, residents appeared more concerned about the appearance of the suburbs than impacts to parkland and watercourses. The SECV responded by reporting placement of the line underground was too expensive and the route along watercourses selected as least likely to disfigure the suburb.[144]

During the latter half of the 20th century, further transmission line extensions were proposed through other Melbourne suburbs. Lines were constructed along several other watercourses including; a section of the Merri Creek to the north; the lower section of the Maribyrnong River to the west; the northern section of the Moonee Ponds Creek at Broadmeadows; a section of the Yarra through the Yarra Flats Parklands system at

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[139] "Victoria's Electricity. Story of Great Scheme," *Newcastle Morning Herald and Miners' Advocate*, June 24, 1924, 5; State Electricity Commission Victoria, *Yallourn* (Melbourne: State Electricity Commission Victoria, 1938), 8.
[140] Ausnet Services, *A Guide to Living with Transmission Line Easements* (Melbourne: Ausnet Services), accessed July 26, 2016, 4-5, http://www.ausnetservices.com.au/CA257D1D007678E1/Lookup/easements/$file/Easements_Guide_web.pdf.
[141] "Electricity Commission: Review of Operations," *Argus*, November 28, 1923, 17.
[142] "New Transmission Line. Towers in Eastern Suburbs," *Age,* June 30, 1928, 25.
[143] "Transmission Line. Route through Suburbs," *Argus,* June 30, 1928, 26.
[144] Ibid, 25.

Heidelberg.[145] The MMBW's 1954 planning scheme discussed future expansion of the power transmission system, however, did not refer to new transmission lines being constructed along Melbourne's watercourses. Instead, these would be constructed in parallel with those existing.[146]

The arguments used by the SECV in defending the choice of route in 1928 along Scotchmans and Gardiners creeks (page 220) would be repeated during the late 1970s and 1980s when proposing further extensions to the high voltage transmission network. In 1982, the SECV released *Development of the transmission supply for Melbourne*, outlining use of existing easements and criteria for assessing alternative routes.[147] The factors identified in considering a choice of route for any transmission line included: compatibility with existing and future land use; visibility of lines; financial factors; impacts and proximity to other infrastructure; maintenance and operational procedures.[148] The SECV considered the main environmental issues in locating transmission lines were the visual impact and interrelated effects on land use. For example, land underneath transmission lines were deemed unsuitable for buildings but appropriate for parkland and outdoor recreation facilities.[149] As previously identified by the MTPC (1929), land adjacent to watercourses unsuitable for urban development due to periodic flooding, was considered highly suitable for parks and parkways.[150] The SECV was in effect echoing this idea by using undeveloped flood prone land along watercourse valleys. The watercourses and adjacent flood plains provided perfect corridors of either vacant land or present parkland in existing suburbs where transmission lines required expansion.[151] Figure 67 shows the power line easements along Melbourne's watercourses with figure 68 showing the visual impacts of such infrastructure along the Merri Creek and Maribyrnong River.

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[145] Melbourne and Metropolitan Board of Works, 120.
[146] Ibid.
[147] State Electricity Commission of Victoria. Transmission Development Dept., *Development of the Transmission Supply for Melbourne* (Melbourne: The Department, 1982), S3-S4.
[148] Ibid, S4.
[149] Ibid, S5.
[150] Metropolitan Town Planning Commission, *Plan of General Development, Melbourne: Report of the Metropolitan Town Planning Commission*, S5.
[151] State Electricity Commission of Victoria. Transmission Development Dept., S5.

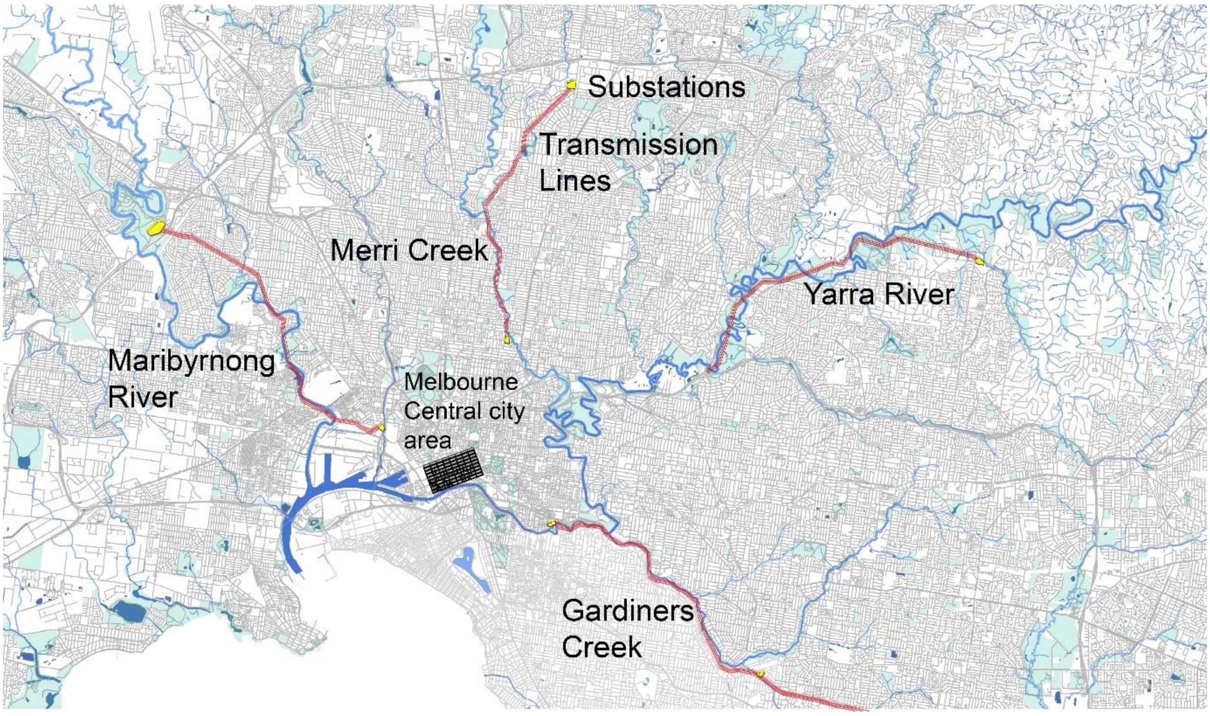

Figure 67. High voltage power transmission lines along watercourses.

Figure 68. Power transmission lines along the Merri Creek and Maribyrnong River. Source: Author photos (2016).

The practice of using watercourse valleys for transmission lines was strongly challenged in a dispute beginning in the early 1970s and raging until 1989.[152] The SECV proposed locating a high voltage transmission line (figure 69) to secure the power supply to Melbourne's central business district. Consisting of overhead cables, it would connect a terminal station on the Merri Creek, with another on the Yarra at Richmond.[153]

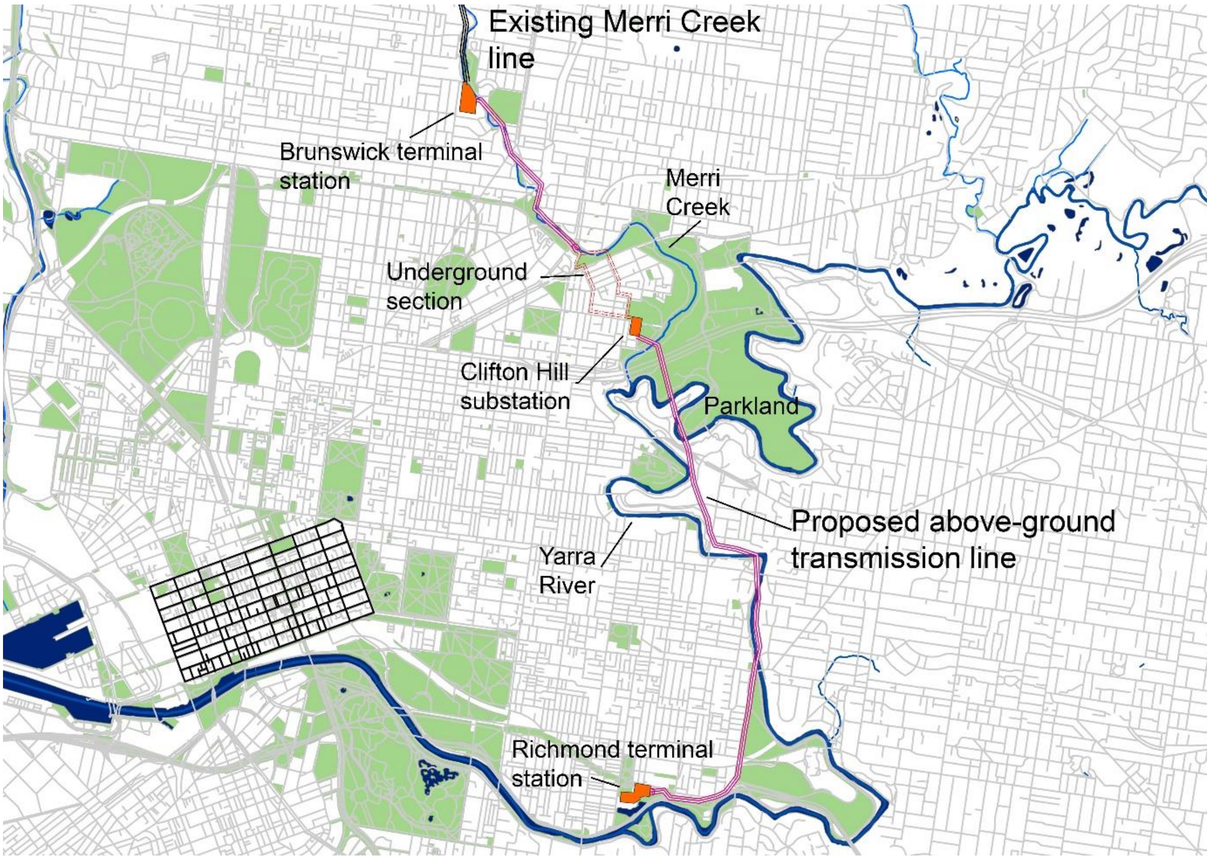

Figure 69. Proposed route for the Brunswick to Richmond Power line.

The proposed route consisted of overhead lines across linear parkland along the Merri Creek, Yarra River, and along a section of the South-Eastern Freeway. A small section passing through a terminal station in Clifton Hill would be laid underground following residential streets.[154] As both the Merri and Yarra also determined municipal boundaries, the

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[152] Ian C. Winter, *Radical Home Owner : Housing Tenure and Social Change* (Basel, Switzerland: Gordon & Breach Publishers, 1994), 162-89.
[153] State Electricity Commission of Victoria., *Proposed Brunswick to Richmond 220kv Transmission Line : Analysis of Technical Issues and Review of Options* (Melbourne: The Commission, 1985), 11; Winter, 162.
[154] State Electricity Commission of Victoria, 42-117.

proposed route involved the residents and councils of seven municipalities, a mix of working and middle class suburbs.[155] In addition to protest and outrage at the suburban level, the wider population of Melbourne also objected to use of the cherished Studley Park (see chapter seven, page 332) and the Yarra, as an easement for transmission lines.[156] The case against the power line was originally argued on the grounds of aesthetic and environmental damage to parkland and the watercourse valleys. Opponents widened their opposition in 1984 to include evidence of the link between electromagnetic radiation, emitted by high voltage power lines, and leukaemia in young children.[157] Thus, they argued the only method to reduce health risks to residents and damage to environmentally sensitive areas was to locate the entire power line underground. A protracted and often emotional battle following that included: the issuing of two environmental impact statements; protest and environmental bans placed on the project by trade unions involved in construction; several hearings; the establishment of the Power Line Action Group; a state by-election in the seat of Kew, one of the opposing councils; and the arrest of demonstrators.[158] In July 1989, the Brunswick to Richmond Power Line Review Panel released their final report recommending the line be constructed underground along the route of a main arterial road.[159] The dispute marked a significant event in the continued use of watercourse floodplains and riparian zones for location of service infrastructure along Melbourne's watercourses. Since that time, only existing overhead lines along watercourses have been upgraded or enlarged.

The use of watercourse riparian zones as service easements results in periodic clearing of existing and revegetated areas to access infrastructure for maintenance, and reconstruction. For example, work on the main trunk sewer along the Merri Creek in 2017, shown in figure 70.

[155] Winter, 164.
[156] Ibid, 164
[157] Ibid, 162.
[158] Ibid, 163-68.
[159] Ibid, 168.

Figure 70. Rehabilitation work on a main trunk sewer along the Merri Creek. Source: Author photo (2017).

The second freeway – Tullamarine: Sending Moonee Ponds Creek west for traffic to travel north

Melbourne's second freeway, the Tullamarine, was the city's first major road project that completely eradicated the reach of a creek. A section of the Moonee Ponds Creek streambed was realigned to the west of its original course, its flow confined within a concrete channel. The Tullamarine Freeway was constructed in three sections between 1964 and 1970, becoming Melbourne's first freeway completed to plan; though begun earlier, the South-Eastern (since 1999 known as the Monash) was constructed in stages across several decades.[160] The realignment of the lower section of the Moonee Ponds to accommodate the southern end of the Tullamarine Freeway was a dramatic shift away from the ideal, expressed by the MTPC with its 'parkway' schemes, of watercourses being valued as picturesque features of the urban fabric. The Modernist vision of the future now included the 'freeway'

[160] Lay, 206-07, 11-13.

rather than the parkway. The urban environmental history of the Moonee Ponds Creek valley, along the southern section of the Tullamarine, highlights this modernist approach regarding the natural environment, and the evolution of a parkway idea to modernist engineering.

The Moonee Ponds Creek's headwaters rise 40 kilometres (24 miles) from its confluence with the Yarra (figure 71) to flow in a south-easterly direction across an undulating surface of Younger basalt.[161] The creek has two main tributaries, the Yuroke and Attwood Creeks, rising from younger basalt plains in the north to join the Moonee Ponds 20 kilometres (12.4 miles) downstream.[162] The tributaries and upper reach are between 130 to 150 metres (427-820 feet) above sea level.[163] The last 5.2 kilometres of the creek (3.23 miles) rises only one metre over 578 (3.3 feet over 1896), providing the creek with minimal fall or slope, its flows also influenced by tidal movements from the Yarra.[164]

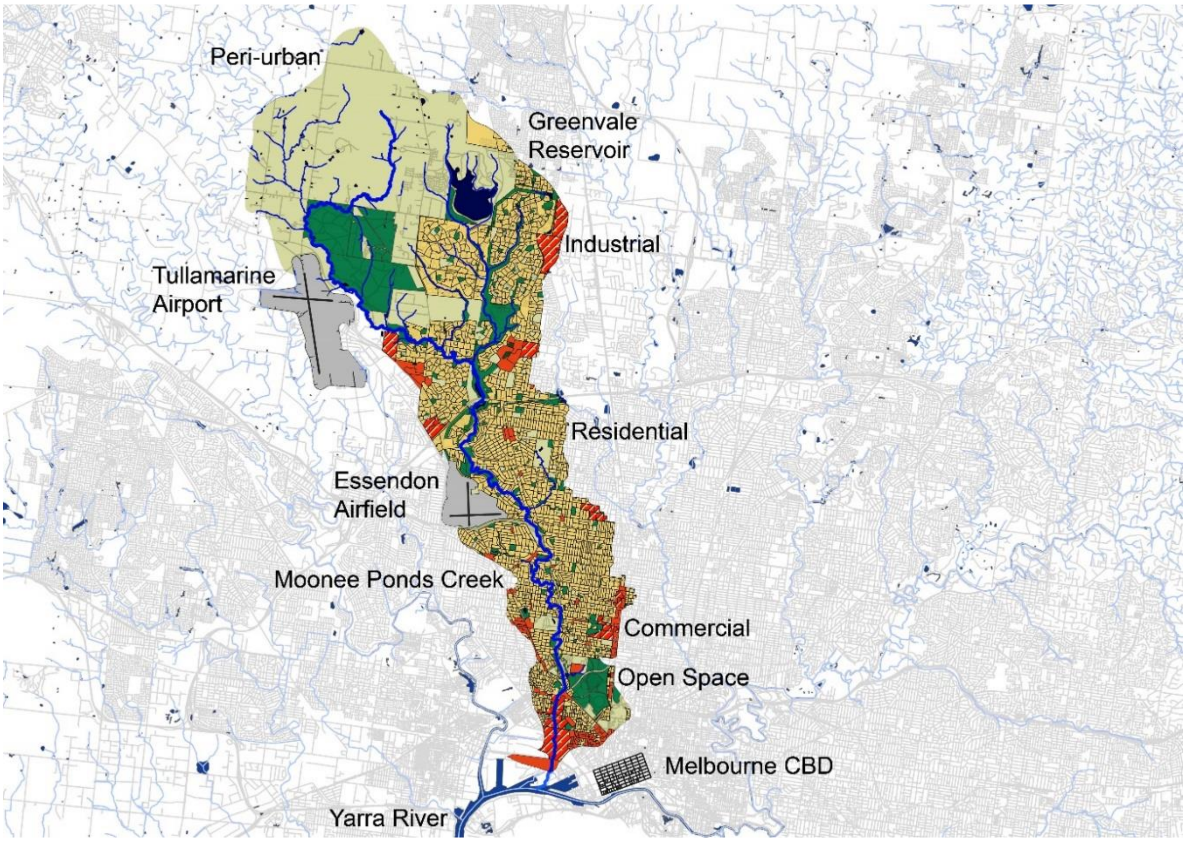

Figure 71. Moonee Ponds Creek catchment showing the creek in relation to adjacent land use.

[161] Leigh and Melbourne Metropolitan Board of Works, 11.
[162] Ibid.
[163] Ibid.
[164] Ibid.

The creek has incised a valley along the geological boundary between basalt and underlying Silurian sedimentary rocks.[165] Midway along the middle reach the basalt is replaced by Silurian sediments and Tertiary sands resulting in the creek being deeply incised along several sections.[166] An outcrop of Silurian rock along one of these sections was identified as one of the finest locations in Melbourne for Silurian fossils.[167] Such was the site's importance during construction of the freeway and concrete-lined creek channel, the design was modified to protect the outcrop (page 275-276).[168] The lower reach of the creek meandered across a floodplain composed underlying silts, sands and clays, where it ended by diffusing into a series of small ponds in a periodical cycle of flooding and evaporation.[169] The final pond in the series was a salt-water lagoon, known to European settlers as West Melbourne Swamp, located between the Yarra to the south and Maribyrnong to the west.[170] It was also widely referred to as West Melbourne Lagoon, Batmans Swamp, or Salt Water Lake.[171] The series of ponds was identified in 1836 as the 'chain of ponds' by Joseph Gellibrand, former Attorney-General of Tasmania who later joined the Port Phillip Association, leading expeditions to explore the Port Phillip area. His description of the chain of ponds, it is assumed, provided the early name for the creek.[172] In 1837, Robert Hoddle surveyed and mapped the creek beyond the pond system, describing it as 'The Water Hole-Monee Monee', and 'chain of ponds.'[173] The *Map of the suburban lands of the City of Melbourne,* (Ham Brothers1852) illustrates a series of interconnected ponds, figure 73. Hoddle's description illustrates a characteristic feature of many watercourses discovered by European settlers across parts of Victoria and News South Wales. For example, Charles Darwin, in his *A Naturalist's Voyage Round the World* (1860) discussed the Macquarie River in New South Wales thus:

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[165] Ibid.
[166] Ibid.
[167] J. Talent, "Sedimentary Petrology and Palaeontology," *Geological Survey of Victoria Bulletin* 59 (1967): 25.
[168] Leigh and Melbourne Metropolitan Board of Works, 112.
[169] G. Vines, "Dudley's Flat Archaeological Investigation," (Melbourne: Melbourne's Living Museum of the West Inc., 1999), 9; Presland, *The Place for a Village: How Nature Has Shaped the City of Melbourne*, 92.
[170] Vines, 9.
[171] Presland, *The Place for a Village: How Nature Has Shaped the City of Melbourne*, 66; G. McCrae, "Some Recollections of Melbourne in the "Forties," *The Victorian Historical Journal* II, no. 3 (1912): 117.
[172] Thomas Francis Bride, Letters from Victorian Pioneers: Being a Series of Papers on the Early Occupation of the Colony, the Aborgines, *etc*. (Melbourne: R.S.Brain, 1898), 289; Vines, 9; P. James, "Gellibrand, Joseph Tice (1792-1837)," *Australian Dictionary of Biography,*National Centre of Biography, Australian National University, accessed 24 November, 2016, http://adb.anu.edu.au/biography/gellibrand-joseph-tice-2088.
[173] H. McComb, "Surveyor Hoddle's Field Books of Melbourne " *The Victorian Historical Magzine* XVI, no. 3 (1937): 82; Robert Hoddle, *Plan Shewing the Surveyed Lands to the Northward of Melbourne and Allotments Contiguous to It,* [cartographic Material]: By Robert Hoddle Surveyor, 1837.

> The Macquarie figures in the map as a respectable river, and it is the largest of those draining this part of the watershed; yet to my surprise I found it a mere chain of ponds, separated from each other by spaces almost dry. Generally, a small stream is running; and sometimes there are high and impetuous floods.[174]

This was in stark contrast to the wetter climates of Europe and North America, as Australia's rainfall was half when compared.[175] In addition, the content's river discharge was less than one-sixth of those in Europe and Asia.[176]

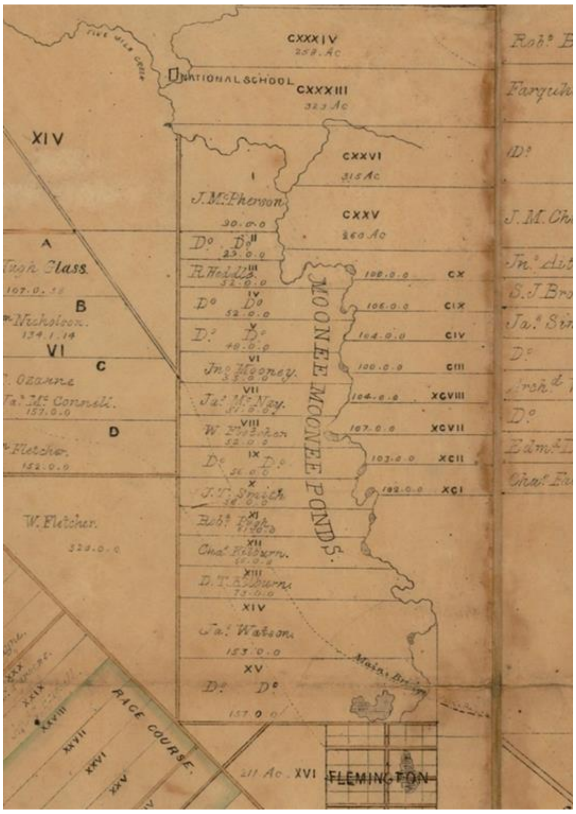

Figure 72. The distinctive chain of ponds along Moonee Ponds Creek. Source: SLV http://handle.slv.vic.gov.au/10381/158842

The section of the creek flowing through Woodlands Park 5.5 kilometres (3.48 miles) downstream from its headwaters, featured in figure 74, shows the creek during the summer

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[174] Charles Darwin and R. T. Pritchett, *Journal of Researches into the Natural History & Geology of the Countries Visited During the Voyage Round the World of H.M.S. Beagle under the Command of Captain Fitz Roy*. (London: John Murray, 1890), 471.
[175] M. Cathcart, *The Water Dreamers: The Remarkable History of Our Dry Continent* (Melbourne: Text Publishing 2009), 2.
[176] Ibid.

when it typically evaporates. This section, flowing within a peri-urban area, receives minimal runoff from impervious urban surfaces. It exemplifies the way much of the creek prior to urbanisation would have originally ceased flowing and evaporated during dry periods.

Figure 73. Moonee Ponds Creek upper reach during January (summer). Source: Author photo (2014).

As stated above, the Moonee Ponds Creek originally flowed onto the floodplains of a shallow valley where it fed a series of small ponds and a larger salt-water lagoon.[177] A map produced by land surveyor W. H. Wells in 1840 shows the southern course of the creek (figure 74, left map).[178] It shows a definite stream connecting the creek with a wetland and the swamp while the later 1875 map (figure 74, right map) shows the ponds and swamp unconnected. This discrepancy is typical of problems encountered when mapping season or ephemeral flowing streams; their presence dependent on recent rainfall, the season, or time of year when the surveying and mapping occurred.

[177]Vines, 9.
[178] Presland, *The Place for a Village: How Nature Has Shaped the City of Melbourne*, 92.

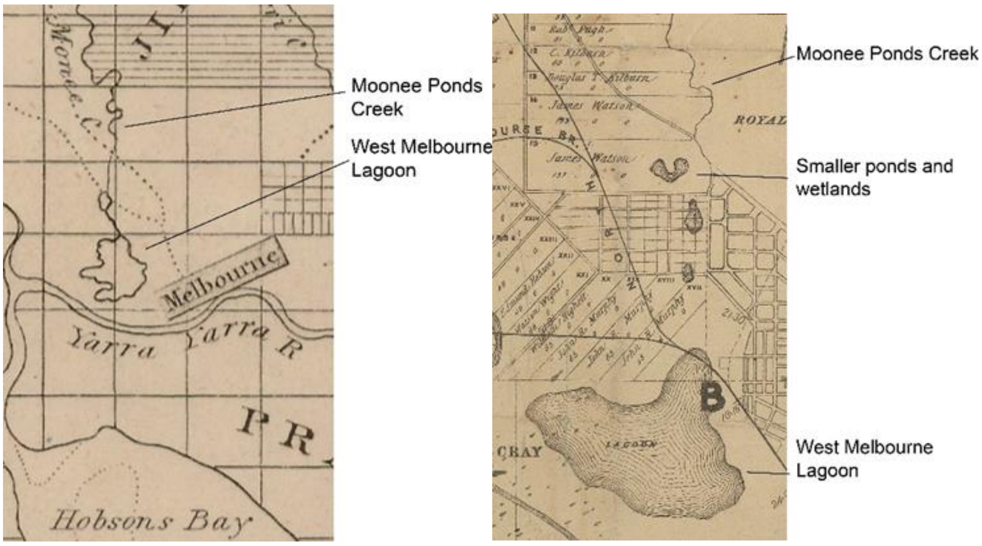

Figure 74. Comparison of the 1840 map with 1875 map and relationship of the creek to the lagoon. Source: SLV http://handle.slv.vic.gov.au/10381/114255 and http://handle.slv.vic.gov.au/10381/114830

Figure 75 illustrates the valley, wetland lagoons and the West Melbourne Lagoon. Figure 76 shows the historical locations of seasonal lakes, wetlands and the lagoon. It also indicates the historical extent of tidal flows from Hobsons Bay along the Yarra and Maribyrnong. The falls on the Yarra’s city reach were the original barrier to salt flows, while along the Maribyrnong tidal flows extend 15.6 kilometres (9.7 miles) to a rock ford (known as Canning Street Ford).[179]

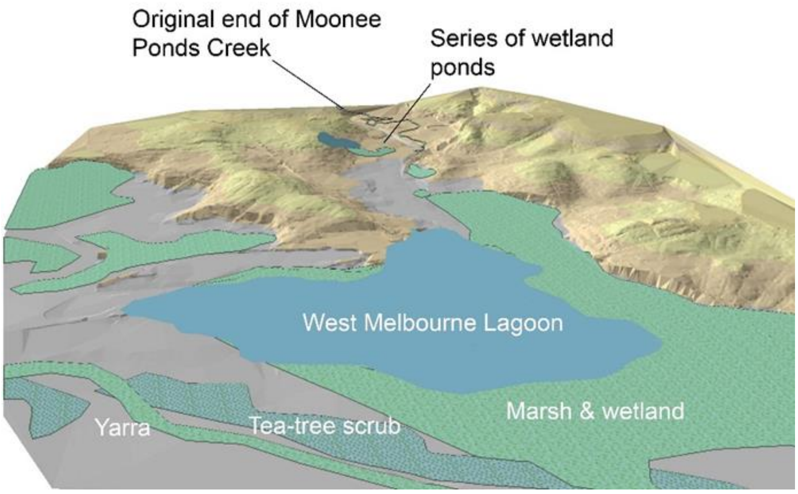

Figure 75. Model illustrating where the creek ended and dispersed across a floodplain into a series of ponds and eventually the lagoon.

[179] Jones, 57-58; R. Faulkner and G. Vines, “Ecomuseum Broadsheets: 4 Maribyrnong River,” ed. Living Museum of the West inc. (Melbourne Living Museum of the West 1990), 1.

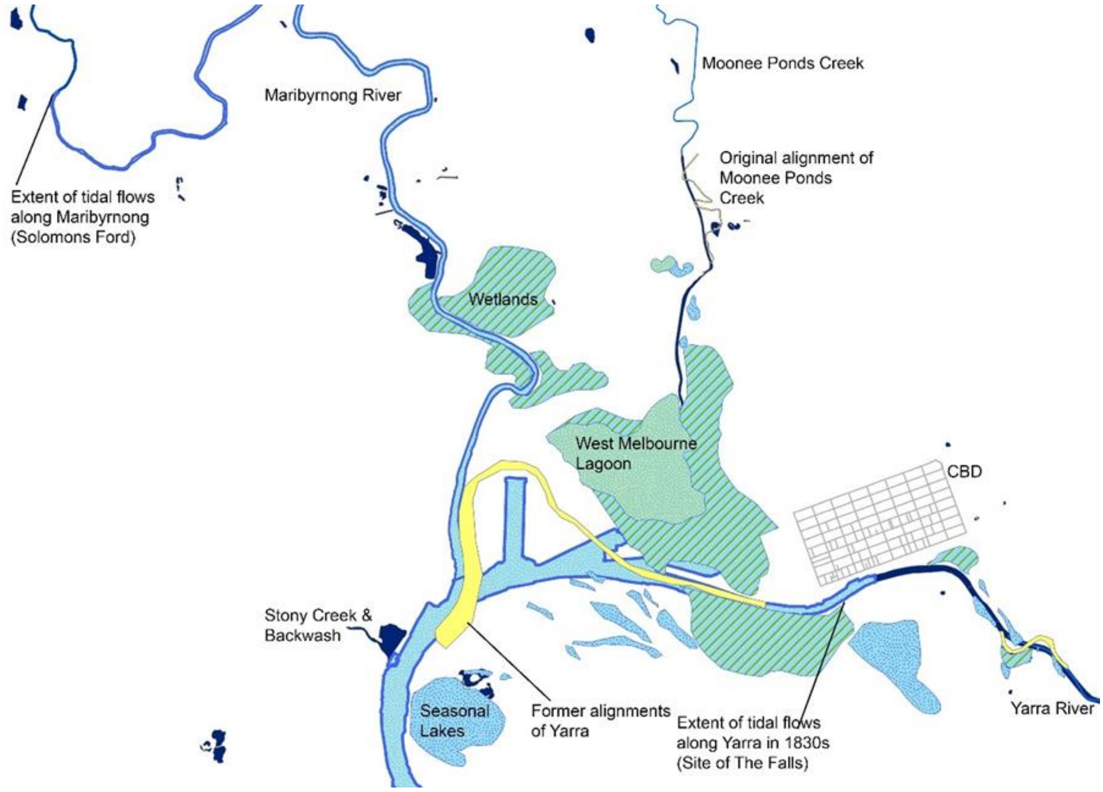

Figure 76. The relationship between the Yarra - Maribyrnong Rivers, Moonee Ponds Creek, and the distribution of fresh water and tidal flows.

The early European populations of Melbourne perceived wetlands as unproductive areas offering minimal potential for development.[180] As the city expanded without proper sewerage or drainage systems, wetlands became public health hazards, collecting all sources of polluted runoff while also being purposefully used as dumping grounds for refuse.[181] The West Melbourne Lagoon although fed by fresh-water overflows from the Moonee Ponds, was a salt-water lagoon, due to a range of conditions that included: overflows from the Yarra during floods; seasonal high tides rising from the bay; and the surrounding low elevation and associated high water table.[182]

As illustrated in the preceding maps, Moonee Ponds Creek was not a tributary of the Yarra or Maribyrnong, as evident in William Westgarth's (see chapter four, page 135-6) description of the creek in 1857.

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[180] Gary Presland, "A Boggy Question: Differing Views of Wetlands in 19th Century Melbourne," *Victorian Naturalist* 131, no. 4 (2014): 99.
[181] Ibid Bride, 289; Vines, 13.
[182] McCrae, 117.

> Two miles from Melbourne, we crossed the Moonee Ponds…These 'Ponds" as they are called, forming a winding change of water-holes, afford, close to Melbourne a genuine specimen of Australian river peculiarities. After a course of twelve or fourteen miles, they terminate in a salt lagoon, having no outlet…The Moonee Ponds have seldom any stream in the winding-bed excepting during very wet weather. The water, in many of the holes or ponds, is brackish [and] unsuitable for drinking.[183]

The public servant, poet and writer, George Gordon McCrae, provided one of the few descriptions of the lagoon from the time he resided in West Melbourne, during the 1840s. His description and one of few photographs of the lagoon, figure 89, demonstrate it was a significant waterscape of the region.

> To the west of us and just a little to the north…lay a beautiful blue lake… intensely blue, nearly oval, and full of the clearest salt water; but this, by no means deep. Fringed gaily all round by mesembryanthemum (vulgo, "pigs-face ") in full bloom…[184]

The lagoon, pictured in figure 77, was only one metre above sea level, lined with alluvial silt over blue clay, and was subject to frequent flooding often to a height of seven feet (2.1 metres).[185] The scale of flooding across the area was reported in the *Bendigo Advertiser*; 'Batmans Swamp was one sheet of water, from Spencer-Street to Footscray', a distance of 2.54 miles (4.08 kilometres).[186]

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[183] William Westgarth, *Victoria and the Australian Gold Mines in 1857 with Notes on the Overland Route from Australia, Via Suez*, (London Smith, Elder, and Co. , 1857), 194-95.
[184] McCrae, 117.
[185] R. Adams, Amess, S., Bell F., Birnie, G., Blackburn, J., Reid, P., "Low Lands Commission Progress Report " (Melbourne Low Lands Commission 1873), 51-52 ; Vines, 8.
[186] "Melbourne: Latest Intelligence," *Bendigo Advertiser,* March 18, 1863, 2.

Figure 77. View of West Melbourne Lagoon in 1869. Source: SLV H41470/3

From 1854, the lagoon was progressively filled, the land reclaimed, to accommodate railway infrastructure, port facilities and the City of Melbourne Gas and Coke Company's gas manufacturing plant.[187] Although the area was developing into an industrial hub, it remained subject to intermittent flooding with overflows from the Moonee Ponds and Yarra. Sewage and waste draining from surrounding suburbs also flowed into the low-lying area, filling the lagoon. In 1872 following a series of severe floods the government established a Low Lands Commission to address a range of issues including the insanitary condition of the lagoon and ongoing flooding. The Commission's progress report released in 1873 stated: 'In its present condition the West Melbourne Swamp is admittedly a nuisance, injurious to health, and a disgrace to the city'.[188] Consequently, the draining and reclamation of the lagoon was

[187] B. Harper, "The True History of the Design of the Melbourne, Mount Alexander and Murray River Railway," *Australian Journal of Multi-Disciplinary Engineering* 3, no. 1 (2004): 83; Vines and Lane, 16.
[188] R. Adams, Amess, S., Bell, F., Birnie, G., Blackburn, J.,Reid, P., *Low Lands Commission Final Report*, Parliamentary Paper,Victoria Parliament.(Melbourne: John Ferres, Government Printer, 1873), 3.

recommended.[189] This meant the Moonee Ponds Creek would require a channel to direct normal and flood flows through or around the area. In 1877, several projects were initiated to improve flows in the creek and alleviate flooding. Two separate channels were cut to allow the creek to flow into the Maribyrnong and Yarra rivers, illustrated in figure 78.[190] The Dynon Road Tidal Canal is the remaining western section of the channel cut through to the Maribyrnong.[191]

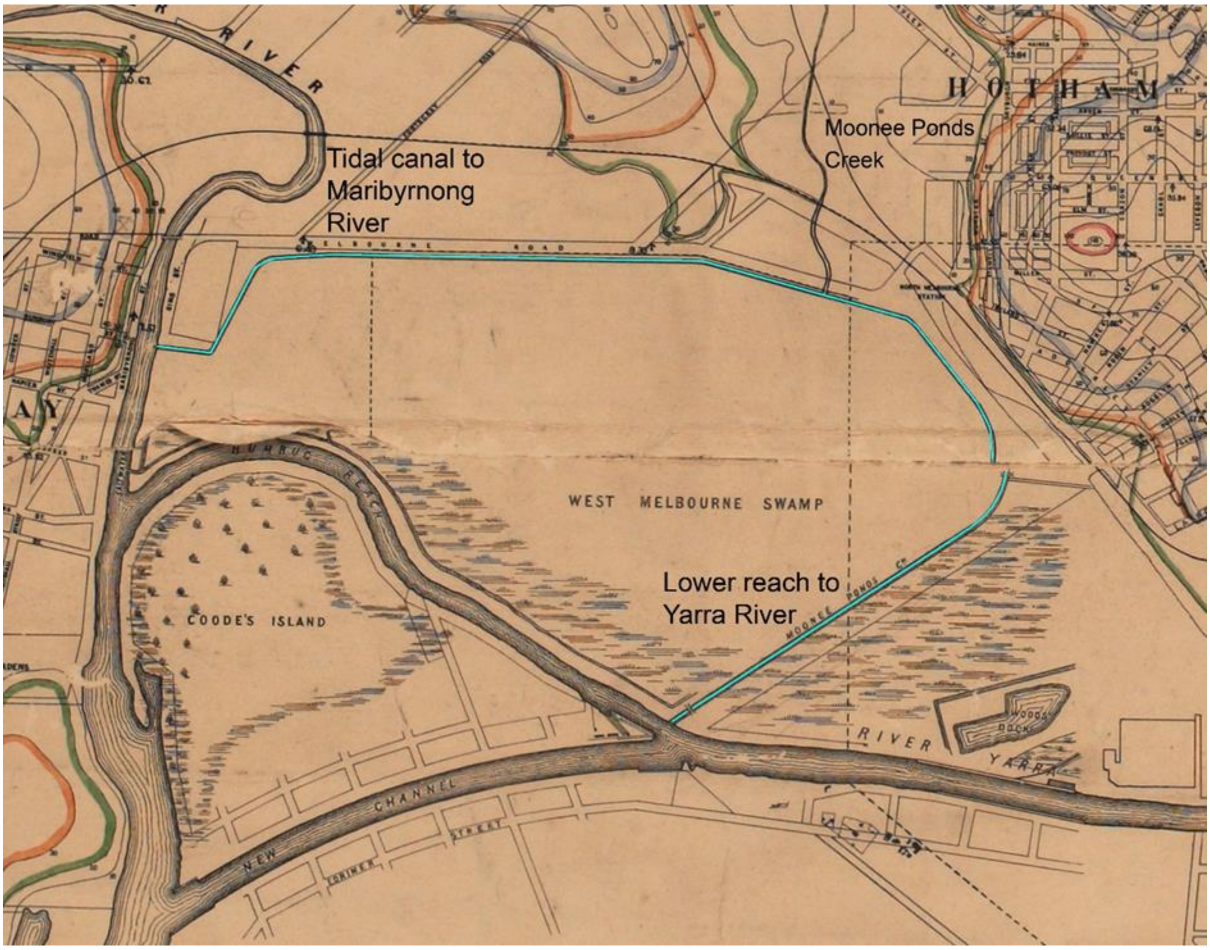

Figure 78. Contour plan from 1887 showing the discharge channels from the Moonee Ponds Creek. Source: SLV http://handle.slv.vic.gov.au/10381/170462

The channel excavated towards the Yarra was blocked in 1886 by the construction of new locomotive engine sheds at Spencer Street, (now Southern Cross) Railway Station, the

[189] "Low Lands Commission Progress Report " vi-vii.
[190] Leigh and Melbourne Metropolitan Board of Works, 25.
[191] Ibid.

terminus for regional trains.[192] The railway department excavated a new channel from the end of the Moonee Ponds channel in a southerly direction to the Yarra, and in 1889 excavated a dock along the channel that would allow unloading of coal for locomotives. This became known as Coal Canal, directly connecting the Moonee Ponds Creek with the Yarra to allow access for coal barges, and consequently led to the channel to the Maribyrnong being abandoned and partially filled.[193]

The Commission’s description of the swamp as a public nuisance contrasts dramatically with the value indigenous populations placed on the vital food supplies and other material resources provided by lagoons and wetlands.[194] The numerous wetlands around the Melbourne region were used by the indigenous populations as regular meeting places, capable of supporting large groups with food.[195] Within the western lexicon however, swamps and wetlands were associated with death and disease, viewed as melancholic, and generally horrific, unpleasant areas of ‘black water’.[196] The common western response was to drain and reclaim these areas that offered spatial and temporal transition from dry land to open water.[197] Across Melbourne, a number of large wetlands were officially reclaimed. A selection shown in figure 79. In 1963, the last, a coastal wetland at Altona, was transformed into Cherry Lake, a 60-hectare (148 acre) retarding basin.[198]

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[192] Ibid, 29.
[193] Ibid.
[194] Presland, “A Boggy Question: Differing Views of Wetlands in 19th Century Melbourne,” 96.
[195] Ibid.
[196] Giblett, 3.
[197] Ibid, 3-4,122.
[198] T. & Davis Mackintosh, J., “The Importance of Urban Wetlands,” ed. S Paul, *Workbook for Managing Urban Wetlands in Australia* (Sydney Sydney Olympic Park Authority 2013), 12,http://www.sopa.nsw.gov.au/__data/assets/pdf_file/0003/804522/1.01_The_importance_of_urban_wetlands.pdf

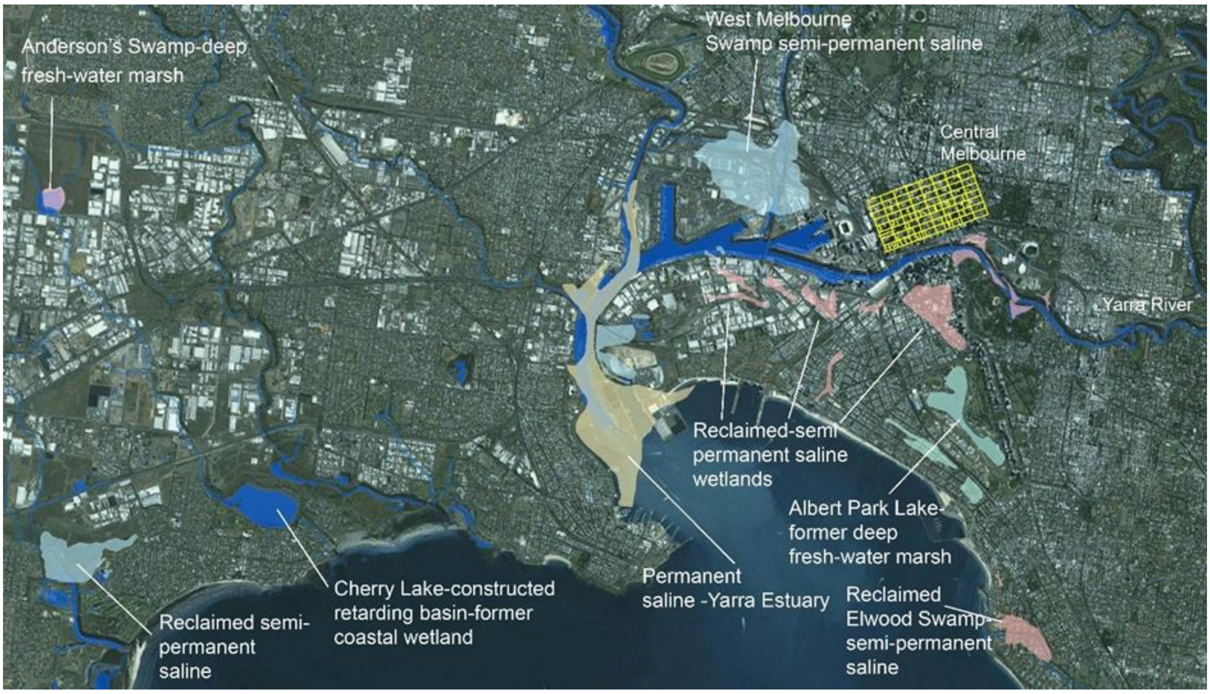

Figure 79. Location map of former wetland sites reclaimed since the mid-19th century.

It was not until formation of the Harbor Trust in 1877 that reclamation of the lagoon commenced in full.[199] Spoil excavated for the Coode Canal and docks totalling over 700,000 cubic yards (535188.4 cubic metres) were used as fill.[200] By 1890, the eastern edge was used as a refuse dump by local councils and tipping site for locomotive ash.[201] A jetty was constructed along the Coal Canal to load refuse for dumping into the bay.[202] The swamp became synonymous with rubbish dumping, noxious industries, railway and shipping facilities.[203] Figure 80 shows the last remaining ponds of the swamp seen in right lower corner of the photograph from 1965. By 2000 all trace of the swamp had been removed, the area demarcated by the Maribyrnong, Yarra, Moonee Ponds Creek, and Dynon Road; the Dynon and Coal Canals its only remaining legacy.

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199 Adams, *Low Lands Commission Final Report*, 3; Presland, "A Boggy Question: Differing Views of Wetlands in 19th Century Melbourne," 100.
200 Leigh and Melbourne Metropolitan Board of Works, 30.
201 Vines, 14.
202 Ibid.
203 Ibid, 13-15.

Figure 80. Aerial image of the creek, Yarra, ports, and remaining drainage ponds of the lagoon (bottom right) in 1965. Source: Lancaster (1965).

Moonee Ponds Creek: Coal Canal and further upstream

Just as the lagoon was being used as a refuse dumping ground and cesspit for the surrounding suburbs, the Moonee Ponds Creek was functioning as an open drain. In 1887, receiving the stormwater and sewage from several expanding suburbs, the Chairman of the Vigilance Committee of North Melbourne described the condition of the creek as 'a disgrace to the name of civilisation.'[204] The creek bed contained a layer of solid waste between four to six feet deep (1.2 – 1.8 metres) that washed upstream on the incoming tide. The water was described as a deep inky hue, with the bodies of cats, dogs and goats carried up and down stream on the tides.[205] The *Independent* (1888) while praising the remarkable growth rate of the population of suburbs along the creek, labelled it a 'pestilential drain' and stated it had 'become a common sewer for the polluted drainage of the whole area.'[206] Gresswell (1890) in

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[204] "Pollution of the Moonee Ponds Creek," *Argus,* November 29, 1887, 5.
[205] Ibid.
[206] "Moonee Ponds Creek," *Independent,* January 7, 1888, 3.

his report on the sanitary condition of Melbourne (see chapter four, page 145) described the Moonee Ponds as; 'a shallow tidal creek with sandy bed, covered thickly (a foot or two deep) with sewage-sludge."[207] The creek was subject to continuous, though intermittent, cleansing works that involving the removal of silt and rubbish.[208] The work also included continual widening and straightening of sections of the creek's banks and channel.[209] In 1899, the Public Works Department commenced works to improve the creek's sluggish flow due to the lack of fall on the channel.[210] The amount of fall or slope along the last reach of the creek is only nine metres over 5.2 kilometres (29.5 feet over 3.23 miles), the low slope slowing the flow rate.[211] This slower flow resulted in deposition of eroded material and pollution that occasionally required the reach to be dredged.[212] The project involved raising the creek above the low-water level to create a scour that was to enable regular flushing of the channel.[213] The work achieved little, the *Argus* describing it in 1900 as 'one of the most polluted streams near the city'.[214] By 1921, despite the construction of the sewerage system the creek remained a 'filthy suburban sewer' that only received flushing when flood flows from upstream scoured the pollution and deposits downstream into the Yarra.[215] Throughout the 1920s and 30s as suburbs and noxious industries within the catchment were connected to the sewerage system, the creek's condition improved.[216]

Once sewage and industrial effluent ceased entering the Moonee Ponds Creek, surface drainage, erosion and flooding dominated. In times of high rainfall, flooding significantly increased and further upstream the creek often flooded on a spectacular scale. In November 1849, the *Argus* reported the level of flood damage from where the creek course originally ended at a road bridge (Flemington Bridge) before diffusing into the pond system. The *Argus* reported:

> Great quantities of farm produce, agricultural implements, casks, hides, &c, continued to come down from the Moonee chain of ponds, and were secured at the bridge… Fat

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[207] Gresswell, 19.
[208] "Fighting a Nusience," *Kalgoorlie Western Argus,* April 27, 1899, 23.
[209] Ibid.
[210] Ibid.
[211] Leigh and Melbourne Metropolitan Board of Works, 11.
[212] Ibid.; "Ancient Muddling: Modern Inefficiency," *Age,* April 27, 1936, 11.
[213] "Fighting a Nusience," 23.
[214] "The Bubonic Plague," *Argus,* May 23, 1900, 7.
[215] "A Filthy Suburban Sewer," *Age,* June 9, 1921,6.
[216] Leigh and Melbourne Metropolitan Board of Works, 37.

> cattle, cows, calves, goats and pigs in scores were lying in all directions, and showed the suddenness of the invasion of wastewater.[217]

Despite the land below Flemington Bridge being a floodplain system and subject to regular flooding, sections were subdivided in 1849-51 as residential and industrial property.[218]

Flooding across the area continued well into the 1930s, with a range of flood alleviation projects proposed.[219] One, involving construction of a 5000-cubic foot per second (cusec) flow rate channel or 142 cubic metres per second (cumecs), was commenced.[220] The project involved a tidal channel, 95 to 100 feet (29-30.5 metres) wide, the banks beached with stone to control erosion and trees planted along the top of the batters or levee banks (figure 81).[221]

Figure 81. Moonee Ponds Creek tidal channel, 1955. Source: PROV, VPRS 8609/P32, Unit 7, PA17

[217] "The Late Storm," *Argus*, November 29, 1849, 2.
[218] Leigh and Melbourne Metropolitan Board of Works, 37.
[219] Ibid, 50.
[220] Ibid.
[221] Ibid.

A larger outlet into the Yarra was also constructed, completed in 1937.[222] To ensure greater flood protection of the low-lying suburbs, Melbourne City Council installed a system of five pumping stations behind the levee bank to pump floodwater into the channel. [223] Much of the stone beaching remains, while the pumping station system is still in operation catering for floods with an average recurrence interval (ARI) of 20 years.[224]

By the 1930s, upstream of Flemington Bridge along the original course of the Moonee Ponds, bank erosion had become a major problem along sections of the middle reach.[225] Normal stream processes of sediment erosion, transportation and deposition were being accelerated by sand mining along the creek, in combination with increased runoff rates from impervious surfaces associated with expanding suburban development.[226] Much of the mining was illegal, involving excavation of the streambeds and sand within the creek bed. During high and flood flows, the banks became subject to undercutting and collapse. As suburban development spread across the creek's catchment and local councils allowed subdivision of some land to extend to the water's edge, private home owners were watching their land slip away.[227] The *Broadmeadows Keilor Observer* (1959) reported one resident purchased a block of land backing onto the creek with a depth from the street of 130 feet (40metres).[228] Due to ongoing erosion, 30 feet (9 metres) had been lost off the block, collapsing into the creek.[229] Another concern was a rise in the number of flash floods. As impervious surfaces collected all stormwater and directed the flows to the creek, larger, faster floods overflowed the banks and swept through adjacent houses. In response to public and local council concern, the MMBW proposed construction of a series retarding basins, fenced and operate similarly to irrigation locks, capturing flood flows and releasing water when levels in the creek fell to normal.[230]

Although the MMBW objected to filling floodplains on the grounds of significant loss of floodwater storage capacity, the practice continued along sections of the creek to within 25

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[222] Ibid, 50-51.
[223] Ibid, 50.
[224] City of Melbourne, *Drainage Plan 2004-2009* (Melbourne: City of Melbourne 2004), 32.
[225] Leigh and Melbourne Metropolitan Board of Works, 52.
[226] Ibid.
[227] Ibid.
[228] "He Watches His Land Disappearing," *Broadmeadows Keilor Observer,* September 20, 1959, 5.
[229] Ibid.
[230] Ibid.

feet (7.6 metres) of the banks.[231] The 25-foot limit was enforced by the MMBW's bylaw number 25, gazetted in 1927, and stipulating all persons and corporations were prohibited from dumping or discharging material into or within 25 feet of any river, creek, or watercourse as specified by the *Metropolitan Drainage and Rivers Act 1923*.[232] Regardless of this bylaw and its enforcement, Melbourne's watercourses during the 20th century were used as dumps, and floodplains for dumping excavation spoil from building sites.[233]

As urban development continued to spread across the lower and middle Moonee Ponds' catchment during the 1940s to 60s, increases in runoff accelerated erosion along the creek and its tributaries.[234] For example, in 1930 it was noted erosion of the tributary Melville Creek, as seen in figure 82, had cut incised sections 10 to 20 foot (3-7 metres) deep in some places.[235]

Figure 82. Melville Creek bank erosion. Source: PROV, VPRS 8609/P32, Unit 7, PA17

The potential for the area's soils to erode by water scouring was identified by Pretty (1926) *On the Bad Lands Deposits of Coburg, Victoria, and their Mapping by Elutriation*

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[231] Leigh and Melbourne Metropolitan Board of Works, 52.
[232] Ibid, 56.
[233] Senior, 413-14.
[234] Leigh and Melbourne Metropolitan Board of Works, 56.
[235] Ibid, 58.

Methods.[236] Pretty identified a location of canyon-like formations scoured out by running water flowing through the same Silurian sediments and Tertiary sands of the Moonee Ponds Creek valley.[237] So bad was the scale and depth of erosion Pretty labelled the site the *Bad Lands*, identifying the soils as highly friable (crumbly textured) and extremely susceptible to erosion following land clearing and loss of organic matter and root systems that bind the soil.[238] Despite this knowledge and the MMBW's bylaw prohibiting development of floodplains and stream banks, suburban development continued, significantly degrading the creeks, and leaving the MMBW to provide engineering solutions for erosion and flooding problems. Many of these were executed over the period 1941 to 1967, including placing rocks and boulders along the toe (base) of the stream bank, use of rock beaching, lining the bank, and levelling the upper bank and planting grass.[239] Much of this work is still functioning as erosion protection. By 1959 complaints received from property, owners about land loss due to continued erosion along the Moonee Ponds' banks prompted the MMBW to execute several hard-engineering solutions.[240] These included straightening, realignment of streambed, and partial concrete lining of the worst effected sections and the removal of two meander loops.[241] Much of the middle reach of the creek was engineered for erosion and flood mitigation throughout the period. Despite this, and success in stabilising the banks along properties bordering the creek's middle reach, flooding remained a significant problem. Comparison of two major floods in the catchment illustrates the dramatic effects impervious urban surfaces have upon runoff flows and creation of flood levels. In September 1960, a flood along the creek was estimated at 6000 cusecs which was a comparable flow to flood recorded in February 1946.[242] The 1946 flood resulted from 127 millimetres (five inches) of rainfall across a dry catchment. The 1960 flood occurred following only 50.8 millimetres (2 inches) on a wet catchment.[243] Between 1946 and 1960, suburban development across the catchment had dramatically increased the amount of impervious surface, which in turn significantly raised runoff amounts flowing into the creek. Although an analogous situation

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[236] Pretty, "On the Bad Lands Deposits of Coburg, Victora, and Their Mapping by Elutriation Methods " *Proceedings of the Royal Society of Victoria* 39, no. 2 (1926): 59.
[237] Ibid.; Leigh and Melbourne Metropolitan Board of Works, 11.
[238] Pretty, 61-62.
[239] Leigh and Melbourne Metropolitan Board of Works, 61.
[240] Ibid, 62-63.
[241] Ibid, 61-79.
[242] Ibid, 84.
[243] Ibid.

was occurring across Melbourne's other watercourse catchments, the use of floodplains and lack of undeveloped land along the middle and lower reaches of the Moonee Ponds was increasing the risk of severe flooding. Based on the extent of the 1960s flood the MMBW decided on the following engineered solutions. Further bank protection works along the middle reach; the levee heights raised on the lower reach; land purchased for construction of three retarding basins along the creek; and a basin designed and constructed at Jacana, 19 kilometres (11.7 miles) upstream from where the creek flows into the Yarra.[244]

The Jacana retarding basin was constructed over the period November 1965-June 1967 with a design capacity at the top water level of 2899 megalitres.[245] Of 200 retarding basins across the greater Melbourne area, Jacana's has the largest capacity.[246] In 2016, the basin wall and spillway were upgraded to comply with updated design standards for earthen embankments.[247] A series of wetlands constructed upstream within the basin in 2003, reflected the changing attitudes and management practices towards Melbourne's watercourses that commenced during the 1970s.[248] The wetlands were constructed to manage nitrogen levels of local runoff entering the creek.[249] The project also highlighted the shift away from the earlier management of the creek by engineers and hydrologists as primarily a stormwater drain and erosion problem, towards being an ecological system.

Undergrounding tributaries: Five Mile and Westbreen

The middle reach of Moonee Ponds Creek has several smaller tributaries flowing from the east and west. Two significant creeks are Five Mile and West Breen.

Five Mile Creek had a main tributary, whose headwaters commenced within what has become Essendon Airfield. The tributary drained runoff from the field and was subsequently undergrounded by the MMBW in 1948 for its entire length.[250] The un-named tributary now exists as Magdala Avenue Main Drain.[251] Like many Melbourne creeks, Five Mile was subject to complaints about its polluted condition. In 1914 a meeting of the Public Works

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[244] Ibid, 87.
[245] Ibid, 98.
[246] Melbourne Water, *Jacana Retarding Basin Upgrade Project* (Melbourne: Melbourne Water, 2015), 2.
[247] Ibid.
[248] Jacobs Australia Pty Limited, "Growling Grass Frog Management Plan " in *Jacana Retarding Basin Wetlands Rectification Project* (Melbourne 2016), 2
[249] Ibid, 1.
[250] Leigh and Melbourne Metropolitan Board of Works, 94.
[251] Ibid.

Committee for Essendon Council highlighted remarked on 'the bad state of the Five-mile creek, where there were stagnant pools' and called for construction of a drain to alleviate the problem.[252] In 1918, eight acres (3.2 hectares) of land along the creek was gifted to the council for the development of children's playground and public walks by William Salmon, owner of the adjoining Roseneath Estate.[253] Salmon was an avid campaigner for tree planting and land reclamation, claiming criminal neglect of successive governments' land clearing policies.[254] The *Essendon Gazette and Keilor, Bulla and Broadmeadows Reporter* (1918) provided a description of the creek and some of Salomon's work along the banks; 'Five-Mile Creek runs in a serpentine fashion…On each side of the creek are splendid growths of well-established ornamental trees…planes, oaks, elms…sugar gums, and reserves representing the 'forest primeval.'[255] Despite the picturesque view of Five Mile in 1928, (shown in the left image of figure 83) the MMBW commenced progressively lining the streambed with bluestone pitches, (right photograph) presumably to manage erosion and flooding.[256]

[252] "Essendon City Council," *Flemington Spectator*, October 22, 1914, 3.
[253] "Parks and Playgrounds," *Essendon Gazette and Keilor, Bulla and Broadmeadows Reporter*, November 7, 1918, 2.
[254] Ibid.
[255] Ibid.
[256] Leigh and Melbourne Metropolitan Board of Works, 94.

1932 1933

Figure 83. Five Mile Creek before and after lining with bluestone pitchers (basalt rock blocks). Source: PROV, VPRS 8609/P32, Unit 7, PA17

Flooding and erosion saw residents often complain to the MMBW.[257] In 1959, a short section was undergrounded to allow subdivision of private land.[258] At Five Mile's confluence with the Moonee Ponds in 1960-61, a sharp bend was removed from the Moonee Ponds, the new course lined with concrete and bluestone pitches. The former course was filled upstream of the confluence with Five Mile, while the downstream section was used to create a new outlet for Five Mile Creek.[259] Major flooding in 1963 inundating several houses along the middle reach of Five Mile provided a reason for further undergrounding the creek. Over the period 1966-67, it was entirely undergrounded except for 300 metres (984 feet) on railway easement land and the last 260 metres (853 feet) where the creek enters the Moonee Ponds.

Although Five Mile Creek appears no different to many other smaller creeks across Melbourne, a restoration project involving one of its undergrounded tributaries illustrated a

[257] Ibid.
[258] Ibid.
[259] Ibid, 79.

whole innovative approach to undergrounded creeks, stormwater management and its reuse, and the changing paradigm towards urban water. In 2014, a section of a tributary of Five Mile Creek flowing from the northeast was day-lighted, becoming one of the first stream sections to be uncovered in Melbourne.[260]

The section of Five Mile Creek's day-lighted tributary was an ephemeral stream flowing only after rainfall. It had been buried in the 1960s when the land was subdivided, and roads were constructed.[261] The original course of the stream (illustrated in figure 23 and photograph of figure 85) flowed across the northeast corner of Napier Park.

Figure 84. MMBW contour plan of 1933 with assumed course of tributary. Sources: SLV http://handle.slv.vic.gov.au/10381/143111 and Author photos (2015-2017).

[260] "Return of Park's Lifeblood," *Moonee Valley Leader*, May 7, 2014, 4.
[261] "Napier Park " B. Barbour, Strathmore Community Online, updated October, 2014, http://www.strathmore3041.org/napierpk.html.

Figure 85. The un-named tributary of Five Mile in c.a. 1930-1940. Source: SLV H91.160/854

Napier Park, (originally Northern Park) is located in the middle-class suburb of Strathmore within the Five Mile Creek catchment.[262] The park contains significant remnant vegetation including River Red Gums (*Eucalyptus Camaldulensis)*, from the original ecological vegetation class of Plains Grassy Woodland.[263] The land for Napier Park was gifted to Essendon Council in 1920 by Theodore Napier, a local landowner.[264] Napier gifted the land on the conditions it would not be subdivided, the Red Gums would be retained and preserved as relics of the original forest, and the site developed as picnic grounds for the community.[265] Due to the removal of the ephemeral stream and drainage of the surrounding area, less water was available for the red gums, leading to significant decline in their

[262] Heritage Council Victoria, *Napier Park* (Melbourne: Heritage Council Victoria, 2017),accessed March 15, 2017, 2, http://vhd.heritagecouncil.vic.gov.au/places/29808/download-report.
[263] Ibid.; Australian Plants Society. Keilor Plains Group, *Plants of Melbourne's Western Plains: A Gardener's Guide to the Original Flora*, 2nd ed. (Niddrie, Vic.: Australian Plants Society, Keilor Plains Group, 2012), 192-95.
[264] "A Gift Park for the People of Essendon," *Daily News*, October 7, 1919, 5.
[265] Ibid.

health.[266] A prolonged drought over the period 2001-2009 further affected the trees. River Red Gums commonly grow on sites with higher water supplies of permanent or seasonal water, with deep moist subsoils.[267] A major driver of the Napier Park daylighting project was improving the health of the trees by increasing the amount of available water.[268] This involved daylighting the section of stream piped within the park and sending the stormwater flows along a vegetated swale for filtering.[269] The water then collects in an underground tank for later reuse for re-establishing soil-moisture levels favourable for the red gums via an irrigation system.[270] Excess treated water is discharged back into the drainage system to enter Five Mile Creek. Although a small-scale project, it demonstrates the changing paradigm from the efficient and swift removal of stormwater and runoff from the urban fabric to retaining and reuse for maintaining vegetation, ecological habitat and green space.

Westbreen: a late undergrounding

The history of the undergrounding of Westbreen Creek highlights changing public perceptions towards creeks flowing through Melbourne's residential areas. It also provides a possibly exceptional situation regarding outcomes for the creek and the period when the event occurred; a time when increased environmental awareness was driving improvements to the quality of water and environs of many creeks across Melbourne.

Westbreen Creek, a sub-basin of the Moonee Ponds, was developed as a residential area over the period 1946 – 1960, with a significant area devoted to public housing.[271] As with many suburbs developed over the period, housing construction commenced before main line sewers were constructed, resulting in the use of septic tanks, and grey-water (sullage) connected into stormwater drainage and discharged into local watercourses.[272] As the suburb expanded the Westbreen followed the now familiar sequence of problems common to Melbourne's creeks; erosion, flooding, and pollution.[273] Following numerous complaints from residents, Shire of Broadmeadows and the Glenroy Progress Association, the MMBW

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[266] M. Gooding, "Preserving Napier Park," *Ponderings,* Summer, 2013, 3.
[267] "Eucalyptus Camaldulensis " CSIRO, updated July 5, 2004, https://www.anbg.gov.au/cpbr/WfHC/Eucalyptus-camaldulensis/.
[268] Gooding, 3.
[269] Ibid.
[270] Barbour; Gooding, 3.
[271] Leigh and Melbourne Metropolitan Board of Works, 94.
[272] Ibid.
[273] Ibid.

undergrounded sections of the creek between 1952 and 1967.[274] In 1968, a further section of creek was straightened to allow land containing the meandering Westbreen to increase potential block sizes for future development.[275] By the mid-1970s, much of the creek had been undergrounded, except for sections flowing through a golf course and parkland.[276] [277] In 1978, the City of Coburg was cleaning up one of the last open sections of Westbreen that flowed through KW Joyce Reserve. It was decided to create a linear parkway connecting the upstream with the open reach extending 40 metres (424 yards).[278] Residents opposed to the parkway expressed support for undergrounding and developed a petition circulated to the MMBW, the state government Minister for Conservation, and a local Member of Parliament.[279] The residents cited three reasons: the creek was a public health hazard, threatening hepatitis in particular; rubbish dumping along the creek further increased danger to children; flooding was also a particular danger.[280] The residents' petition was at odds with the view of the Pascoe Vale Naturalists Club, which had previously written to the MMBW requesting the creek remain open. Residents believed a minority club's views should not overrule those of the public. The MMBW was engaged in cleaning up and landscaping many watercourses across Melbourne, the result of criticism and concern from various groups and individuals regarding the MMBW's engineering approaches to watercourses and a desire to beautify the suburban environment.[281] On the strength of the residents' objections to the parkway, the City of Coburg abandoned the project and requested the MMBW underground the Westbreen as soon as possible.[282] The project was completed by June 1979. It provides a clear illustration of perceptions towards urban watercourses by residents living within proximity and those of other interested groups living in various locations.[283]

This project occurred at a time the MMBW was developing a dramatically different direction in its drainage philosophy.[284] Rather than funding construction of drainage infrastructure including undergrounding creeks, the MMBW adopted a position of allowing

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[274] Ibid.
[275] Ibid, 132.
[276] Ibid.
[277] Ibid.
[278] Ibid.
[279] Ibid.
[280] Ibid.
[281] Dingle and Rasmussen, 310; Leigh and Melbourne Metropolitan Board of Works, 132.
[282] Leigh and Melbourne Metropolitan Board of Works, 132.
[283] Ibid.
[284] Dingle and Rasmussen, 308.

natural floodplain systems to slow down and store flood flows.[285] This involved prohibiting building on floodplains and development of flood prone land, such as the land along the Westbreen where property boundaries extended to within metres of the creek banks.[286] The protection of floodplains had been instigated by the MMBW's chair from 1966-82, Alan Croxford.[287] He had observed changing approaches to floodplain management in the United States.[288] He encouraged sending MMBW staff to America to examine new practices and brought in American consultants to develop new urban water management approaches.[289] These first surfaced in 1971 as part of *Planning Policies for the Melbourne Metropolitan Region*; the first time a planning document for Melbourne featured a specific flood control overlay for suburban development. This mapped the city's 'floodway's' and wetlands and divided the metropolitan area into three regions (see figure 86).[290] These were based upon topography, threat of flooding and costs involved with providing adequate flood management and drainage infrastructure.[291]

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[285] Ibid.
[286] Ibid.
[287] Ibid, 308, 92.
[288] Ibid, 269,308.
[289] Ibid, 308.
[290] Melbourne Metropolitan Board of Works., *Planning Policies for the Melbourne Metropolitan Region*, 40-41.
[291] Ibid, 41.

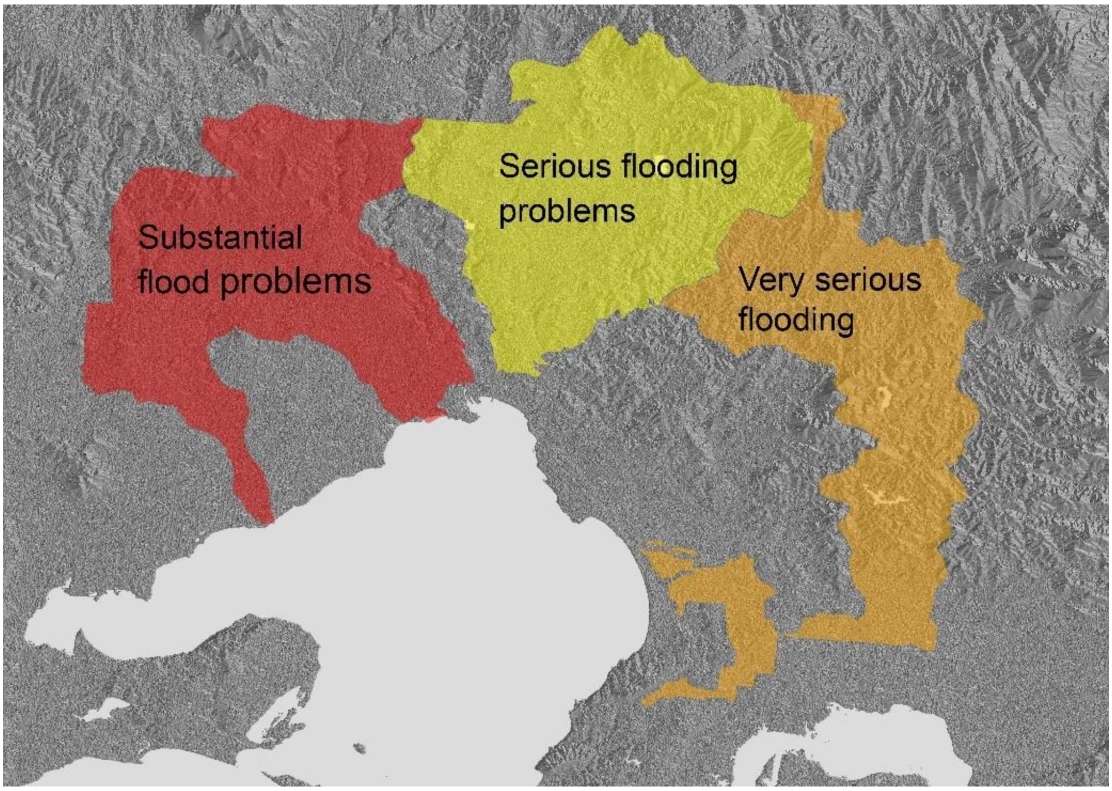

Figure 86. Flooding classifications of the MMBW 1971 Planning Policies, based upon topography, level of control works and scale of flooding. Source: MMBW (1971).

Westbreen Creek currently exists as an underground drain with only two sections on the surface. On the upper reach a section flows through a golf course, while a section of the middle reach flows through two parks. Since the 1970s when residents pushed for the undergrounding of the creek, the Friends of Westbreen Creek group has developed.[292] The group conducts restoration works along the open middle reach with the aims of improving the creek as habitat and restoring indigenous vegetation to the riparian zones and banks.[293]

Both Five Mile and Westbreen Creeks provide examples of the evolution of perception of watercourses in Melbourne, from being perceived as dangerous, polluted places to be feared and remediated, to valuable environmental assets providing habitat and ecological services for the suburban fabric.

At time of writing Moonee Ponds Creek consisted of the following channel typologies mapped in figure 87.

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[292] Moonee Ponds Creek Coordination Committee, "Friends of Westbreen Creek," *Ponderings,* Summer, 2013, 2.
[293] Ibid.

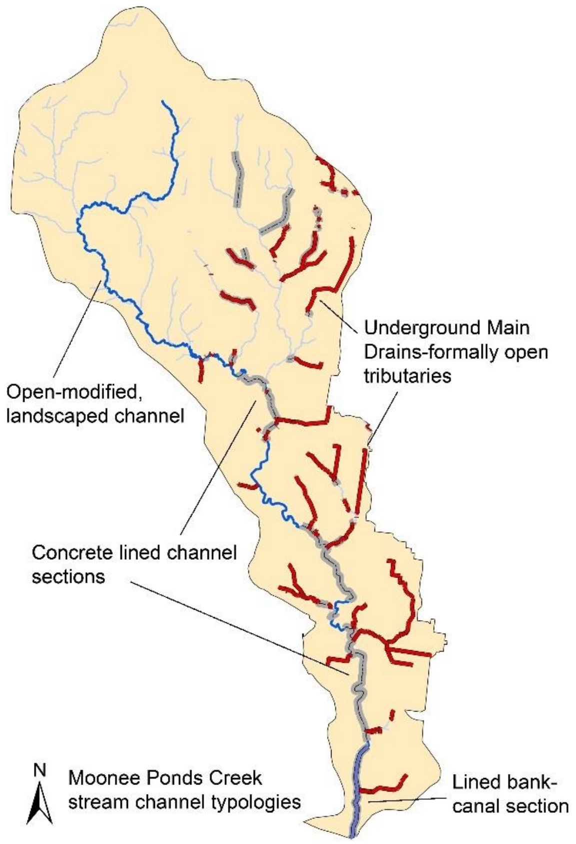

Figure 87. Channel typologies and undergrounded tributaries - Moonee Ponds catchment.

Tullamarine Freeway: Traffic along the creek bed

The southern section of the Tullamarine Freeway, covering six kilometres (3.7 miles) was constructed over the period 1967 to 1970.[294] The MMBW constructed this section located within the metropolitan boundary of Melbourne, while the CRB constructed the further two northern stages.[295] The route of the southern section followed the lower Moonee Ponds Creek valley and required realignment of the creek in three separate locations in addition to extensive drainage works including modification to several tributaries flowing from the east.[296] During construction, the freeway was eagerly anticipated as, to quote one contemporary writer, 'a jet-age road – designed to whisk you 14 miles…to the new jetport in

[294] Leigh and Melbourne Metropolitan Board of Works, 107; Victoria Country Roads Board, *Fifty - Seventh Annual Report* (Melbourne: Country Roads Board, Victoria, 1970), 1.
[295] Lay, 206.
[296] Leigh and Melbourne Metropolitan Board of Works, 107, 10-17.

25 minutes'.[297] However, recent appraisals have been more circumspect, such as Lay's (2003) description of the Tullamarine as 'an old-style freeway which did little or nothing to enhance the valley.'[298] This becomes apparent viewing the image below, figure 88, taken two years after completion.

Figure 88. Southern section of the Tullamarine Freeway. Moonee Ponds Creek channel is centre left. This section became an infamous symbol, within sections of Melbourne's population, of creek destruction and extreme engineering of a watercourse. Source: MMBW (1972).

The southern section of the freeway's route was first delineated in the MTPC's 1929 plan in which an arterial roadway along the creek valley was proposed as a north-south connection between two major east-west arterial roads.[299] Although the MTPC traced parkways for Melbourne's other main watercourses, it believed that a range of problems presented by the Moonee Ponds Creek prohibited the creation of a continuous strip of parkland or an associated parkway system.[300] These problems included the creek's irregular course, the evaporation of the stream into a series of long pools during periods of low rainfall, and the amount of infringing suburban development along its lower reach.[301] The available land between the existing development and the stream banks prevented the construction of

[297] R. Haupt, "14 Miles in 25 Minutes," *Sun News Pictorial,* March 5, 1968, 8.
[298] Lay, 206.
[299] Metropolitan Town Planning Commission, *Plan of General Development, Melbourne: Report of the Metropolitan Town Planning Commission*, 224.
[300] Ibid.
[301] Ibid.

parkway drives to the same scale proposed along Melbourne's other main watercourses.[302] Instead, the MTPC proposed an arterial route along the valley connecting a chain of parks to be established on undeveloped land. To accommodate the road, sections of the creek would require straightening.[303] The development of parks along the Moonee Ponds Creek's course was viewed as compensation for the overall lack of open space, within the surrounding suburbs.[304] Like most of its detailed plan, the MTPC's arterial road was not built and sections of the lower reach of the creek and flood plain remained relatively undeveloped as evident from the 1945 aerial image, figure 89. However, the plan's existence does indicate that the specific problems posed by the Creek's unusual form was to the fore of planners' minds as early as the mid-1920s.

[302] Ibid.
[303] Ibid.
[304] Ibid.

Figure 89. The lower reach of the Moonee Ponds in 1945 that was realigned for the freeway. Source: University of Melbourne Library ERC Map Collection (1945).

In 1954 with the release of the MMBW’s planning scheme the possibility of constructing a road along the creek was again proposed in the form of arterial Routes 13 and

14.[305] Route 13 would follow the creek valley to provide the city with improved connection with Melbourne's major airport, at the time located at Essendon Aerodrome, while route 14 would continue in a north-west direction, connecting newer outer suburbs with the city.[306] Arterial Route 13 like its 1929 predecessor was not constructed, although the 1954 plan did reserve land along the Moonee Ponds Creek for a future road.[307] In 1959, when the plan to build a new international jetport at Tullamarine was announced, the need for a new road linking the city and jetport again focussed attention on the Moonee Ponds Creek valley as a possible route.[308] By 1965, the MMBW had decided the freeway would traverse the creek valley as far as Essendon Aerodrome. A diagram of the final route (figure 90) was published by the *Sun* in 1965 illustrating the sections of Moonee Ponds Creek to be affected. In the accompanying article the MMBW's Chief Town Planner, Mr John Hepburn, reported construction would require the compulsory acquisition of 154 houses, three blocks of flats, nine shops, two service stations, and two factories.[309] The freeway would also pass through 18 acres of parkland, 21 acres of unimproved land reserved for open space, five acres of vegetable gardens at the Royal Park Mental Hospital and five and a half acres of what was described as 'wasteland'.[310]

[305] Melbourne Metropolitan Board of Works, *Melbourne Metropolitan Planning Scheme 1954*, 97, 99.
[306] Ibid, 99.
[307] Lay, 52.
[308] "Site for City's New Jetport, " *Herald,* June 10, 1959, 3.
[309] "Jetport Freeway Start Mid-'66," *Sun News Pictorial,* December 8, 1965, 4.
[310] Ibid.

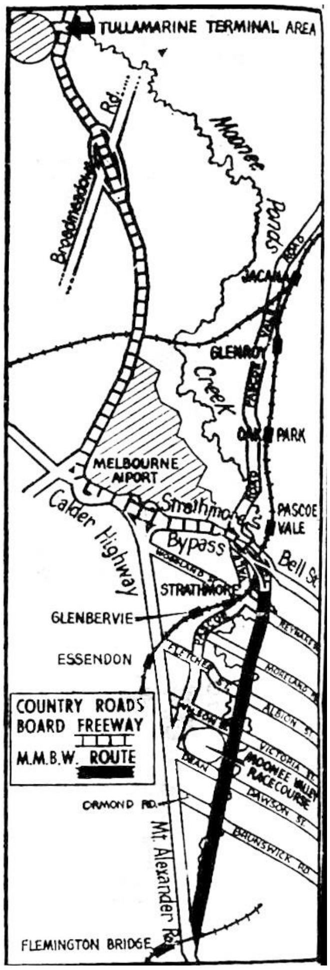

Figure 90. The final route for the Southern section of the Tullamarine Freeway released in 1966. Source: Sun News Pictorial (1966).

Protest over the proposed route came from two sources: residents whose homes, located along the proposed roadbed, were to be acquired; and local councils (Cities of Brunswick and Coburg) objecting to the use of public parkland for roads.[311] Coburg's council objected so strongly to loss of parkland it refused to transfer the park to the MMBW without resumption orders issued by the state government.[312] Public protest over the site for the Tullamarine Jetport however was significantly more vocal. Prior to the official announcement of the intention to locate the jetport at Tullamarine, local councils and land owners including farmers and suburban residents expressed strong opposition to the project, which received

[311] "Jetway Losers Blast Board," *Sun News Pictorial,* December 9, 1965, 15; Dingle and Rasmussen, 256.
[312] Broome, 313.

significant media attention.[313] Protest groups expressed concern over issues including: the loss of good agricultural land, limits to further suburban development and loss of the area's rural character.[314] There does not appear, however, to have been any protest regarding the treatment of the Moonee Ponds Creek or the use of the floodplains and riparian zones for the freeway route. This is hardly unexpected: at that time, Melbourne's creeks were generally perceived as drains, and largely ignored by the public.[315]

However, such lack of interest towards watercourses and freeways dramatically changed prior to completion of the Tullamarine with the release of the 1969 Metropolitan Transport Plan (page 185). The level of public outcry over the plan initiated anti-freeway protests focussing on destruction of inner suburban neighbourhoods to accommodate the proposed freeways.[316] By the early 1970s, public protest had expanded to include opposition to use of streambeds, watercourse valleys and public open space for freeways.[317] This change in public opinion developed from opposition to the 1969 freeway plan proposing construction of freeways through inner city suburbs and evolved through the 1970s to include protest over plans to locate freeways along watercourse valleys.[318] Residents who settled in areas with views of watercourses and bushland fought hard to retain picturesque landscapes.[319] The level of protest made it increasingly difficult for governments to "drop" a freeway along a watercourse valley and over a streambed unchallenged. Although the protests were not a direct result of treatment of Moonee Ponds Creek, there is some evidence that the treatment of the southern section of the creek and the concrete channel became synonymous with freeway-creek alignments. For example, the 1969 F2 freeway proposal was sited to follow the Merri Creek Valley.[320] The creek was to be concrete lined with the freeway adjacent; protestors assuming the design was modelled on the Tullamarine along the Moonee Ponds.[321] Figure 91 shows the concrete channel and freeway in 2015. The vegetation and recently constructed sound wall now obscure the creek from view when traveling the freeway. The

[313] "Jetport Plan Sparks Off Protest," *Sun News Pictorial,* July 5, 1958, 11.
[314] Ibid, 11.
[315] Senior, 413.
[316] Davison and Yelland, 200-01.
[317] Ibid, 223-38.
[318] Ibid, 224-28.
[319] Ibid, 224.
[320] Lay, 202.
[321] "History of Creek Activism," B. McGregor-Friends of Merri Creek, accessed September 23, 2016, http://www.friendsofmerricreek.org.au/pages/activism-history.php.

photograph in figure 92, shows the creek, concrete-lined, hidden in the lower left corner under the interchange bridges in 1970, following completion of the freeway.

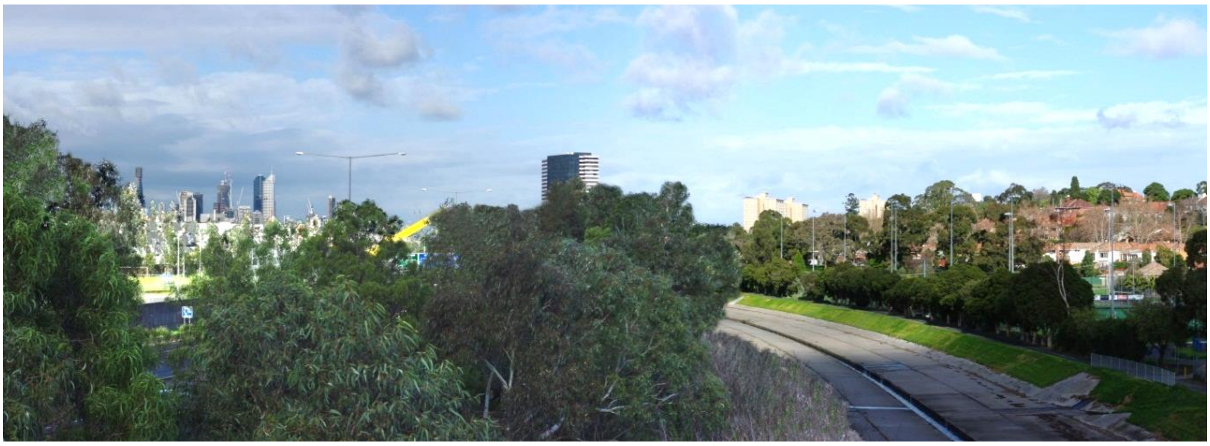

Figure 91. The freeway and Moonee Ponds Creek, realigned southern section, within the concrete channel. Source: Author photo (2015).

Figure 92. The Bell Street interchanges. The Moonee Ponds Creek is hidden beneath the bridges in the lower left corner. Source: CRB (1970).

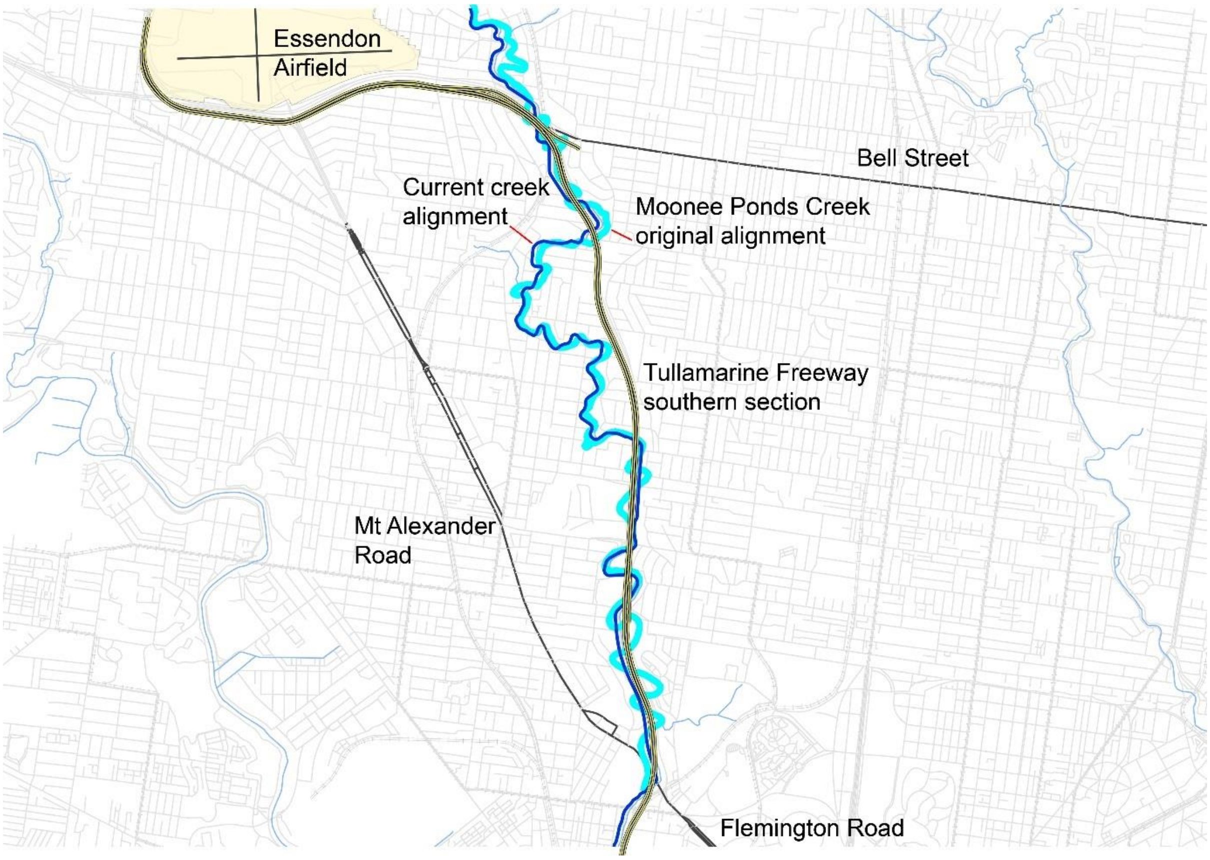

Figure 93. Original creek alignment in aqua with current alignment in blue, overlaid with the freeway route.

Figure 93 shows the meandering original alignment of Moonee Ponds Creek prior to construction of the freeway. This section flows through an underlying geology of sedimentary strata and tertiary sands that has resulted in the stream eroding a deeply incised and meandering course.[322] Due to the meandering, it was considered impractical and too costly to follow the stream's course or construct enough bridges to cross the creek. In one section the freeway, as planned, would have crossed the creek eight times.[323] To minimise the number of bridges the streambed was realigned in three locations, through construction of concrete lined channels of varying widths, designed to accommodate a one-in-a-hundred-year flood.[324] The longest section of creek realigned was to accommodate the final southern

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[322] Presland, *The Place for a Village: How Nature Has Shaped the City of Melbourne*, 92; Leigh and Melbourne Metropolitan Board of Works, 11.
[323] Ibid, 111.
[324] Ibid, 110.

section of the freeway. This involved shifting the creek west into a new course. The *Gazette* (1968) reported a concrete channel 2430-foot-long by 35-foot-wide (732 by 11 metres) would re-align the creek away from the roadbed.[325] Over the following decades, the MMBW received significant criticism about the concrete channel, now a symbol of mid-century modernist engineers and/or planners' total disregard for watercourses and the natural environment. In defending this approach, the MMBW opined that a channel of that size was required to accommodate flood flows that were previously stored on the floodplain, now covered by the freeway.[326] Figure 94 is a comparison of normal and flood flows. Figure 96 illustrates the amount of floodplain land lost for construction of the freeway.

Figure 94. The longest section of realigned creek course during normal and flood flows. The freeway is along the original creek bed. Source: MMBW (1976).

[325] "Straightening the Creek," *Gazette,* November 6, 1968, 17.
[326] Ibid, 111.

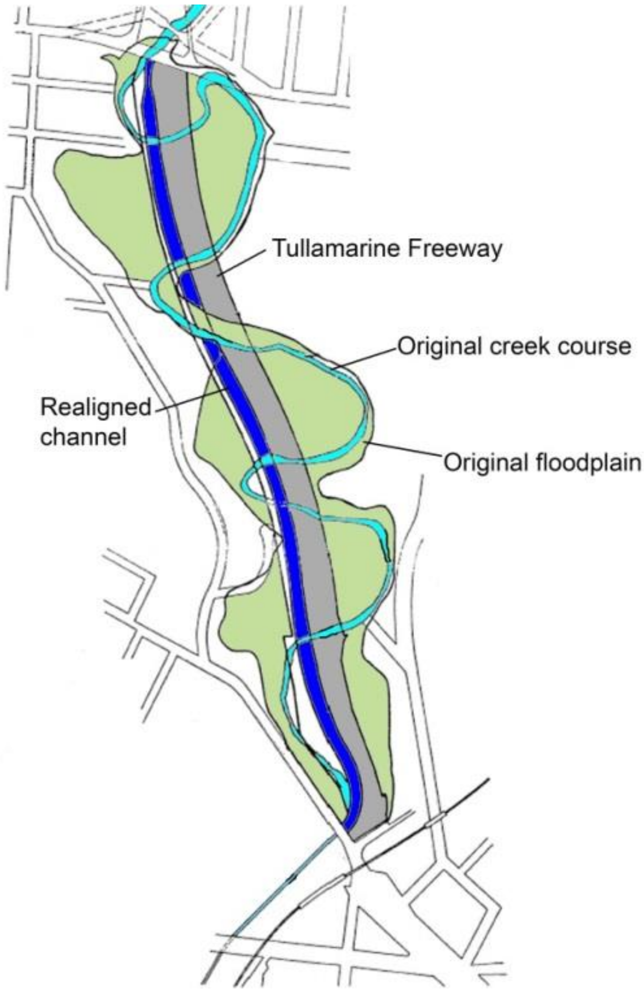

Figure 95. Plan showing the area of floodplain lost due to construction of the freeway. Source: MMBW (1981).

As discussed on page 239, the middle reach of the creek passed through a section of Silurian rock, one of the best locations within the region for collection of Silurian fossils.[327] When the freeway was constructed, although the original course of the creek was to be retained in the location of the rock outcrop, the creek was to be placed into a concrete channel for flood mitigation and erosion control.[328] Due to the scientific importance of the rock outcrop, the Director of the National Museum of Victoria requested the outcrop be preserved and protected.[329] In response to the museum's request, the MMBW modified the section of

[327] Talent, 25.
[328] Leigh and Melbourne Metropolitan Board of Works, 111-12.
[329] Ibid, 112.

channel wall to affect less than one metre (three feet) of the bank and agreed to retain the bank in its natural state, as evident in figure 96.[330]

Figure 96. The Silurian rock outcrop in 215. Source: Author photo (2015).

The treatment of the Moonee Ponds and its tributaries highlights the level of suburban development within the Moonee Ponds Creek catchment as one of Melbourne’s most urbanised open watercourses. As discussed on pages 266-67, this was the only main watercourse in the MTPC 1929 plan identified as unable to accommodate a continuous strip of parklands, due to encroaching suburban development.[331] Indeed, such has been the level of change and modification to the creek caused by urbanisation the MMBW produced a report, *Development of the Moonee Ponds Creek Drainage System* (1981), detailing how and why sections of the creek were engineered to control flooding, erosion and pollution, and to allow sections of flood prone land to be developed.[332] The MMBW believed the report would serve to address the significant level of ongoing public criticism largely focused upon the design and scale of the concrete channel constructed along the southern section of the Tullamarine

[330] Ibid.
[331] Metropolitan Town Planning Commission, *Plan of General Development, Melbourne: Report of the Metropolitan Town Planning Commission*, 214-27.
[332] Leigh and Melbourne Metropolitan Board of Works, 1.

Freeway.[333] It took the position that such criticism was largely uninformed and emotional.[334] This public attitude was nonetheless common.[335] Concerned citizens and interested organisations were seeking creeks to look more natural and less engineered.[336] The MMBW responded to the criticism by landscaping creeks while retaining required flow capacities for flood management.[337]

Continued expansion of freeways affecting the Moonee Ponds

By the early 1990s, Melbourne's central city area was linked to many of its suburbs by three radial freeways: the South Eastern, the Tullamarine; and the West Gate, which includes the West Gate Bridge, crossing the Yarra 2.5 kilometres (1.6 miles) upstream from its mouth at Hobsons Bay.[338] Nevertheless, the freeways themselves were not linked; a 2.6-kilometre (1.6 miles) gap existed between the South Eastern and West Gate Freeways, combined with a 4.5-kilometre (2.8 mile) gap between the Tullamarine and West Gate.[339] In a city servicing a population of three million, the connecting of these three freeways was perceived as the solution to the increasing traffic problems and provision of uninterrupted traffic flows between the airports, seaport, and interstate railway terminal.[340] However, past proposals for encircling Melbourne's CBD with freeways were not executed due to fierce public protest and high construction costs. As a solution, the CityLink project was proposed, a privately funded toll road, administrated as a public private partnership between the state government and privately funded road consortium.[341] The project involved the widening of the three freeways, construction of two tunnels to connect the South Eastern with Westgate and construction of an elevated roadway joining the Tullamarine with the West Gate. As illustrated by figure 97, this section involved straddling the last reach of the Moonee Ponds Creek with an elevated structure, crossing the reclaimed land of the West Melbourne Lagoon.

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[333] Ibid, 11.
[334] Ibid.
[335] Dingle and Rasmussen, 310.
[336] Ibid.
[337] Ibid.
[338] M. G. Lay and K. F. Daley, "The Melbourne City Link Project," *Transport Policy* 9, no. 3 (2002): 261.
[339] Ibid.
[340] Ibid, 261-62; I. Muhammad and N. Low, *Mega Projects in Transport and Development: Background in Australian Case Studies, City Link Motorway Expanson, Melbourne* (Melbourne: Australasian Centre for the Governance and Management of Urban Transport, 2006), 4-6.
[341] Emilia. Tagaza, *Journey and Arrival: The Story of the Melbourne Citylink* (Melbourne: Institution of Engineers, Australia, 2002), 2.

The freeway then crossed the Yarra adjacent to the Moonee Ponds' confluence with the river, to connect with the West Gate Freeway.[342]

Figure 97. The location of CityLink, Western Link, joining the end of the Tullamarine with the West Gate. The link covers sections of the Moonee Ponds, crosses reclaimed land of the West Melbourne Lagoon, and the Yarra to join with the West Gate (not shown) The freeway to the right is the South-Eastern (Monash) ending where it enters a tunnel. The map also shows the original course of the Moonee Ponds and the Yarra.

[342] Muhammad and Low, 6; Tagaza, 51,56.

The Eastern Freeway: Two realignments of the Yarra, shifting and undergrounding a section of the Koonung

The Eastern Freeway or, formally, F19 was the third freeway constructed in Melbourne. The road was first proposed in March 1951when the MMBW raised the idea of constructing a rapid transit highway along the Yarra and Koonung Creek valleys to connect with another highway in the Darebin Creek valley.[343] The MMBW envisaged highways would link far northern and eastern suburbs and relieve traffic congestion in the inner northern suburbs; construction of the roads was, to the MMBW, planning for 50 years into the future.[344] The highway's route was not part of the MTPC's 1929 plan in which access to the eastern suburbs was proposed via the upgrading of existing main arterial roads.[345] The route first featured in the MMBW'S 1954 planning scheme as Route 19, a controlled-access roadway located along the Yarra Valley's eastern flood plains, described as 'through open country'.[346] Construction of the first section of the Eastern, 8.13 kilometres (5.05 miles) commenced in 1971 and consisted of three stages completed in 1977.[347] The freeway was further extended 3 kilometres (1.74 miles) in 1982 with a further extension of 7 kilometres (4.31 miles) completed 1997.[348]

The Infamous Reilly Street drain and the Yarra: Industrial drains of Collingwood and Abbotsford

The western city end of the freeway starts in Collingwood, along its only main boulevard, Alexandra Parade.[349] Once known as Reilly Street, it was known for the stone lined drainage channel which traversed its centre, and the notoriously polluted state of what

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343 "Highways Planned to Link Outer Suburbs," *Age,* March 22, 1951, 7.
344 Ibid.
345 Lay, 208.
346 Melbourne Metropolitan Board of Works, *Melbourne Metropolitan Planning Scheme 1954*, 99-100.
347 Lay, 209; Victoria Country Roads Board, *Country Roads Board: Sixty-Fifth Annual Report for Year Ended 30th June 1978* (Melbourne: Country Roads Board Victoria, 1978), 7.
348 V. Uch, "M3 Eastern Freeway," accessed, 23 May, 2016, http://mrv.ozroads.com.au/SRNS/M%20Routes/M3%20Eastern/M3.htm.
349 Davison and Yelland, 206.

the *Age* (1898) called its 'soup-like' discharge into the Merri Creek.[350] Constructed in the 1850s, the channel collected all types of drainage, waste and refuse from three suburbs and various noxious industries.[351] The drain's flow was described in 1887 as a greyish black colour think with mud and garbage, and in 1881 as 'so offensive that it almost turns one sick to approach it.'[352] The urban environmental history of the Reilly Street drain provides valuable insight into the early development of Melbourne's first suburbs and how wetlands, small tributaries and floodplains, were commonly managed and treated before the creation of the MMBW. Following the subdivision of land from 1839 until 1891 when the MMBW was created, the common approach to drainage, public sanitation, and watercourses was piecemeal at best, with this approach clearly illustrated by the Reilly Street drain.[353] The history of the drain and Collingwood's development also includes the first serious attempts during 1855 by the state government to legislate against noxious industries polluting the Yarra.

The drainage of the inner suburbs of Collingwood and neighbouring Fitzroy and Clifton Hill could be assumed as problematic since the area sloped from the north and west towards the east onto a section of the Yarra's floodplains.[354] Despite drainage channels being constructed across part of floodplain by 1858, flooding remained a problem. As with much of the river's floodplains within Melbourne, the area consisted of plains grassy woodland, floodplain riparian woodland and riparian scrub.[355] The vegetation was interspersed with swampy lagoons, wetlands and creeks.[356] Subdivision of the land commenced in 1839 with development concentrated essentially on the higher contours, the floodplains left largely undeveloped due to the flooded, marshy nature of the land.[357] This situation changed with the establishment of noxious industries including abattoirs, fellmongers, tanneries, woolwasheries and other animal product processes, close to the Yarra. These industries utilised the river as a source of free fresh-water and a convenient drain for waste.[358] As

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[350] "Pollution of the Yarra. A Filth Accumulator at Dights Falls," *Age*, June 29, 1898, 6.
[351] Andrew Ward and Associates, *Collingwood Conservation Study* (Melbourne City of Collingwood 1989), 59.
[352] "The Pollution of the Yarra," *Argus* April 30, 1887, 13; "Pollution of the Yarra," *Advocate*, April 23, 1881, 11.
[353] Dingle and Rasmussen, 32-39.
[354] Andrew Ward and Associates, 59.
[355] City of Yarra, *Gardening with Native Plants in Yarra*, ed. City of Yarra (Richmond City of Yarra, 2001), 3-4.
[356] C.E.S., "The Suburbs of Melbourne. The Story of Their Growth," *Age*, June 2, 1934, 5.
[357] Andrew Ward and Associates, 35-42.
[358] Barrett, 11; G. M. Hibbins and Collingwood Historical Society, *A Short History of Collingwood* (Abbotsford, Vic.: Collingwood Historical Society, 1997), 14.

Collingwood developed, a mixture of residential and industrial buildings spread eastwards towards the Yarra.[359] The area became known locally as 'The Flat' and, during winter, 'Mud Island'.[360] The Flat continually received drainage and runoff from the higher contours, frequent inundation from floods on the Yarra, as seen in figure 98 of the 1901 flood, and overflows from the Reilly Street drain.[361]

Figure 98. Flood on the Yarra, 1901, looking across Dights Falls towards Collingwood and noxious industries. Source: SLV H92.200/408

The drain, originally constructed through a swamp, followed a small tributary sloping towards the Merri Creek.[362] Figure 99 is a depiction of the swamp during the 1870s.

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[359] Andrew Ward and Associates, 72-79.
[360] C.E.S., 5.
[361] Ibid.
[362] Fitzroy History Society and Cutten History Committee, *Fitzroy: Melbourne's First Suburb* (South Yarra, Vic.: Hyland House, 1989), 41; Department of Crown Lands and Survey, "Contour Plan of Portions of the Cities of Melbourne, Fitzroy, & Collingwood " (Melbourne Department of Crown Lands and Survey 1880).

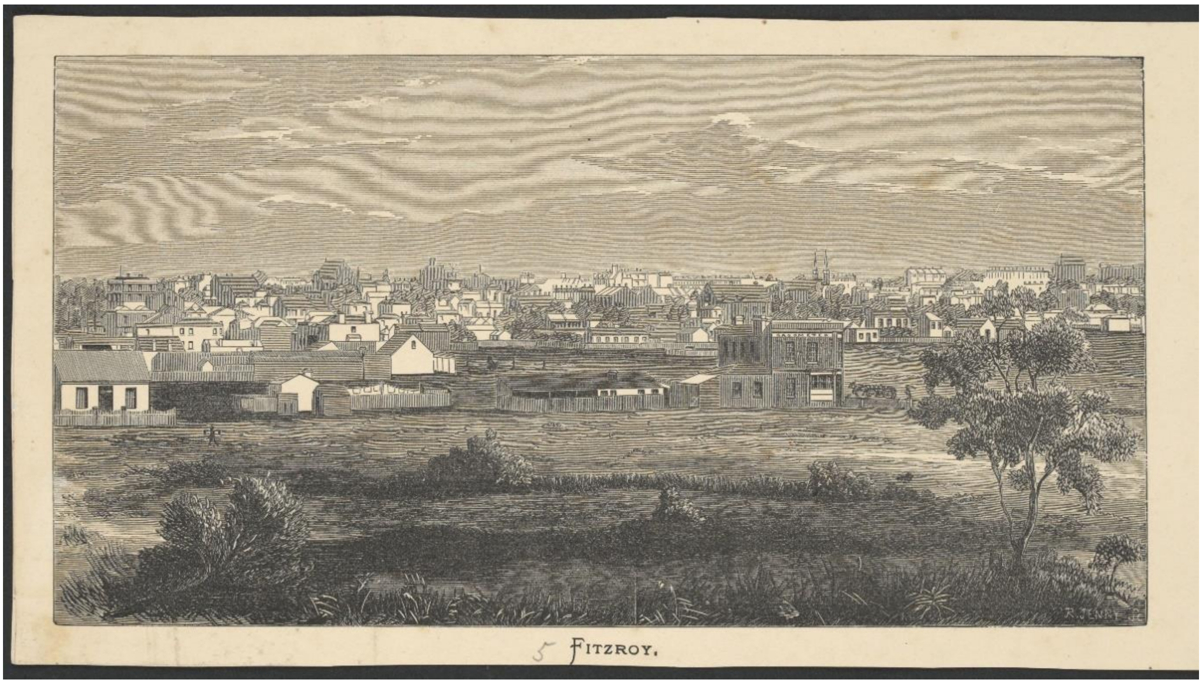

Figure 99. View looking south from Reilly Street during the 1870s. The wetland in the foreground is the 'swamp' the Reilly Street Drain traversed. Source: SLV H85.70/98

Once the drain was constructed, noxious industries established along Reilly Street utilising the channel as a repository for waste, all contents ultimately discharging into the Yarra.[363] As the City of Melbourne was obtaining its potable water further downstream, the city council quickly became alarmed at the polluted state of the river.[364] The council urged the introduction of the *Yarra Pollution Prevention Bill* (1855) into the legislative council of the colonial government.[365] The bill sought to prevent further pollution of the Yarra by prohibiting the construction of new noxious industries upstream of Melbourne and the enlargement of existing establishments. The legislative council divided into two groups, pro- and anti- factory, arguing over compensation for existing operators, which argued they faced bankruptcy if forced to move. A compromise was finally reached allowing existing industries to remain, with new factories and any expansion prohibited.[366] The legislation was largely ineffective in controlling noxious trades.[367] Although the legislative council was concerned

[363] Hibbins and Collingwood Historical Society, 16.
[364] Barrett, 88.
[365] Ibid.
[366] Ibid.
[367] Ibid, 89-105.

about protecting the Yarra, the Collingwood Council's 1865 drainage plans sought to encourage new industries to the area by providing a drainage system that effectively directed noxious wastes underground to the river.[368] The Yarra was viewed as one of the key components to the further economic development of The Flat.

As the suburb developed Reilly Street, drain frequently overflowed onto The Flat, requiring the channel to be deepened to three metres (ten feet) during the early 1860s.[369] Adding to the pollution of the Merri and the Yarra was the Collingwood, Fitzroy and District Gas and Coke Company located on Reilly Street, discharging gas-tar and refuse into the drain, and a manure depot located on the banks of the Merri Creek near its confluence with the Yarra.[370] During the 1860s the depot was filled over capacity resulting in night-soil being dumped directly into the river at the Johnston Street Bridge connecting Collingwood with the eastern suburb of Kew, the river described by Barrett (1971) as 'a flowing manure depot'.[371] Although generally ignored for the control, development, and expansion of noxious industries, the Yarra Pollution Prevention Act (1855) was occasionally enforced leading to offenders being committed to stand trial. In April 1875, the *Argus* reported three persons indicted for conveying nightsoil into the Yarra.[372] A property owner next to the Johnston Street Bridge was allowing the dumping of nightsoil on his property into a shallow hole connected to the river by a 100-yard (91 metres) long channel.[373] During the same year, the Secretary of Mines and Chief Inspector of Mines conducted an examination of mining claims within the Yarra's river basin on instruction of state government. The examination was requested following various complaints of sludge produced from sluice mining flowing into the river and spreading across farmland during floods.[374] Water samples were collected along the entire reach of the river including the urban section noted as being contaminated by sewage matter.[375] The results of the section from Merri Creek confluence along the boundary of Collingwood are displayed in the table seven.

368 Ibid, 104-05.
369 Hibbins and Collingwood Historical Society, 16.
370 "The Round of Yarra Pollution," *Argus*, July 6, 1869, 7; Barrett, 79.
371 Hibbins and Collingwood Historical Society, 15; Barrett, 79.
372 "The Yarra Pollution Cases," *Argus*, April 3, 1875, 5.
373 Ibid; Bates, Jackson, and Gary, 516.
374 "Pollution of the Yarra," *Argus*, June 5, 1875, 4.
375 Ibid.

Table 7. Analysis of pollution of the Yarra River in 1875

Sample site	Date and time of sample collection	Parts per 100,000			Discharge rate per hour (gallons) at time of sample	Discharge rate per hour of solid matter at time of sample (pounds)
		Organic matter	Inorganic matter	Total solid impurity		
Merri Creek below abattoirs – just above confluence with Yarra	31st March 1875 12.00 noon	21.750	27.692	49.442	8.934	16
Reilly Street drain near outfall	31st March 1875 11.30 am	64.788	45.644	108.382	41.460	1
Collingwood main drain, near outfall	31st March 1875 1.00pm	82.202	48.072	78.334	94.740	20
Richmond drain, at outfall- Richmond Bridge 2.9 km (1.8 miles) downstream	31st March 1875 2.00pm	17.965	19.965	27.951	22.230	0

Table 7. Water testing results from samples collected from the Yarra flowing along the boundary of Collingwood. Source: Smyth and Couchman (1875) published in the Argus 5 June 1875, page 4.

The main sources of pollution were near discharges from noxious industries that dissipated when mixed into the flow and carried downstream. Although the report was highlighting the amount of silt deposition in the river caused by mining, the authors' main concern was the amount of silt entering the river from the urban fabric. They reported the sewage drainage of Melbourne and the suburbs created the greatest quantity of silt entering the river continually throughout the year. The authors also believed the steep gradients of the tributaries were responsible for substantial amounts of mud, powdered basalt rock, and sewage transported into Yarra by flows of extreme velocity and power. So alarmed were the authors by the pollution they proposed diverting all drains into a settling-pit system before they flowed into the river.[376]

A small tributary of the Yarra, Blind Creek, 2.18 kilometres (1.35 miles) downstream on the Yarra from Reilly Street drain, was also used to receive drainage from a series of underground brick barrel drains constructed between 1866 and 1881, collecting drainage from the higher contours and The Flat.[377] Figure 100 is one of the few maps showing Blind Creek as an open channel.

[376] Ibid.
[377] Andrew Ward and Associates, 59.

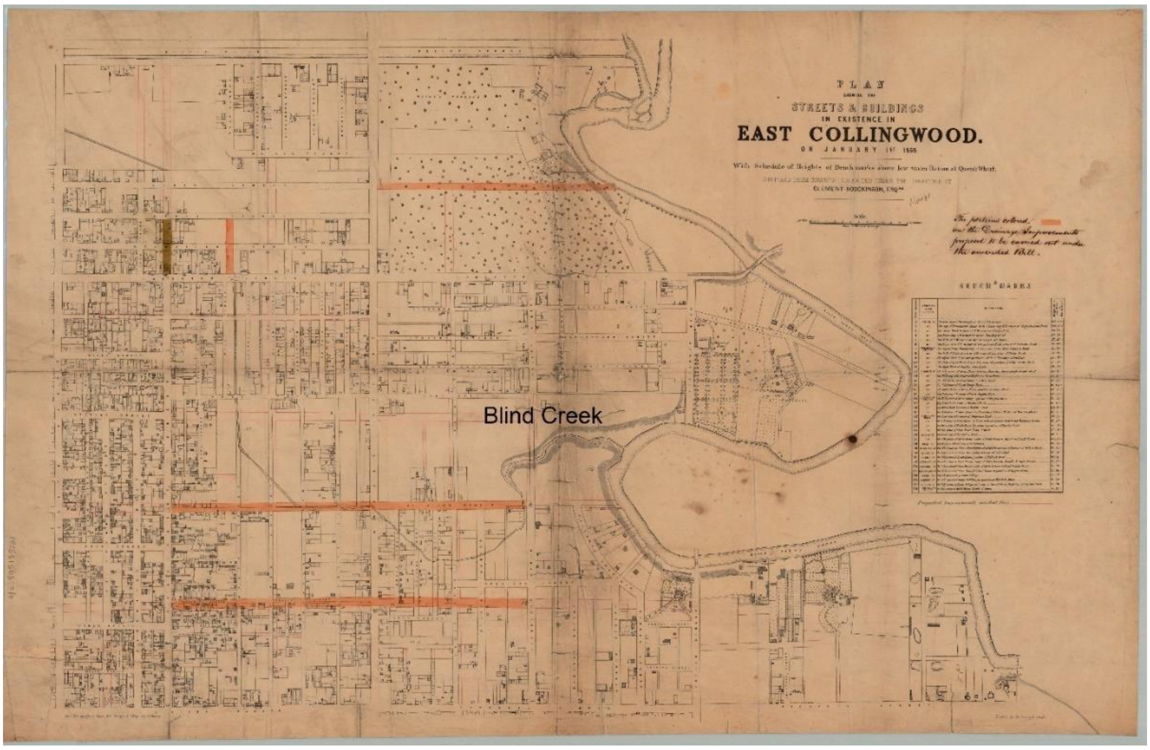

Figure 100. Blind Creek in 1858, showing the upper reaches either changed into lined channels or undergrounded into barrel drains. Source: SLV http://handle.slv.vic.gov.au/10381/117381

Blind Creek was progressively placed into a barrel drain; the final section covered by the MMBW during the 20th century and renamed Harper Street Main Drain 4411.[378] The Reilly Street drain was also placed underground, in stages commencing from June 1898, with the final section completed in mid-1930.[379] The section of drain traversing the median strip of Alexandra Parade was covered over with concrete decking commencing in April 1905, its surface landscaped with ornamental reserves.[380] The project was funded by the City of Collingwood with a contribution from the state government.[381] In 1923, the MMBW took responsibility for the sewer and classified it as a Main Drain.[382] Today it flows as Alexandra Parade Main Drain and discharges into the Merri Creek adjacent to the southern end of the Eastern Freeway, as seen in figure 101.

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[378] Teniswood, F. W. *Melbourne and Suburbs Drainage Record Plan as at 30th June 1955 [cartographic Material]* Melbourne: Melbourne Metropolitan Board of Works, 1955.
[379] "Reilly-Street Drain," *Age*, November 17, 1930, 10; "The Reilly-Street Drain," *Age*, June 14, 1998, 6.
[380] "Improving Reilly-Street Drain,"*Age*, April 11, 1905, 7; "Municipal Intelligence. Improving Reilly-Street Drain", *Age* May 24, 1905, 10.
[381] "Covering Reilly Street Drain," *Age*, July 5, 1904, 8; "Pollution of the Yarra," 13.
[382] "Reilly-Street Drain. Discussion at Collingwood," *Age*, July 19, 1927, 10.

Figure 101. The portal of Alexandra Parade Main Drain (Reilly Street Drain) at Merri Creek. Source: Author photo (2016).

The Eastern Freeway: Melbourne's third, the Yarra's second

Until construction of the freeway, the eastern end of Alexandra Parade ended at the Merri Creek: now in-bound lanes traveling from east to west funnel traffic from the end of the eight-lane freeway onto a controlled main arterial road.[383] From the outset, the project was consistently met with fierce protest, particularly when it was decreed that the freeway would end abruptly in eastern Collingwood, causing traffic to disperse through suburban streets; noise and air pollution's effects on the health of residents, and the destruction of parkland for the freeway, were related issues.[384]

Residents new to the working-class suburb of Collingwood and neighbouring suburb of Clifton Hill, including young professionals, students and academics in conjunction with local councils, community groups and individuals who were passionate about the environmental impacts created by freeways, raged a long and often bitter campaign against construction, the MMBW and the government.[385] The fight against the F19 (Eastern Freeway) is widely acknowledged as one of Melbourne's most important anti-freeway protests.[386] Although

[383] Davison and Yelland, 207.
[384] Ibid, 206-16.
[385] Ibid.
[386] Ibid, 207-16.

fought on the local level, Lay (2003) considers one of the main elements of the protestors' objection was regarding the freeway forming the initial section of a proposed system of 192 kilometres (119 miles) of freeways to criss-cross Melbourne.[387] Further arguments focussed on the destruction of parkland and flood plains for freeway construction, and fear of a precedent being created for future freeways to be constructed across parkland.[388]

The intent to construct the Eastern Freeway was announced by the MMBW in May 1969, when it was described as a $24-million eight-lane freeway and touted as the 'only one of its kind in Australia'.[389] The first stage of its route was located essentially along 8.6 kilometres (5.5 miles) along a section of the Yarra.[390] Although the freeway's route would require significant modification to sections of the Yarra's bed, riparian zones and valley, and cut through the northern end of Yarra Bend Park (see chapter seven, page 295), the MMBW only reported the demolition of 94 houses, 13 factories, one shop and a block of flats.[391] The Yarra and, later, one of its main tributaries (Koonung Creek) would be significantly affected by the freeway. This is evident from the passing of the *Eastern Freeway Lands Act 1971* to allow the MMBW to construct a metropolitan main highway, and railway (to date not constructed) and diversion of the Yarra, creating a new course for the river.[392] Comparison of the Yarra's course along the Eastern with its course in 1852 of the same reach of river reveals three significant bends or meanders were removed and 756 metres (2480 feet) of streambed was realigned. Figure 102 shows the original course of the Yarra with the realignments and freeway overlayed.

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[387] M. G. Lay, *Ways of the World: A History of the World's Roads and of the Vehicles That Used Them* (New Brunswick, N.J.: Rutgers University Press, 1992), 202.
[388] Davison and Yelland, 209.
[389] "Eight-Lane Road for Melbourne," *Canberra Times*, May 27, 1969, 7.
[390] "Eight-Lane Freeway Starts in 1970," *Herald*, June 26, 1969, 1.
[391] "Eight-Lane Road for Melbourne," 7.
[392] *Eastern Freeway Lands Act 1971*, (7 December 1971).

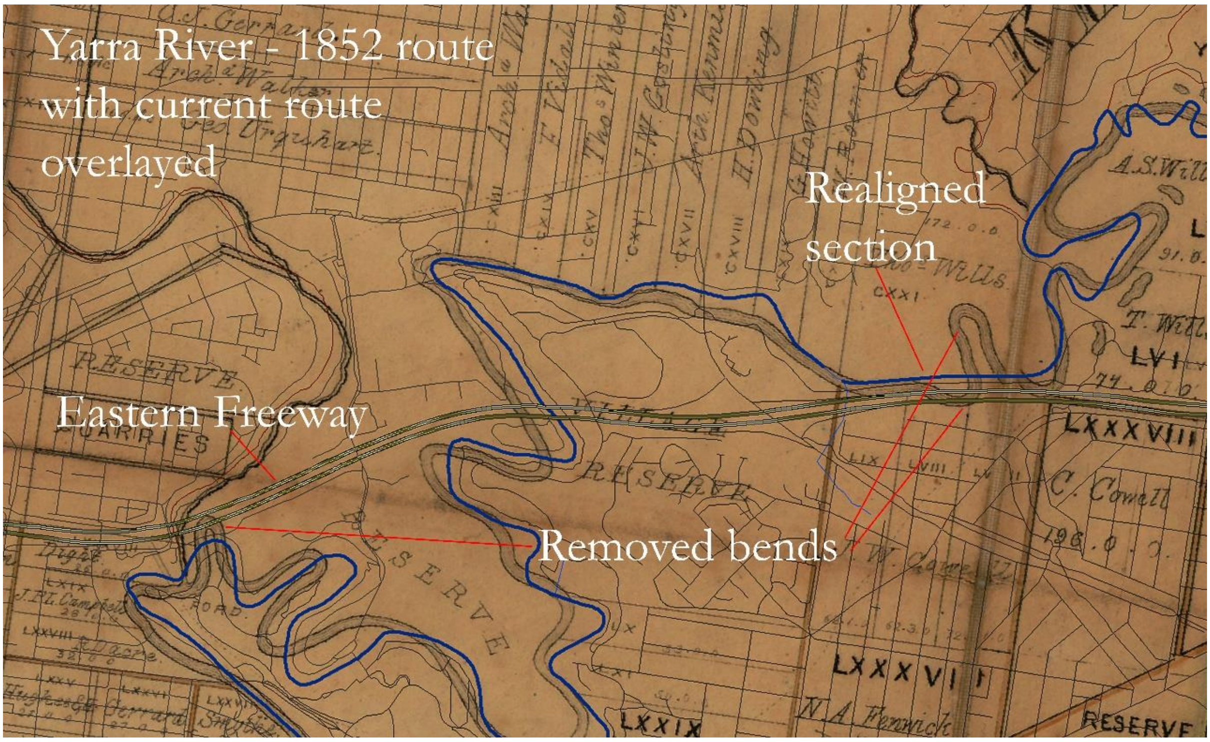

Figure 102. Modifications to the Yarra for the freeway.

The act also referenced *Cultural and Recreational Lands Act 1963* (page 213) to allow compulsory acquisition of land in the Yarra Bend Park for the freeway.[393] The western, city end of the freeway crosses the Merri Creek upstream from its confluence with the Yarra and Dights Falls on two large bridges spanning the creek's narrow valley. Earthworks for the freeway at this point involved filling a large bend on the Yarra, widening the river and confluence, levelling stream banks and diversion of the river approximately 175 metres (574 feet) to the south.[394] The filled river bend was previously the location of the Deep Rock Swimming basin, famous for its swimming carnivals held during the first half of the 20th century.[395] After crossing the Merri Creek, the freeway cuts deeply through the northern end of Yarra Bend Park dividing both the park and northern end of Yarra Boulevard. Park and boulevard were linked with a road bridge constructed across the cutting. Crossing the park involved the compulsory acquisition of 4 hectares (10 acres) of land and excavation of a deep

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[393] Ibid, 1.
[394] Ian D. Clark and Toby Heydon, *A Bend in the Yarra: A History of the Merri Creek Protectorate Station and Merri Creek Aboriginal School 1841-1851* (Canberra: Aboriginal Studies Press, 2004), 6.
[395] Lacey, 144.

cutting through basalt rock to level the road surface.[396] The MMBW began land clearing in the park five weeks before the *Eastern Freeway Lands Act 1971* was approved; an editorial in *The Age* (1971) asked whether the MMBW or state government was in charge.[397] After illegally clearing 300 yards (274metres) of tree-lined riverbank, workers ceased until the act was passed.[398] The (Labor) opposition argued a precedent had been set regarding the current government's enthusiasm for siting urban infrastructure within parkland.[399] Evidence of locating arterial roads along watercourses and through parkland is found in the MMBW's 1954 planning scheme with sections of the valleys of the Darebin, Merri, Back, and Woreek Creeks and Yarra River proposed road reserves for future highway expansion.[400] The *Melbourne Transportation Plan* (1969) revised many of the 1954 arterial road proposals, renaming them freeways and proposing they be arranged in a grid covering 307 miles (494 kilometres) along new alignments that would not follow existing roads.[401] Although much of the 1969 plan was scrapped due to public outrage and cost constraints, freeways along sections of the Yarra, Gardiners and Koonung Creeks were constructed.[402]

Following the illegal clearing in the park, the state government increased its control over the MMBW, requiring permission from the responsible Minister to spend borrowed funds.[403] In 1974, the state government transferred all metropolitan roads planning to the CRB.[404] The entire Eastern Freeway project was passed to the CRB for completion together with the planning and construction of further extensions.[405]

Once the Eastern Freeway crosses Yarra Bend Park it meets the southern edge of the Yarra's flood plains, where a further section of the river was straightened, a large bend to the north located in Willsmere Park was filled and the river diverted across the neck of the bend.[406] Willsmere Park, (formally Willsmere Estate dairy farm) before being isolated by the freeway was part of the suburb of Kew and was the site of one of only three remaining

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396 Dingle and Rasmussen, 318
397 "Consent by Bulldozer," *Age,* November 22, 1971, 9.
398 Staff Reporters, "Labour May Shun Bulldozer Probe," *Age,* November 24, 3.
399 Ibid.
400 Lay, 199.
401 Wilbur Smith and Associates., L. T. Frazer & Associates., and Metropolitan Transportation Committee (Melbourne Vic.), *Melbourne Transportation Study,* 3 vols., vol. 3 (Carlton, Vic.: Metropolitan Transportation Committee, 1969), 48.
402 Lay, 198.
403 J. Jost, "State to Tighten Control of M.M.B.W," *Age,* November 27, 1971, 3.
404 Lay, 54.
405 Ibid., 202.
406 Lacey, 144-45.

billabong and preserves for native birds within the metropolitan region.[407] In 1969, the Yarra Valley Conservation League expressed concern that construction of the freeway and resulting diversion of the Yarra would destroy the area.[408]

Following construction of the freeway the Willsmere billabong was retained, however in 2008 it was again under threat by construction of a large bridge structure, boardwalk and commuter cycle path. [409] In 2013, the local council which had previously approved the project decided against construction following public protest typifying it as environmentally damaging for the billabong and parkland.[410]

Lost Yarra tributaries, under Kew

This section of the Yarra also contains two main tributaries flowing from the south that pass under the freeway before flowing into the river.[411] Connors Creek was the largest and longest in the area, evident from a (since removed) large Red Gum tree (*Eucalyptus camaldulensis*) located on the stream bank.[412] The tree, known locally as the canoe tree displayed a large scar on its trunk where indigenous peoples had cut the bark for building a canoe, suggesting the creek was at least seasonally large enough for traveling along by canoe.[413] Image 103, circa 1940s, illustrates a heavily eroded Connors Creek and the Yarra with some of its billabongs sited within a semi-pastoral landscape of open paddocks and the Latrobe Golf Course fairways, all bordered by encroaching suburban development. This is in stark contrast to the original landscape of the area consisting of riverine floodplain, billabongs and river flat swampland.[414] The creek ceased to flow in summer, resulting in polluted pools of stagnate water, while heavy rainfall caused flooding and erosion of the stream banks.[415] It was deemed unsightly and hazardous by residents and the council. Consequently, it was progressively covered; its riparian zone and floodplains were reclaimed

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[407] "Diversion 'May Ruin Sanctuary'," *Sun News Pictorial*, May 27, 1969, 4.
[408] Ibid.
[409] Protectors of Public Lands Victoria Inc., "Community Battles to Save Historic Willsmere Billabong," Candobetter.net, accessed 16 August, 2016, https://candobetter.net/node/649.
[410] G Gliddon, "Willsmere Park Bike Path Tussle Hits a New Fork in the Road," *Leader Community Newspapers*, April 13, 2013, 1.
[411] Rogers, 11,13-14 ; Presland, *The Place for a Village: How Nature Has Shaped the City of Melbourne*, 76.
[412] Rogers, 13-14.
[413] Ibid, 14.
[414] Campbell Beardsell, *Vegetation Communities of the City of Banyule* (Ivanhoe: City of Banyule, 2000), 46.
[415] Rogers, 115-17.

for parkland and suburban development.[416] Entirely covered, Connors Creek is now referred to as Kew Main Drain.[417]

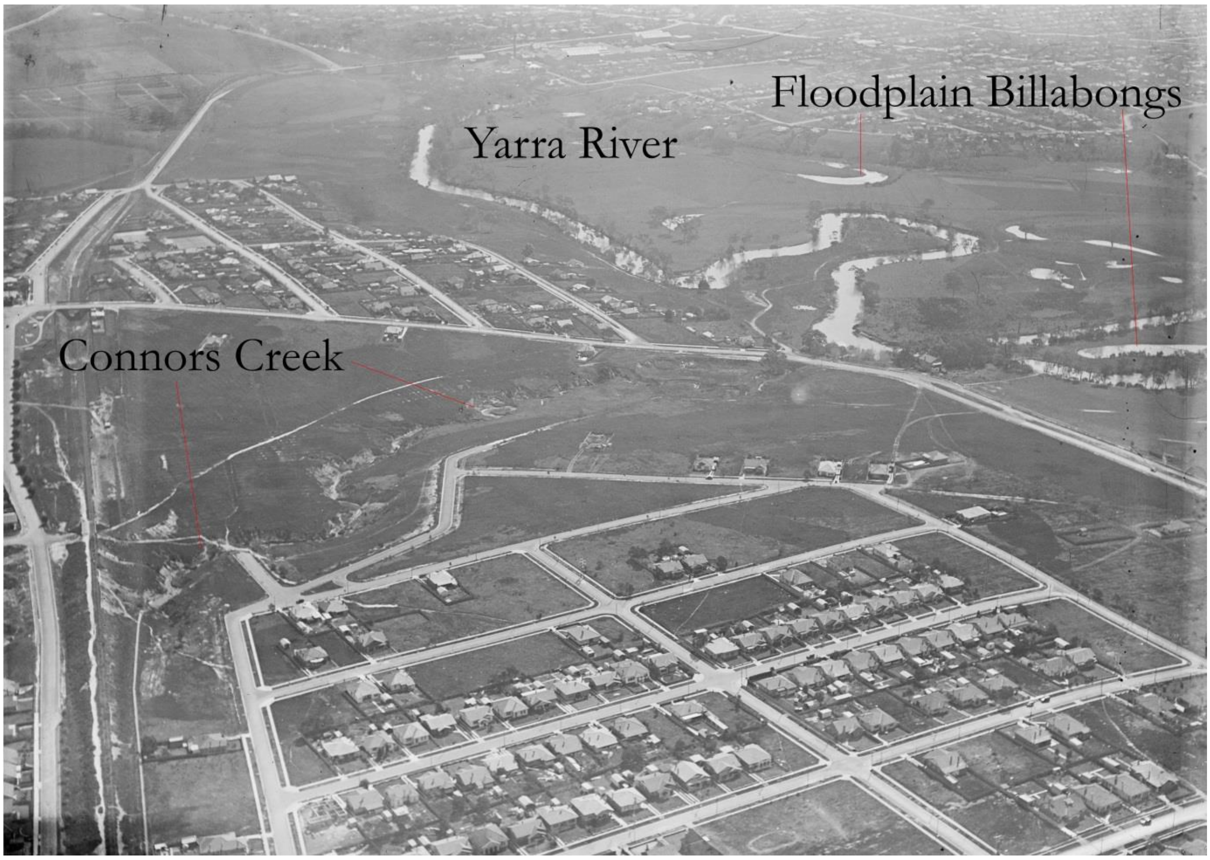

Figure 103. Aerial view showing Connors Creek, Yarra, floodplains and suburban development c.a.1940s. Source: Museums Victoria Collections https://collections.museumvictoria.com.au/items/2062621

Glass Creek is the other main tributary flowing through Kew, the majority historically confined to brick and concrete barrel drains throughout the 20th century. As the suburb developed, land subdivision encroached along the upper and middle reaches of the creek as illustrated by a section of the MMBW 1933 plan of Kew (figure 104). As house blocks along the creek's floodplain were surveyed with very little offset from the stream bank, Glass Creek was destined to become a flooding and erosion hazard, a site for rubbish dumping and detested by residents as an eyesore.[418] Once the MMBW's main drain legislation of 1926 was

[416] Ibid, 116-17.
[417] Teniswood, F. W. *Drainage Record Plan as of 30th June 1955.*
[418] "Metropolitan Board. Kew Council Criticism," *Age,* February 23, 1938, 9.

enacted, Glass Creek became a focus of a lengthy dispute between the Kew council and the MMBW.[419] [1]

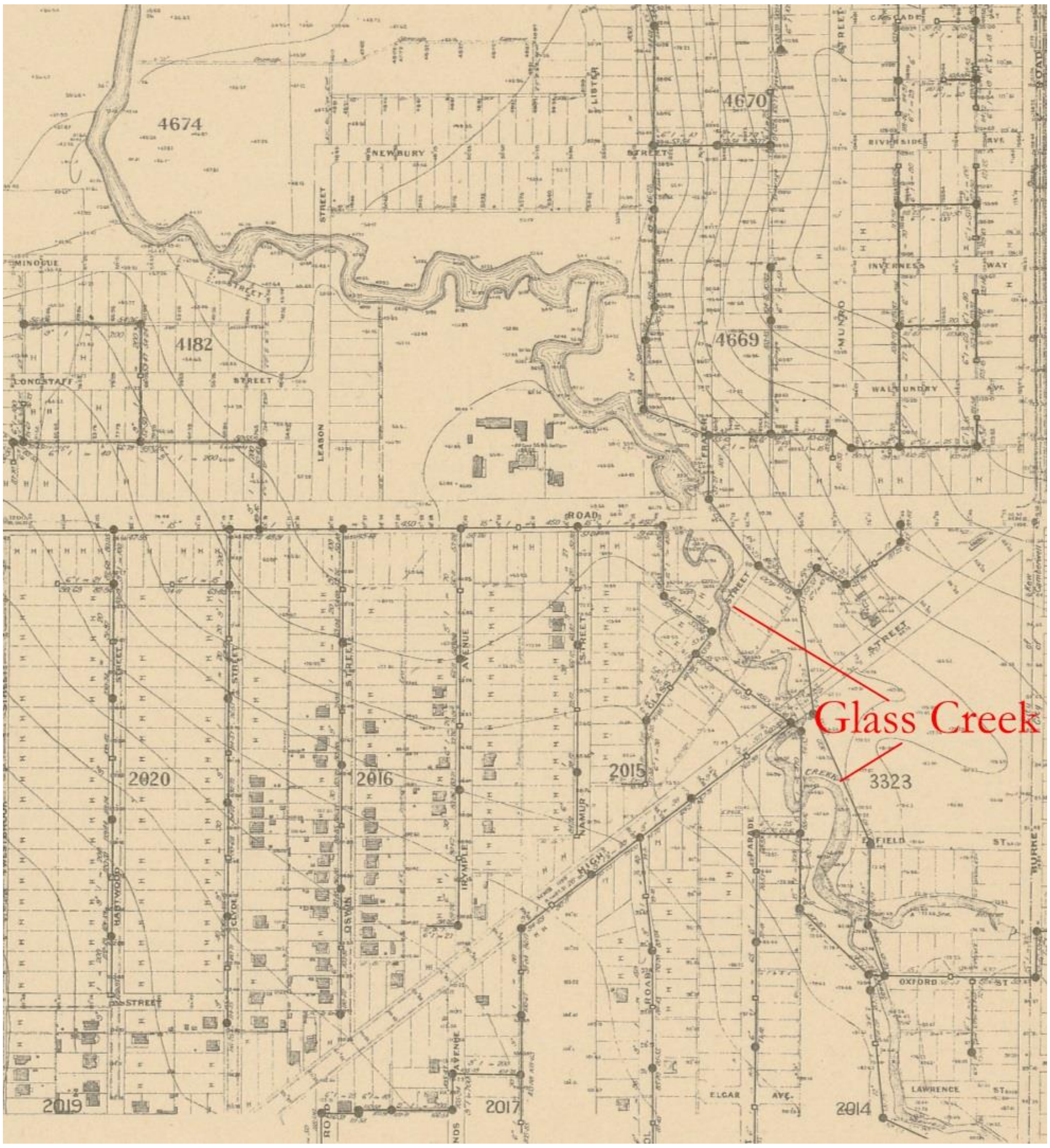

Figure 104. MMBW 1933 map of Kew showing land parcels along Glass Creek. Source: SLV http://handle.slv.vic.gov.au/10381/142498

Throughout the 1930s, the council repeatedly requested the MMBW declare the creek a main drain, as it passed through the municipalities of Kew and Camberwell, collecting

[419] Ibid.

drainage from both council areas.[420] In September 1938, the MMBW acceded to this wish.[421] The covering of the creek over the following decades is not well documented; however, during the 1950s sections remained uncovered. The *Argus* (1956) reported on the concerns of local parents regarding the proximity of Glass Creek to a local primary school in Balwyn fears that children may fall down the steeply eroded banks; it used the headline 'There's death in this creek, says Balwyn'.[422] Meanwhile downstream sections of the creek were being placed underground, and the Glass Street Kindergarten in Kew was constructed on land immediately adjacent the creek.[423] The land was now available, as covering the creek had removed the banks and riparian zones. The final reach, which flowed through parkland and Kew Golf Club, was left open. However, during construction of the Eastern Freeway and redesign of the Kew Golf Club's course, the MMBW planned to underground the lower reach entirely.[424] Due to cost constraints on the freeway construction, only a partial section of the creek was covered leaving the final 254 metres (833 feet) open to flow into the Yarra.[425] On the southern side of the freeway, 852 metres (2795 foot) of the creek also remains open flowing through the Hays Paddock parkland.[426] This section of the creek was the focus of attention from both Landscape Gardner/Architect Ellis Stones (see chapter seven, page 340) and residents during the 1970s. Figure 105 shows the portal on Glass Creek, where it flows into the open landscaped reach.

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420 "Glass's Creek, Kew. Metropolitan Board's Inaction," *Age,* April 12, 1935, 15.
421 State Government of Victoria, "Melbourne and Metropolitan Board of Works Acts," *Victorian Government Gazette* 193, (August 24, 1938): 2573.
422 "There's Death in This Creek, Says Balwyn," *Argus,* April 9, 1956, 3.
423 David Nichols and Philip Goad, "Early Learning: The Modern Kindergarten," in *Community: Building Modern Australia*, ed. Hannah Lewi and David Nichols (Sydney: UNSW Press, 2010), 73.
424 Joseph Johnson and Kew Golf Club History Committee, *Birdies and Billabongs: A History of the Kew Golf Club, 1894-1994* (East Kew, Vic.: The Club, 1994), 124.
425 Ibid.
426 Formium Landscape Architects, *Hays Paddock Plan* (Melbourne: Boroondara Council 2011), 3.

Figure 105. Glass Creek portal. Source: Author photo (2015).

The first section of the Eastern Freeway was opened in December 1977, following six years of construction including diverting and realigning the Yarra's stream bed and major earthworks and drainage that changed the hydrology of the river, its flood plains and the lower reach of Glass Creek.[427] Such was the level of public sentiment against the freeway's construction; the *Melbourne Times* (1977) described the opening with the announcement: 'The inner suburbs' Hiroshima Day has arrived'.[428] However little was reported on construction's effect on the Yarra and its floodplains. The ideas of the MTPC's 1929 plan regarding watercourses being cheap land unsuitable for building were still possibly deeply set in minds of the government, planners, and many amongst the public. Figure 106 shows the first stage of the Eastern Freeway cut through Yarra Bend Park.

[427] G Wettenhall, "Here Come the Cars," *The Melbourne Times,* December 7, 1977, 1.
[428] Ibid.

Figure 106. The first stage of the Eastern cut through Yarra Bend Park - the Yarra is where the trees are seen between the lanes. Source: Author photo (2016).

The Koonung Creek stage of the Eastern

The second stage of the Eastern Freeway, completed in 1982, veers away from the Yarra to follow the valley of Koonung Creek, a major tributary flowing from the east. The creek, 15 kilometres (9.3 miles) in length has several smaller tributaries, the main one, Bushy Creek flowing in from the northeast.[429] The Koonung’s catchment is 3000 hectares (741 acres), draining a section of Melbourne’s middle-eastern suburbs.[430] The route along the Koonung Valley was first identified in the MTPC’s 1929 plan with a proposal to add 876 acres (354.5 hectares) of floodplain along the creek to be connected with the Gardiners Creek and Yarra Valley park systems.[431] In 1976, before completion of the first section of the Eastern the CRB announced the freeway would be extended along the Koonung Creek valley on land previously reserved for an arterial in the 1954 Metropolitan Planning Scheme.[432] The Koonung flows in public open space varying between 70 to 250 metres wide (230 – 820 feet)

[429] Presland, *The Place for a Village: How Nature Has Shaped the City of Melbourne*, 76.
[430] G Boully, I Mullett, and R Watkinson, “The Environmental Rehabilitation of Koonung Creek as Part of Melbourne's Eastern Freeway Extension” (paper presented at the Combined 18th ARRB Transport Research Conference and Transit New Zealand Land Transport Symposium, 1996, Christchurch, New Zealand, Christchurch 1996), 406.
[431] Metropolitan Town Planning Commission, *Plan of General Development, Melbourne: Report of the Metropolitan Town Planning Commission*, 221.
[432] Victoria Country Roads Board, *Sixty-Third Annual Report for Year Ended 30th June 1976* (Melbourne: Country Roads Board, Victoria, 1976), 18.

along a course of 13 kilometres (8 miles), through the municipalities of Manningham, Boroondara and Whitehorse. The creek delineates part of Manningham's southern boundary with Boroondara and Whitehorse.[433]

Koonung Creek: A typical eastern suburbs creek

The history of the Koonung's transformation into an urban watercourse provides a valuable illustration of how Melbourne's urban development impacted on and spread across the eastern side of the Yarra's catchment. Although the Koonung's confluence with the Yarra is 18 miles (29.5 kilometres) upstream from the city, pastoral development of the valley commenced just two years after Melbourne's founding in 1835.[434] As Melbourne developed its urban fabric, the Koonung and its valley developed simultaneously firstly as a pastoral run evolving into a peri-urban area by the late 1880s consisting of small towns, farms, and orchards.[435]

The discovery and early pastoral development of the Koonung Creek valley by Europeans is credited to Arundel Wrighte, a Launceston Postmaster who accompanied John Batman to Port Phillip in May of 1835.[436] Wrighte returned to Melbourne in January 1837 with his family and 500 sheep, setting off to explore and then settle the Koonung Creek valley.[437] The first formal licences for use of crown land as pastoral runs by squatters were issued in 1838. Wrighte constructed cattle yards near the confluence of Bushy and Koonung Creeks.[438] Wrighte's run was soon under threat: in 1840 when timber felling was prohibited within five miles (eight kilometres) of Melbourne, timber fallers and sawyers moved into the region, as it was one mile outside the limit and contained stands of *Eucalyptus camaldulensis, Eucalyptus melliodora* and *Eucalyptus macrorhyncha*.[439] Additionally, settlers were forming tracks as direct routes from Melbourne to pastoral land further upstream along the Yarra.[440] These encouraged further settlement in the area, leading to many disputes between Wrighte

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[433] Manningham City Council, *Koonung Creek Linear Park Management Plan* (Doncaster: City of Manningham 2011), 3.
[434] Andrew Lemon., *Box Hill* (Melbourne: Box Hill City Council in conjunction with Lothian Publishing, 1978), 2-3.
[435] Ibid, 71-84.
[436] Ibid, 1-2.
[437] Ibid, 3.
[438] Ibid.
[439] Lacey, 86-87.
[440] Lemon, 6.

and new settlers.[441] However, in 1841 under the regulations of Special Surveys pertaining to land sales, (selling land at a fixed price per acre as opposed to an auction) Wrighte's run was sold off, the Koonung Creek used as the boundary between of two separate Special Surveys and named the water-frontage for the southern boundary.[442] The valley was further developed as agricultural land, predominately occupied by pastoralists with smaller settlements and towns being established.[443] As the first towns, such as Box Hill (now a suburb) were developing along the creek valley gold was discovered in 1856 at the Koonung's confluence with the Yarra (now the site of a golf course) in a reef with a yield of 20 ounces to the ton.[444] The reef varied between two to thirty feet deep (0.6 to 9 metres) and was deemed viable for mining. In addition, the alluvial nature of the Koonung's floodplains was also believed to contain viable amounts of gold that could be extracted using alluvial or placer mining techniques.[445] The miners envisaged the permanently flowing Koonung as an ideal location for placer mining as construction of a dam across the creek would secure a constant source of water, vital for this type of mining operation.[446] This assessment of the Koonung's flows was at odds with that of surveyor Robert Hoddle who in April 1843 reported the creek consisted of a chain of water holes that were often dry and rarely provided a fit source of water.[447] Little else appears to have been written about the gold mine and it is unclear whether the alluvial mining was ever commenced.

Throughout the 1860s and 1870s, farming continued, and orchards developed in the 1870s.[448] As the land was cleared, the creek was further degraded. The *Australasian* (1872) reporting on a local Hunt or Running of the Hounds (involving the use of dingo, a wild dog found only in Australia, being chased in the tradition of the English Hunt), describes the chase crossing the Koonung Creek. The creek had carved an eroded gully through the floodplain with crumbling banks causing the hounds and horses to run hazardously down the sloping bank, jump the creek in two stages via an island with channels flowing each side and climb the opposite bank.[449] The hunt was still occurring in 1899 when the *Argus* described

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[441] Ibid, 6-7.
[442] Ibid, 7-8; Gordon Scurfield and Judith Scurfield, "Creating a Landlord's Landscape: Special Surveys in Victoria," *The Globe*, no. 44 (1996): 28.
[443] Lemon, 8-27.
[444] Ibid, 14-15; "Gold near Melbourne. Mining in the Fifties.," *Age*, August 31, 1896, 6.
[445] "The Boroondara and Bullleen Gold-Mines," *Ovens and Murray Advertiser*, September 8, 1858, 2.
[446] Ibid.
[447] Scurfield, 29.
[448] Lemon, .54-55.
[449] "The Melbourne Hounds, "*Australasian*, July 6, 1872, 11.

the Koonung Creek's banks and surrounds as being; 'of the most picturesque, bright with gorse in full bloom.'[450] This description of the creek is in contrast to Hall (1909). He used the section of the Koonung near its confluence with the Yarra as an example to aid in explaining why other creek stream banks and beds around Melbourne were eroding into narrow deep gullies and in the process destroying bridges built during the 1880s-suburban land boom.[451] Hall described the Koonung in its natural state, surrounded by a thick growth of tea-tree that slowed flood flows and protected the soil from erosion, unlike other creeks where all vegetation had been cleared. Hall also opined that where thick tea-tree scrub was removed, and paved drains constructed to discharge into creeks, flood flows followed heavy rain showers eroding the soil of the cleared banks and cutting channels through wetlands.[452] Hall's work shows an early-published attempt in Melbourne to explain how suburban development was destroying the region's creeks and tributaries.

In 1908, the *Age* reported the Koonung's water quality was endangering public health as the creek provided the water supply for dairy herds scattered along the valley. As flows dropped in the creek, the resulting waterholes where the cattle drank became contaminated with polluted runoff and refuse from the local abattoir.[453] Further pollution entering the Koonung flowed from a small-unnamed tributary that drained waste from the Doncaster gas works. The *Reporter* (1908) described the unnamed creek's water entering the Koonung as 'black and putrid'.[454] Although still a drain, the Koonung featured in the MTPC's proposal for a long chain of parks released in 1927, prior to the 1929 plan. The proposal consisted of the government buying land along the Merri, Gardiners and Koonung Creeks and the Yarra for parkland connecting the northern suburbs with the far eastern suburbs.[455] The scheme was not adopted and by the 1930s, the polluted state of the creek remained the focus of debate. In August 1930, water samples taken from the Koonung indicated an offensive level of pollution being discharged from the Box Hill gas works, (figure 107) with the samples taken by the health inspector to be analysed to decide an appropriate treatment.[456]

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[450] "Hunting. Melbourne Hounds," *Argus,* August 28, 1899, 7.
[451] Hall, 44.
[452] Ibid, 46.
[453] "Abattoirs at Box Hill," *Age,* July 30, 1908, 7.
[454] "Nunawading Abattoirs," *Reporter (Box Hill),* August 21, 1908, 5.
[455] "Melbourne Remodelled. Proposals of New Measure. Long Chain of Parks," *Telegraph* August 11, 1927, 2.
[456] "Riverena News," *Age,* August 5, 1930, 7.

Figure 107. Colonia Gas Association Box Hill, gas works, 1945. Source: SLV H84.219/278

No further report of test results or action regarding the pollution during the period was published. However, the type of pollution discharged from gas works into Melbourne’s watercourses was highlighted in a report concerning effluent discharged into the Yarra by the Melbourne Gas Works. These works, 1.3 kilometres (0.82 miles) downstream from the Queen Street Bridge, discharged thick black tar-like substances and a thick reddish-brown liquid, in a plume across the surface of the Yarra.[457] Large amounts of ammonia additionally destroyed stocks of Black Bream.[458] The only other aquatic species observed were eels which, when captured, smelt strongly of ammonia.[459] Gas was manufactured in Melbourne

[457] “River Pollution. Outfall from Gas Works,” 21.
[458] Ibid.
[459] Ibid.

from 1856 to the early 1970s when natural gas became available commercially.[460] The establishment of gas manufacturing plants within Australian cities has left a legacy of contaminated sites, groundwater aquifers, and surface watercourses, polluted by waste from the manufacturing process.[461] Globally these sites have become major environmental hazards with contaminated soils and polluted plumes from runoff and ground contamination entering watercourses. The scale of the problem is given context by Thomas and Lester (1993) who cite between 75,000 and 100,000 former gas works sites in the United Kingdom alone.[462]

Following the 1923 drainage act and the 1926 amendment the MMBW took responsibility for managing the Koonung consigning the lower reach with the drain number 4730 and the upper section number 4750.[463] In 1979, the Koonung flowed within an existing floodway designed to accommodate a flood with the return period of approximately 100 years.[464] The boundary of the floodway was lined with suburban roads and private property boundaries of house blocks, with the creek flowing along a heavily eroded channel, as evident from the aerial image (figure 108) taken in 1979.

Figure 108. Koonung Creek in 1979. The end of the freeway is seen in the lower left corner. Source: MMBW (1979).

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[460] Australian Academy of Technological Sciences and Engineering, *Technology in Australia, 1788-1988: A Condensed History of Australian Technological Innovation and Adaptation During the First Two Hundred Years* (Melbourne: Australian Academy of Technological Sciences and Engineering, 1988), 816,20.
[461] A. O. Thomas and J. N. Lester, "The Reclamation of Disused Gasworks Sites: New Solutions to an Old Problem," *Science of The Total Environment* 152, no. 3 (1994): 239-42; Australian Academy of Technological Sciences and Engineering, 817; James Baylis and Douglas Allenby, "Gasworks Remediation in the Uk–a Remediation Contractor's Perspective" (paper presented at the 10th International Association for Engineering Geology and the Environment Congress, "Engineering geology for tomorrow cities," Nottingham, UK, 2006), 1-2, 13.
[462] Thomas and Lester, 239.
[463] Teniswood, F. W. *Melbourne and Suburbs Drainage Record Plan as at 30th June 1955*.
[464] Melbourne Metropolitan Board of Works., *Koonung Creek Realignment, Bulleen Road to Doncaster Road, Cities of Camberwell, and Doncaster and Templestowe: Concept Report*, (Melbourne: Melbourne and Metropolitan Board of Works, 1979), 2.

This reach of the creek was also located along the section of valley that the proposed second stage of the Eastern Freeway would follow, its western end shown in the lower left corner of the image. The extension proposal was released in 1976 and following three years of discussions involving the CRB, MMBW, state government and councils bordering the creek, was decided the freeway route would follow the creek bed.[465] The route would eliminate half of the length of the Koonung's meandering streambed along the reach shown in figure 110.[466] Therefore, relocation of the creek bed was required away from the proposed roadbed and additional land that may be necessary for a railway proposed for the median between the lanes.[467]

In 1979, the MMBW released a concept report illustrating the engineering options available for realigning and designing a new course for the creek.[468] Although the main objectives of the report were to define the design criteria for realigning the section of creek and discuss its feasibility, the report also provided a highly detailed analysis of a significantly degraded urban watercourse typical of many flowing through the eastern middle-class suburbs of Melbourne.[469] Between 1949 and 1979, the Koonung Creek catchment developed from a primarily rural catchment to being fully suburbanised.[470] The entire length of the creek featured in the 1929 plan as proposed parkland and in the 1954-planning scheme zoned for a road reserve.[471] By 1979, the urbanisation of the catchment had dramatically altered the Koonung's flow regime resulting in increased daily and flood flows. From 1969 as floods intermittently inundated adjacent sections of neighbouring suburbs the City of Doncaster and Templestowe requested the MMBW to clear all existing vegetation from the creek to aid with flood mitigation and swift removal of floodwaters.[472] Figure 109 shows the creek before vegetation was cleared from its banks, after clearing, and with the freeway over the former stream bed.

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[465] Ibid.
[466] Ibid.
[467] "Eight-Lane Road for Melbourne, " 7.
[468] Melbourne Metropolitan Board of Works, *Koonung Creek Realignment, Bulleen Road to Doncaster Road, Cities of Camberwell, and Doncaster and Templestowe: Concept Report*, (Melbourne: Melbourne Metropolitan Board of Works, 1979).
[469] Ibid, 2.
[470] Ibid, 5.
[471] Metropolitan Town Planning Commission, *Plan of General Development, Melbourne: Report of the Metropolitan Town Planning Commission*, 229-map 9; Melbourne Metropolitan Board of Works, *Melbourne Metropolitan Planning Scheme 1954*, 97,99-100.
[472] Melbourne Metropolitan Board of Works, *Koonung Creek Realignment*, 5.

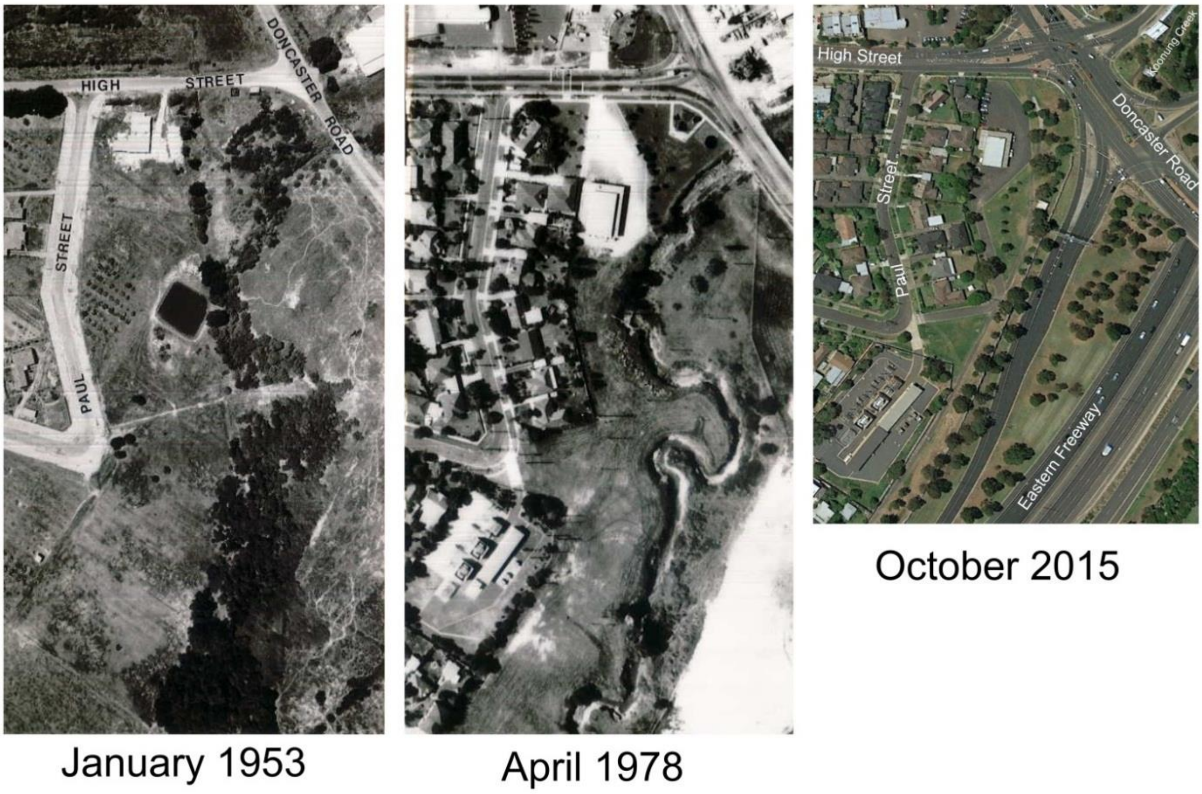

Figure 109. Streambank vegetation before and after clearing. The freeway that displaced the creek is seen in the 2015 image. Source: MMBW 1979) and Google Earth (2015).

In attempting to control the spread of flood flows and increase in-stream velocity to reduce flood-peak heights, extensive river improvement works on both urban and rural watercourses were carried out across south eastern Australia from at least 1886 until 1995.[473] The improvement works, keenly supported by government policy and funding, encouraged the removal of living riparian vegetation to a specified distance from the banks and clearance of large woody debris (snagging, also referred to as desnagging, see page vii) from stream beds and banks.[474] Clearance works were often done in conjunction with the straightening of stream channels to improve stream-flow velocities during flood flows. [475] For example, MMBW straightening works for Melville Creek shown in figure 110.

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[473] T. C. T. Hubble, B. B. Docker, and I. D. Rutherfurd, "The Role of Riparian Trees in Maintaining Riverbank Stability: A Review of Australian Experience and Practice," *Ecological Engineering* 36, no. 3 (2010): 292.
[474] Erskine and Webb, 233.
[475] Andrew P. Brooks et al., "Confronting Hysteresis: Wood Based River Rehabilitation in Highly Altered Riverine Landscapes of South-Eastern Australia," *Geomorphology* 79, no. 3–4 (2006): 396; Hubble, Docker, and Rutherfurd, 292.

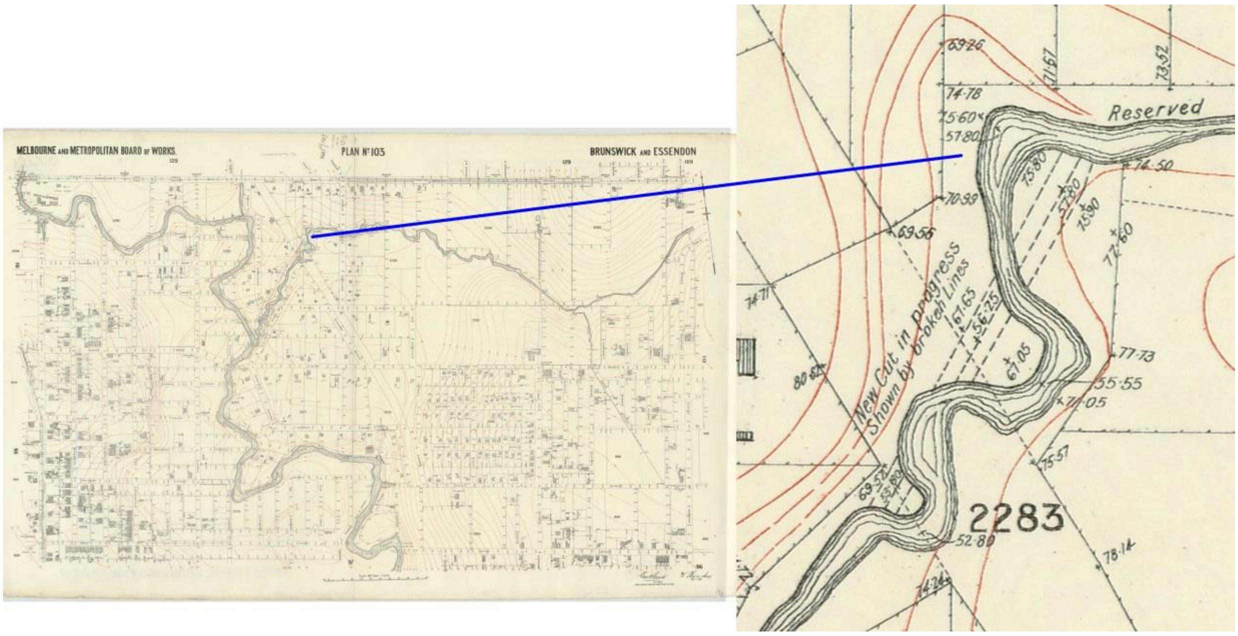

Figure 110. MMBW 1907 plan showing proposed straightening of a section of Melville Creek in Brunswick. Source: SLV http://handle.slv.vic.gov.au/10381/143010

The overall aims of stream clearing was the protection of urban and rural infrastructure (including bridges, roads, service pipelines, private property and agricultural land) and minimising disruption caused by flooding to the daily operation of urban and rural life.[476] The removal of in-stream debris and riparian vegetation combined with increased surface water runoff resulting from land clearing and the spread of impervious surfaces in urban areas caused dramatic widening and incision of stream channels.[477] The enlargement of channels also leads to damage or loss of rural and urban infrastructures and land. The erosion of stream banks and beds also reduced water quality by increasing sediment loads in flows and the loss of vegetation destroyed in-stream habitats of riverine fauna, leading to an overall decline in watercourse ecosystems.[478] Such clearance practices also became common methods for flood control of smaller tributaries.[479] However, as with larger watercourses, the resulting increased flow velocities combined with larger runoff volumes flowing from cleared land and impervious surfaces lead to increased erosion and transfer of sediment.[480]

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[476] Ibid, 292.
[477] Ibid.
[478] Ibid.
[479] F. Shields, Jr. and N. Nunnally, “Environmental Aspects of Clearing and Snagging,” *Journal of Environmental Engineering* 110, no. 1 (1948): 152.
[480] Brooks et al., 396; Melbourne Metropolitan Board of Works, *Koonung Creek Realignment*, 40.

Snagging and vegetation clearance had long been standard management practice for the MMBW.[481] The *Argus* (1926) stated:

> The work already carried out had been of great value in facilitating the escape of flood waters…It was intended to increase…the carrying capacity of the river…the work provided for was designed primarily to facilitate the escape of flood waters. In certain cases, however, work to beautify the stream…would consist mainly of sloping broken and over hanging banks and planting willow trees along the bed of the stream.[482]

It is unclear when the planting willow trees (*Salix Spp.*) along cleared stream banks for erosion control and soil stabilisation was first adopted in Melbourne. A report from 1881 mentioning 'willow trees… planted too close to the water's edge' suggests willows were planted since the 1870s.[483] Indigenous riparian zone vegetation cleared along designed alignment widths was commonly replanted with exotic trees, particularly willows.[484] Figure 111 shows willows growing along the Merri Creek in 2015, with figure 112 showing willows that had been previously planted in the bank of the Yarra River.

Figure 111. Willows along the Merri Creek. Source: Author photo (2015).

[481] Dingle, 6.
[482] "Clearing the Yarra. Prevention of Floods," *Argus*, July 31, 1926, 27.
[483] "The State of the Yarra," *Leader*, May 14, 1881, 5.
[484] Erskine and Webb, 233.

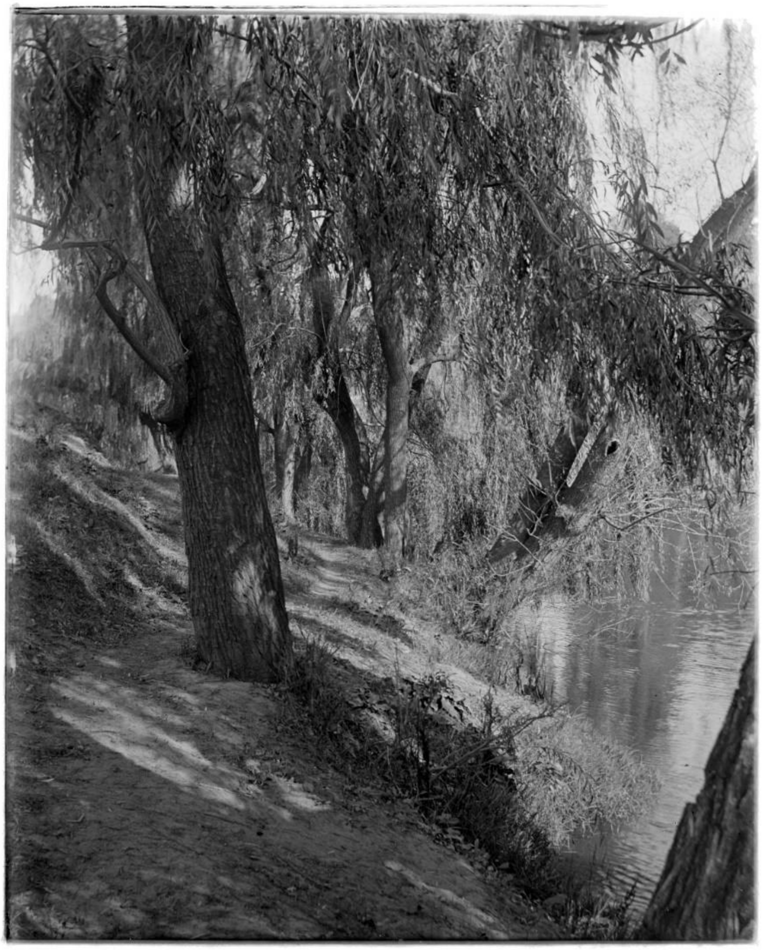

Figure 112. Willows in the bank of the Yarra, 1910. Source: SLV H2012.161/6

The planting of willows created additional problems and further ecological and geomorphological degradation to watercourses. Many species of willow rapidly spread and colonised cleared banks and streambeds leading to obstruction of watercourses and diversion of flows outside the main bank causing added erosion and sedimentation.[485] Due to the aggressively invasive willows, indigenous vegetation became displaced and the monoculture of willows reduced habitat for native fauna. Willows are deciduous with leaf-drop occurring all at once, effectively carpeting the stream surface, which may affect oxygen levels in the water leading to fish and other in-stream fauna death.[486] The trees also reduce areas of open water by trapping sediment, reducing water depth and creating new areas to colonise leading

[485] Molonglo Catchment Group, "Willows Management," accessed June 23, 2016, http://www.molonglocatchment.com.au/Projects/LBGWMP_WillowsManagement.htm.
[486] Ibid.

to further reductions in stream flows that frequently result in stagnation of water and occasional formation of toxic algal blooms.[487] In Australia twenty-one species of willow are classified as Weeds of National Significance, based upon invasiveness, potential to spread, environmental, social and economic impacts and the capacity to be successfully managed.[488] The willow is an important weed in Australia and its seed is spread by flowing water and wind, while the ability of stem fragments to propagate vegetatively (plant fragments taking root, creating a new tree) allows spread by disturbance or damage caused by weather, machinery, animals, and humans.[489] Figure 113 shows willows planted for erosion control along a section of the Yarra in 1910.

Figure 113. Willow trees along the Yarra at Abbotsford in 1910. Source: SLV H84.461/354

[487] Ibid.
[488] Australian Government Department of the Environment and Energy, "Weeds of National Significance," accessed September 8, 2016, http://www.environment.gov.au/biodiversity/invasive/weeds/weeds/lists/wons.html.
[489] Kate Blood and Cooperative Research Centre for Weed Management Systems, *Environmental Weeds: A Field Guide for Se Australia* (Mt. Waverley, Vic.: C.H. Jerram Science Publishers, 2001), 34-35.

In March 1933, the MMBW's flood management practice regarding clearing along the Yarra's banks was questioned by the City of Kew which considered the river's natural beauty under threat.[490] The MMBW's response was that stream clearance was the best practice for flood control and made the river safe by removing timber that endangered lives, while also conceding clearance work would inevitably destroy natural beauty and cause erosion.[491] The council believed the cleared banks should be the focus of a reafforestation program.[492] By August 1933, criticism of the MMBW's clearing along the Yarra had gained momentum. The *Argus* reported over a period of six days a section of riverbank 25 feet (7.6 metres) in length by 6 feet (1.82 metres) wide collapsed following removal of willow trees.[493] Since removal of the trees, the river had encroached 20 feet (6 metres) from the original stream bank.[494] The resulting problems of vegetation clearance and use of willows were realised decades before cessation of this practice. In 1936, the *Age* stated: 'an effort was made to prevent river erosion by planting willows along the banks of many streams…however, precisely the opposite effect resulted. The trees spread. They were growing in the middle of the streams…the position was made worse by logs and general debris choking up the watercourse'.[495] In response, the Victorian state government adopted a river clearance program to alleviate serious flooding including removal of the previously planted willow trees.[496] However, the practice continued. A period of major river engineering works was funded by governments for forty years in the second half of the 20th century.[497] From the 1990s, there was a shift away from government-funded river engineering projects towards community-based watercourse stewardship programs with ecological focus and reduced funding for major river engineering works.[498]

Regardless of the earlier evidence from the 1930s and river engineering projects from the 1950s onwards, vegetation clearing along the Koonung Creek began in 1969. The vegetation removed included a mix of native and introduced grass species, shrubs, gum trees, (native eucalypts), and dense thickets of introduced blackberries (*Rubus fruticosus L.* agg).

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[490] "Clearing the Yarra. Critisism of the Metropolitan Board," *Age,* March 2, 1933, 13.
[491] Ibid.
[492] Ibid.
[493] "Erosion at Ivanhoe,"*Argus,* August 8, 1933, 7.
[494] Ibid.
[495] "Flood Prevention," *Age,* May 1, 1936, 12.
[496] Ibid.
[497] Brooks et al., 396.
[498] Ibid, 397.

Clearing immediately created erosion of the banks and streambed with the eroded material accumulating downstream and leading to the blocking of culverts underneath roads, and eventually entering the Yarra.[499] 'Such erosion might… have been anticipated' the MMBW's 1979 report noted.[500] Erosion along the Koonung was worsened by the composition of the underlying soils and geology.[501] Typical of many of the creeks across Melbourne's eastern suburbs, the soils of the Koonung Valley developed over underlying Silurian rock are extremely prone to mechanical erosion with the clay elements commonly being highly susceptible to dispersion by water.[502] The susceptibility of Silurian-based clay is illustrated in figure 114 along a section of the Koonung.

Figure 114. Erosion along Koonung Creek. Source: MMBW (1979).

The ability of the clay soils to disperse or deflocculate in water is dependent upon a variety of factors including amount of sodium in the soil and the type and concentration of cations (positively charged ions) in the water contacting the soil. Sodium rich soils are

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[499] Melbourne Metropolitan Board of Works, *Koonung Creek Realignment, Bulleen Road to Doncaster Road, Cities of Camberwell, and Doncaster and Templestowe: Concept Report*, 39-45.
[500] Ibid, 40.
[501] Ibid, 45.
[502] Ibid.

generally more dispersible than other soils.[503] Other factors including temperature, organic matter and ion concentrations of the external solution may also affect the level of dispersibility.[504] Another contributing factor to increased erosion was the comparatively steep grade of the creek bed contributed to a range of erosive processes.[505] These included: down-cutting or lowering of the creek bed due to increased sediment in the flows causing corrosion and abrasion along the bed and banks. Lateral erosion of the outside bends and channel, undercutting the banks leading to bank undermining and collapse resulting in channel widening. Creation of benching where higher flows cut into the bank forming a bench; scouring and formation of potholes where eddies from high flows scour away material and around stones and rocks that when displaced leave a pothole; bank slumping that occurs during dry periods. As soils dry out they crack and collapse enlarging the channel width, when saturated the weight of the wet soil may also collapse.[506] Tunnel erosion is caused by water percolating through a layer of dispersible soil to create tunnel structures.[507] The MMBW installed various engineered solutions along the creek throughout the 1970s including; use of rock gabions (rock filled steel mesh baskets); drop structures (small concrete weirs); concrete lining of the stream bank across underlying service pipelines and where street drains discharged into creek and lining stream banks with rock.[508] The MMBW however, did not, construct a concrete-lined trapezoid channel (page 77-8), standard engineering practice at the time for erosion control. As illustrated by figure 115 the control works were unsuccessful with erosion occurring in and around the structures causing undermining and damage.

[503] M. Qadir and S. Schubert, "Degradation Processes and Nutrient Constraints in Sodic Soils," *Land Degradation & Development* 13, no. 4 (2002): 275.
[504] Melbourne Metropolitan Board of Works, *Koonung Creek Realignment*, 45.
[505] Ibid, 45,49.
[506] Ibid, 52.
[507] Bates, Jackson, and Gary, 477.
[508] Melbourne Metropolitan Board of Works, *Koonung Creek Realignment*, 54,57,62.

Figure 115. Damage to erosion control structures along the Koonung. Source: MMBW (1979).

By 1980, freeway construction was well advanced. The CRB’s *Annual Report* (1982) reported that as the design for the roadbed crossed the creek in various places and its embankment (designed to locate the freeway above flood levels) significantly reduced the area of available floodplain, the creek should be relocated. [509] In addition to being moved, the creek channel was redesigned to manage flood-flows of up to 120 cubic metres per second (4238 cubic foot per second) or flows for the 100-year flood.[510] Echoing the earlier report by the MMBW (1979) the CRB reported the Koonung’s banks had been steeply eroded to depths of five to six metres (16 to 19.6 foot) a result of the catchment becoming increasingly urbanised, with poor water quality due to polluted urban runoff.[511] Service lines such as

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[509] Victoria Country Roads Board, *Report of the Country Roads Board for the Year Ended 30 June 1980* (Melbourne: Country Roads Board, Victoria, 1980), 84.
[510] Ibid.
[511] Ibid, 84-85.

phone, water, and sewerage mains were also threatened.[512] A design task force developed four alternative schemes that included; a lined channel for normal flows with a grassed channel for flood flows; an underground pipe for normal flows with grassed channel for flood flows; a lined channel large enough for all flows; an underground conduit for all flows.[513] The CRB's *Annual Report* (1980) records that these four schemes complete with conceptual landscape plans were exhibited for public comment in conjunction with a questionnaire. The report further states 'Of 260 respondents…97% favoured the underground scheme.'[514] Although no further information has been found regarding why the public favoured undergrounding the creek, it appears reasonable to assume, due to the Koonung's condition, the public would view it as a blight. Image 109 on page 303 illustrates before and after realignment and covering the section of the Koonung now adjacent to the Eastern Freeway. Figure 116 shows the severity of erosion and general condition of the creek prior to undergrounding in 1979.

Figure 116. The Koonung Creek in 1979 prior to covering. Source: MMBW (1979).

By 1979, the Koonung was in a similar condition transporting polluted water, its banks heavily eroded and lined with weedy vegetation including blackberry - *Rubus fruticosus L.* agg. – a declared noxious weed in Victoria.[515]

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[512] Ibid, 86.
[513] Ibid, 85.
[514] Ibid.
[515] Agriculture Victoria, "Blackberry," accessed March 23, 2017, http://agriculture.vic.gov.au/agriculture/pests-diseases-and-weeds/weeds/a-z-of-weeds/blackberry.

Once the decision to shift the creek was decided, the final design decision was based on engineering-design objectives. These included: control of normal, flood and major flood flows; control of stream bank and bed erosion and sediment movements along the creek. It was also seen as important to control the effects of pollution entering the water in regard to prevention of public health hazards and the aesthetic effects resulting from polluted flows; minimise intrusion on usage of surrounding public open space; protect the public from daily and flood flows; overall, improve the environment of the area surrounding drainage systems.[516] The final proposal involved placing the creek in an underground drain to carry all flows including the 1 in 100 flood. The drain would be placed clear of the roadway underneath existing parkland.[517] In summarising this design, the MMBW provided a clear insight into the public and local council perceptions of creeks flowing through a range of eastern suburbs of Melbourne at that time. The MMBW stated:

> It should be remembered that over the past 40 years the public and the Council have demanded that all the major drainage systems within the City of Camberwell be undergrounded because of the problems which have arisen from the uncontrolled erosion of creeks. Where the creeks have been undergrounded, linear parks and floodway's have been established which are environmentally satisfactory and aesthetically pleasing… parks along valleys have been developed either for passive recreational purposes or sporting facilities and are a major asset to the community.[518]

Construction of this second section of the Eastern resulted in 2.5 kilometres (1.6) miles of the lower reach of the Koonung being diverted to the south of its original course and placed in an underground drain.[519] Figure 117 shows the realigned course of the Koonung into a concrete arch underground drain.

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[516] Melbourne Metropolitan Board of Works, *Koonung Creek Realignment, Bulleen Road to Doncaster Road, Cities of Camberwell, and Doncaster and Templestowe: Concept Report*, 12.
[517] Ibid, 36.
[518] Ibid.
[519] Victoria Country Roads Board, *Report of the Country Roads Board for the Year Ended 30 June 1982* (Melbourne: Country Roads Board, Victoria, 1982), 70.

Figure 117. Undergrounding the lower section of the Koonung. Source: PROV, VPRS 8609/P0021, Unit 477

As demonstrated by the discussion regarding development of the first sections of the Eastern, little attention was paid to the freeway's effects on the Yarra, the Koonung, adjacent floodplains, existing parklands and neighbouring suburbs. The only environmental concerns demonstrated by the MMBW, CRB and local councils was during the planning for second stage of the freeway, which focussed primarily on flooding, erosion and the effects of pollution entering the creek on public health and landscape aesthetics.[520] However, by 1993 when the state government approved the third extension, environmental concern and awareness of impacts upon the Koonung and its valley within the public and government organisations had become paramount.[521] VicRoads willingly cooperated with local community groups and those opposing the project to allow opportunity for providing input to design and construction.[522] Community input included modifications to the design and the salvaging of local indigenous plant species prior to clearance of the site.[523] This shift towards community engagement and liaison coupled with an increased awareness of environmental impacts upon watercourse valleys was the complete opposite to how freeways were previously developed. This new planning paradigm had developed from a background of earlier public protest towards proposed freeways, which commenced in late 1972 following the earlier release of the 1969 Melbourne Transportation Study.[524] Since 1977 when the first

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[520] Melbourne Metropolitan Board of Works, *Koonung Creek Realignment, Bulleen Road to Doncaster Road, Cities of Camberwell, and Doncaster and Templestowe: Concept Report*, 12.
[521] Boully, Mullett, and Watkinson, 403.
[522] Ibid, 406.
[523] Ibid.
[524] Geoff Rundell, "Melbourne Anti-Freeway Protests," *Urban Policy and Research* 3, no. 4 (1985): 13.

stage of the Eastern was completed, albeit to a background of ongoing public protest, other major infrastructure projects to be located along watercourse valleys had become the focus of prolonged public protests. Concern for Melbourne's watercourse valleys had developed along with the public's general rise in environment awareness, forcing politicians and freeway planners to take notice.[525] Two of the more prominent protests from the 1980s include that surrounding the use of sections of the Merri Creek valley and Yarra valley for construction of the Brunswick to Richmond power-line that raged across throughout the 1970s-80s (page 203) and protest over construction of the third stage of the South-Eastern Freeway along Gardiners Creek (page 196).[526] By the time, the third stage of the Eastern was approved environmental impact statements and public consultation had become important aspects of the planning process. These were in response to criticisms of the earlier stages of the Eastern and its impacts on the Yarra and Koonung valleys.[527]

Stage three of the Eastern was opened in 1997.[528] The project was managed by VicRoads (previously CRB), involved Melbourne Water (previously MMBW) consulting on the Koonung Creek, while the Environmental Protection Authority (EPA Victoria) monitored water quality and pollution control.[529] The local councils bordering the freeway, Cities of Boroondara, Manningham and Whitehorse, were consulted on issues including development of a landscape plan for the valley, and the design and implementation of a shared path system along the creek.[530] As illustrated in image 118, construction of this section of freeway required sections of the Koonung to be realigned.

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525 Davison and Yelland, 230-38.
526 Lay, 212; Winter, 166-68.
527 Lay, 210.
528 Ibid, 09.
529 Boully, Mullett, and Watkinson, 404-05.
530 Ibid, 406.

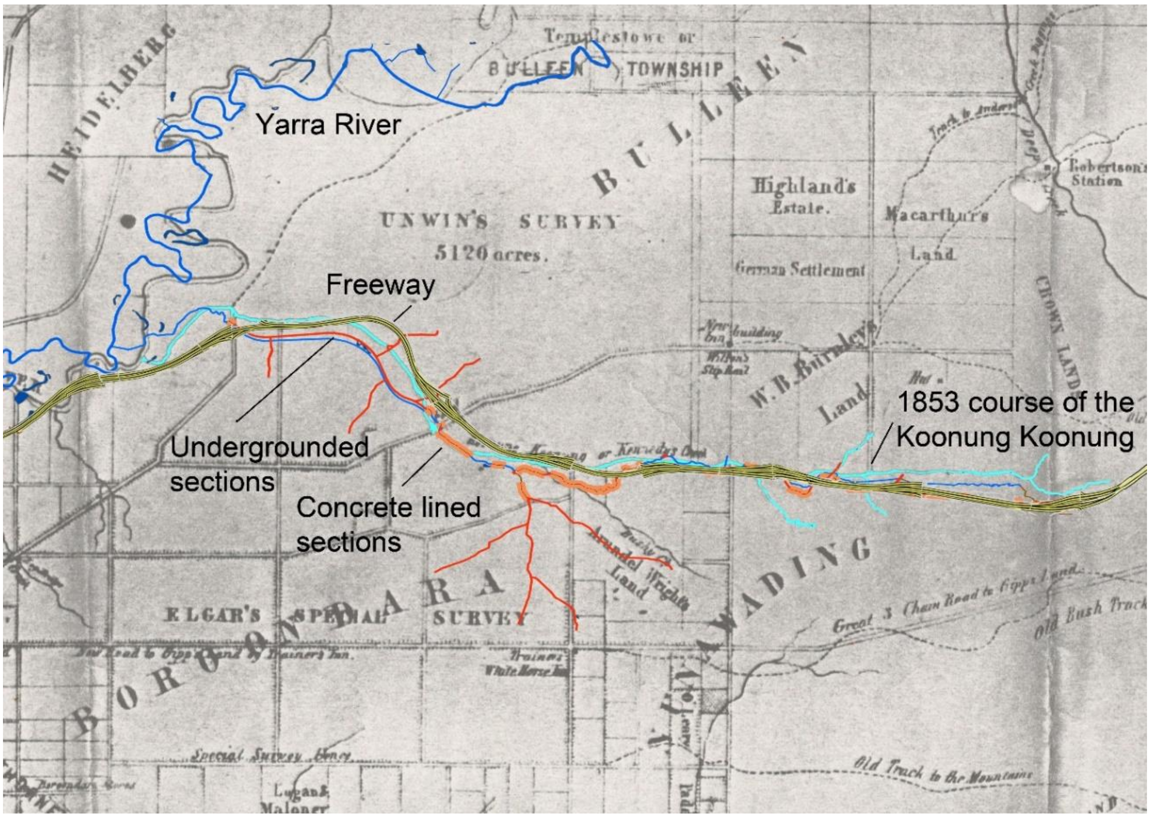

Figure 118. Koonung creek mapped in 1853 overlaid with freeway and contemporary creek course and structures. Source : Base Map – SLV http://handle.slv.vic.gov.au/10381/114195

As stated on page 261, Koonung Creek drains 3000 hectares of suburban fabric. Therefore, the design and final location of the freeway had to ensure the drainage capacity of the creek and floodplains was not obstructed or reduced, while the landscape character of the creek was maintained and improved.[531] This was achieved by designing sections of the creek to accommodate the 1 in 100-year flood level, and construction of two retarding basins, in the form of wetlands.[532] Prior to construction environmental and ecological surveys carried out along the existing creek identified water quality deteriorating as the water flows downstream, the existence of a sparse fish population including a rare native species that was considered preserving, and the existing levels of native vegetation along the riparian zones constituted a habitat for some aquatic species.[533] Recommendations for improving the ecological habitat of the creek and riparian zone were incorporated into the design specifications for each section of the creek being realigned to accommodate the freeway.[534] These included scaling the

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[531] Ibid, 405.
[532] Ibid, 405, 08, 14.
[533] Ibid, 406.
[534] Ibid.

channel to allow the creek to form natural meandering patterns, creation of fish-ways to allow native fish access along the creek, and lining the banks with vegetation and mulch to control erosion.[535] The project resulted in significant improvement to the condition of the creek's riparian zones and erosion of the streambed, while the revegetation of the banks and floodplains greatly increased wildlife habitat values. Local community groups have accepted ownership of the project and actively take part in the maintenance and ongoing improvement of the parkland, creek and wetlands.[536]

The redesigned realignment of this reach of the Koonung was driven by engineering and hydrology to ensure the creek remained a functioning stormwater drain and flood mitigation structure. The inclusion of ecological design resulted from input contributed by local community groups, some of whom opposed the freeway extension.[537] As illustrated from the description of the creek works above, the designers sought to create seemingly natural, meandering stream alignments and a diverse environment along the banks.[538] A major problem identified by Kondolf regarding design of new stream alignments can be the complete failure of the channel within months or years of completion.[539] Kondolf considers the primary aim of many channel reconstructions is the creation of a stable, single-stream meandering channel on watercourses, including many that were not historically meandering. Additionally, irregular and twisting stream courses are frequently reconstructed into symmetrical meanders.[540] Consequently such meanders frequently wash out, while the few that remain stable provide little original habitat. Kondolf also cites a common lack of post-project assessment for both channel realignment and river restoration projects in general across North America and Europe.[541] Brooks and Lake similarly highlight the lack of historical data, ongoing monitoring and outcome assessment of river restoration projects in Australia.[542] Consequently, no data has been found regarding any post-project assessment of the 1997 realignment of the Koonung. Yet the initial success of the project has resulted in the development of a typology of creek located between existing suburban development and a

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[535] Ibid, 407.
[536] Ibid, 415.
[537] Ibid, 406.
[538] Ibid.
[539] G Mathias Kondolf, "River Restoration and Meanders," *Ecology and Society* 11, no. 2 (2006): sec. 1, par 1.
[540] Ibid.
[541] Ibid.
[542] Shane S. Brooks and P. Sam Lake, "River Restoration in Victoria, Australia: Change Is in the Wind, and None Too Soon," *Restoration Ecology* 15, no. 3 (2007): 584.

freeway corridor. Watercourses with sections of reaches adjacent to the next extension of the freeway would result in a similar creek-suburban fabric-freeway corridor design interface.

Although habitat along the creek was dramatically improved, the water quality of the Koonung is amongst the poorest in Melbourne.[543] The Victorian Government's report on water quality of the state's catchments lists the condition of the Koonung as 'very poor' for the period July 2015 to June 2016.[544] This category typifies watercourses (particularly smaller urban tributaries like the Koonung) under severe stress resulting from inflows of polluted urban runoff. These include a range of nutrients and pollutants collected from residential, industrial and commercial areas and hard surfaces including roads (see chapter two, page 30).[545]

Construction of this section of the Eastern Freeway also saw the development of the Koonung Linear Park along both banks of the creek between the freeway and suburban fabric. The linear park covers some of the land proposed by the MTPC in the 1929 plan for a parkway system along the Koonung, shown in figures 119 and 120.

Figure 119. Figure 153. The proposed Koonung Creek park system. Source: MTPC (1929).

[543] State Government of Victoria, "Yarra Catchment," updated August 25, 2017, http://yarraandbay.vic.gov.au/report-card/report-card-2016/yarra#top_of_report.
[544] Ibid.
[545] Ibid.

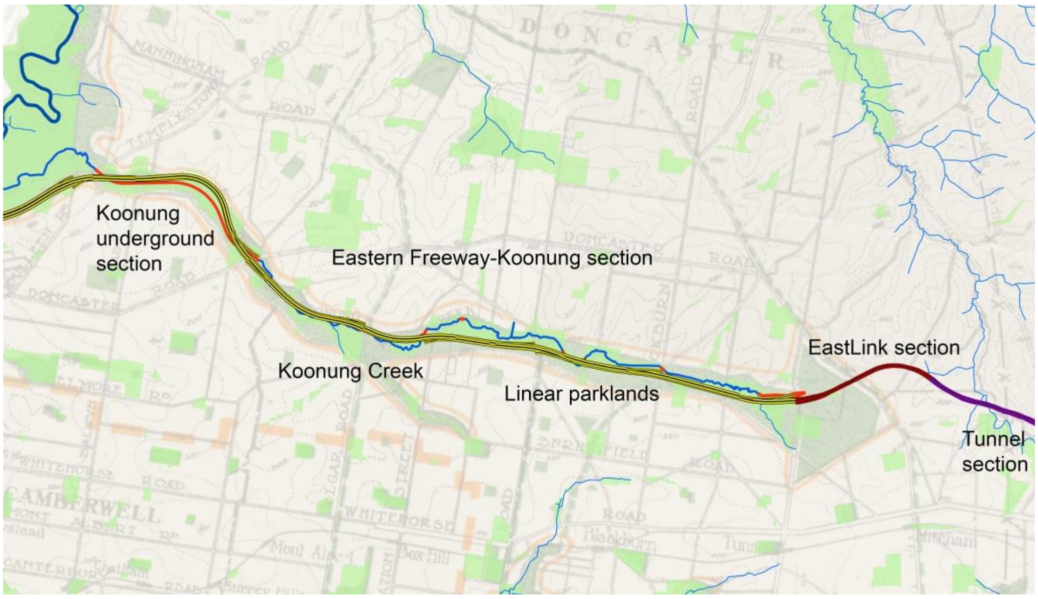

Figure 120. Koonung Valley sections of Eastern Freeway over the 1929 park system plan. Source: MTPC (1929).

Despite the freeway dissecting the Koonung in four separate places, and the amount of parkland significantly reduced to that proposed in 1929, the project illustrates an alternative to either placing the creek underground or within a concrete lined channel. The design also developed a new type of creek typology for Melbourne; a creek with a reconstructed, rehabilitated ecology wedged between urban development and a freeway, located along a narrow corridor. The final seven kilometres (4.4 miles) of the Eastern, completed in 1997, provided a precedent for the rehabilitation and design of watercourses along transport corridors where future freeways were to be located along creek valleys.

Conclusion

During the mid to late 20th century, the use, planning and management of Melbourne's watercourses focused primarily on urban stormwater disposal and flood mitigation. At the same time, main watercourse valleys were reserved as land for an arterial road network, based on the MTPC's 1929 plan for parkways. Over the period, the ideals of aesthetic parkways sweeping along watercourses evolved into modernistic high-speed freeways, which resulted in modifying and in some cases realigning several of Melbourne's watercourses. Streambeds transformed into road routes.

This chapter examined the urban environmental history of the watercourses modified for freeways, leading up to the decision to place a road along the streambed or banks.

Once the uses as stormwater drains and road reserves were established, they have continued, regardless of the introduction of ecology into watercourse design that resulted in standard trapezoid concrete-lined channels being redesigned into rock-lined naturalistic landscaped channels. Despite Victorian, state governments' repeatedly utilising watercourse valleys for freeways, many sections of Melbourne's population remain strongly opposed, wanting to retain these dynamic riparian zones for development as parkland, habitat corridors and conservation areas. The next chapter examines the little-known urban environmental history of establishing parks and reserves along Melbourne's main watercourses.

Chapter Seven: Parks along watercourses - opportunity for ecological preservation, restoration and urban recreation or just temporary use of 'waste land' along drains?

> …The metropolitan park system has come a long way…Once simply areas of agricultural land and remnant bush, focused along water courses, the parks have undergone transformation into areas for active and passive recreation.[1]

Introduction

This chapter explores the urban environmental history of use of many of Melbourne's watercourse valleys and flood plains for parkland of varying scale. This practice was developed with the underlying aims of providing the city's population with enough public open space and the preservation and later rehabilitation of the delicately balanced ecosystems existing within stream corridors and floodplain systems. As Presland (2009) states, 'No feature of the original landscapes of the Melbourne area has been so deliberately altered as the wetlands and drainage patterns.'[2] The first parks located along the Yarra were designed in the tradition of the picturesque while the parks of the early 20th century were based on modernist design theory. By the mid-1970s, the MMBW was developing a metropolitan park system based upon environmental preservation and restoration, habitat improvement, and provision of recreational programs. This is reflected in the editorial quote at the top of the chapter by the Chairman of the MMBW, Ray Marginson, in 1986. Corner (2007) in *Large parks* considers large urban parks (defined as over 500 acres-202 hectares) as significant

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[1] R Marginson, "Ten Years of Metropolitan Parks," *Living City* no. 35 (1986): 3.
[2] Presland, *The Place for a Village: How Nature Has Shaped the City of Melbourne*, 62.

cultural and ecological features of the urban fabric.[3] He further details urban parks as providing exposure to dramatic natural elements including landscapes, geology, climate, flora and fauna, and large open spaces with wide horizons, otherwise limited within built-up areas.[4] Large tracts of parkland also assist to store and process stormwater, direct and cool air temperature heated by hard surfaces and provide habitat for an array of plant, animal, bird, and aquatic species.[5] From the mid-1950s park development moved into the public arena as residents and environmental interest groups dismayed at the destruction of land along watercourses called for the development of local parks in areas deemed worth preserving and developing for recreation.

Although individual local histories for many parks exist, a comprehensive history of Melbourne's park system is yet to be written. Therefore, a selection of park histories has here been examined and combined to establish an important and largely unrecognised layer to the urban environmental history of Melbourne's watercourses.

First Parks along watercourses-main drains

The development of parkland along sections of Melbourne's rivers and creeks turned the authorities' focus from fresh-water supply, drainage and flood mitigation to new attempts to integrate watercourses back into the urban fabric. It also involved rivers and creeks becoming viewed as more than just engineering problems solved with canalisation or barrel drains and resulted instead in involvement of disciplines other than engineering in watercourse design. Following the enactment of the 1923 *Metropolitan Drainage and Rivers Act*, Melbourne's watercourses officially became Main Drains (see chapter five, page 173-74). Although already utilised as components of the wider metropolitan stormwater drainage system, the Act endorsed this use, reinforcing the perception that watercourses had value only as drains. This perception is evident in the caption to the photograph used in the MMBW's Drainage Division report from 1973, shown in figure 121.

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[3] J. Corner, "Forward," in Large Parks, ed. Julia Czerniak, George Hargreaves, and John Beardsley (New York: Princeton Architectural Press, 2007), 11.
[4] Ibid.
[5] Ibid.

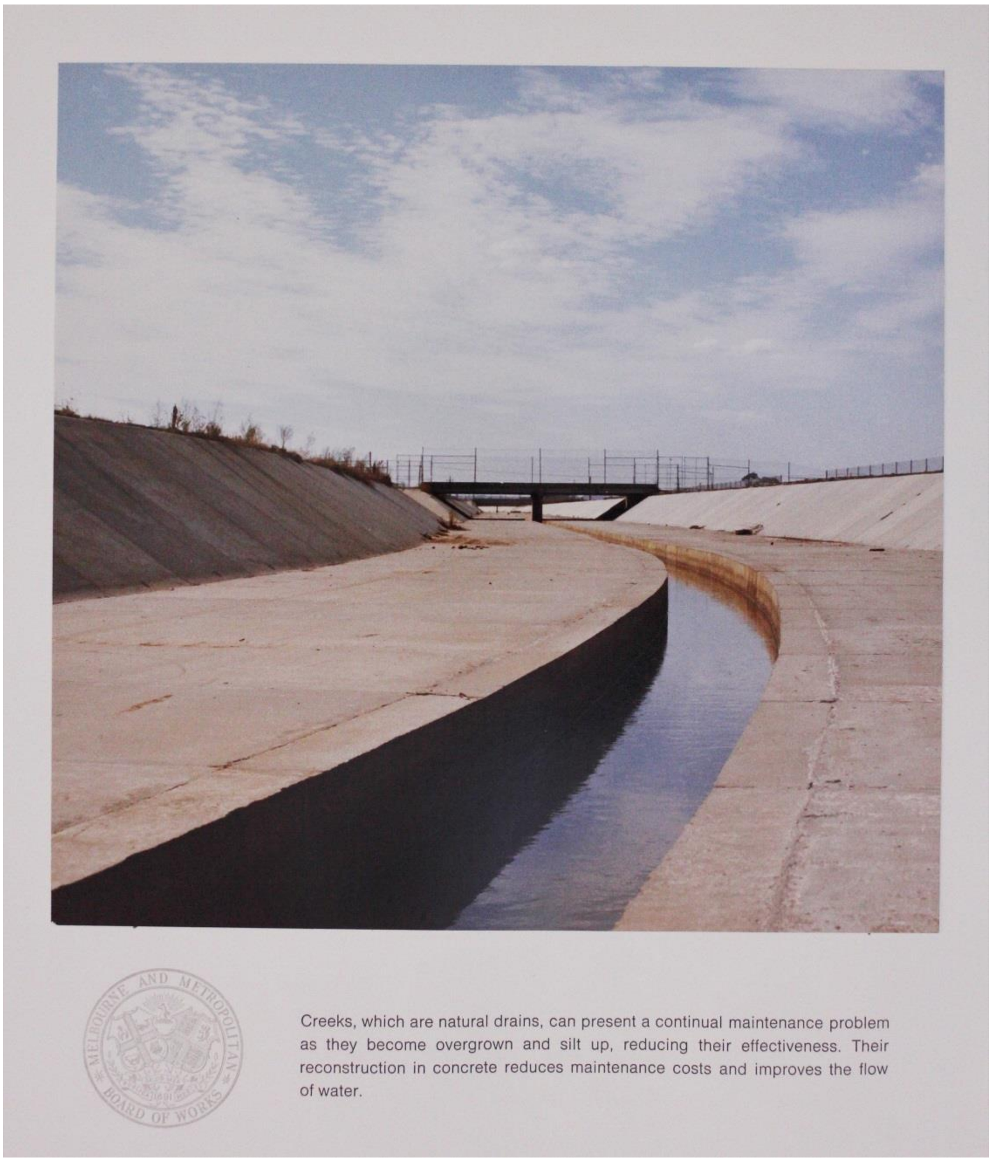

Figure 121. MMBW drainage division, 1973, image of canalised creek including description of creeks as 'natural drains'. Source: PROV, VPRS 8609/P21, Unit 110

This resulted in the MMBW and local councils managing hitherto neglected watercourses as part of the stormwater drainage system.[6] Many stream banks and beds were being eroded by increasing stormwater and runoff flows collected from the ever-increasing impervious surfaces of suburban development.[7] Water quality and aquatic habitat was also being

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[6] Senior, 413.
[7] Melbourne Metropolitan Board of Works, *Koonung Creek Realignment, Bulleen Road to Doncaster Road, Cities of Camberwell, and Doncaster and Templestowe: Concept Report*, 40.

degraded by seepage from septic tank systems and unregulated discharges from industries.[8] Senior (1992) succinctly describes the overall perception of Melbourne’s rivers and creeks during the majority of the 20th century as ‘unhealthy, unpleasant and consequently unwanted’ (see figure 112).[9] This broad perception was applied to the water and riparian lands including floodplains. However, there have been intermittent occasions when Melbourne’s rivers and creeks were perceived differently. At times watercourses were viewed as natural assets to be nurtured, preserved, and developed for the benefit of the community, environment and overall quality of the wider urban fabric.

Figure 122. Maintained as main drains-unpleasant, unhealthy, and unwanted. Melbourne's creeks during the mid-1970s. Source: MMBW (1976).

The desire to create parkland along a watercourse in Melbourne was first expressed by William Westgarth during the 1840s (see chapter four, page 109-10). Westgarth perceived the creek flowing along Elizabeth Street was a missed opportunity to create parkland along its

[8] Senior, 414.
[9] Ibid.

course complete with ornamental lakes, fishponds, gum trees and native grasses.[10] Westgarth's vision was unrealised, and Williams Creek was undergrounded, however, the desire for parkland along Melbourne's watercourses remained a prominent issue for some within the community. The *Age* (1906) reporting on the neglect of the Yarra, argued the parkland along the river was patchy, separated by great gaps of private property that extended to the river's edge resulting in its banks being 'mostly neglected and useless'.[11] The *Age* proposed the government buy back sections of privately owned land to create an extensive linear river park system.[12] The proposal also included; developing the river to encourage boating; stocking the Yarra with fish for angling; and development of a bush-land path system along each bank.[13] It would be 74 years and take a rigorous media campaign run for an entire year by the *Age* before the development of a public path system along the Yarra proposed to connect with smaller creeks would be realised. Figure 123 illustrates the amount of parkland (shown in green) across the Greater Melbourne region and parks located along or adjacent to watercourses.

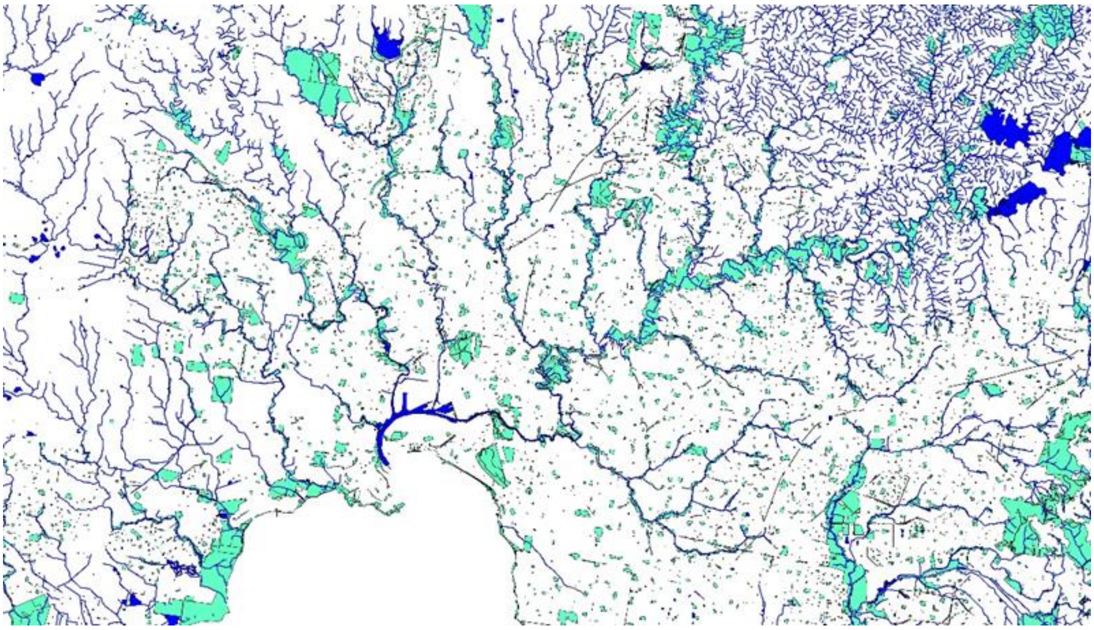

Figure 123. Park networks along Melbourne's main watercourses.

[10] Westgarth, *Personal Recollections of Early Melbourne and Victoria*, 69.
[11] "The Neglected Yarra. By Canoe," *Age*, February 24, 1906, 4.
[12] Ibid.
[13] Ibid.

Many parks and reserves on waterways were first proposed by the MTPC's 1929 plan (see chapter five) on land believed unsuitable for development due to ongoing flooding or unsuitable geology or topography.[14] However, long before the MTPC plan land was being reserved along watercourses of the region initially for the protection of natural resources.[15] Metropolitan Melbourne was subdivided where possible to ensure the maximum amount of land parcels with access to water, and roads to follow section lines rather than the banks of rivers and creeks (see chapter four, page 92-3).[16] This ensured access to watercourses was retained for provision of fresh-water in a land perceived by Europeans as dry.[17] This method of subdivision was known as Order Number 41.[18] Subdivisional boundary lines were to be perpendicular to watercourses.[19] However, by 1843 as the land around Melbourne was surveyed and subdivided, government and land managers became aware of the need to protect Port Phillip's natural resources.[20] An example of action in this regard is the 1842 government order prohibiting timber felling within a two-mile (3.2 kilometre) radius of Melbourne was extended at the end of that decade to five miles (eight kilometres).[21] Watercourses, too, were the subject of protection orders. In addition to following Order 41, the surveyors plotting and subdividing the area became subject to an additional order focussing upon watercourses. In December 1839, the Deputy-Surveyor General Samuel Perry (see chapter 4, page 50) issued an order to surveyor Robert Hoddle (see chapter 5, page 64) stipulating a reserve of 100 feet (30.48 metres) of the high-water mark along watercourses be measured and applied.[22] The exception would be land sold for the development of port facilities for shipping.[23] To enforce this order, Perry returned to Hoddle maps of the recently surveyed and subdivide parishes of Cut Paw Paw and Doutta Galla, both located along the Maribyrnong River west of the city.[24] Figure 124 is a copy of the map returned to Hoddle for

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[14] Metropolitan Town Planning Commission, *Plan of General Development, Melbourne: Report of the Metropolitan Town Planning Commission*, 214.
[15] R. Wright, *The Bureaucrats' Domain: Space and the Public Interest in Victoria, 1836-84* (Melbourne: Oxford University Press, 1989), 40.
[16] Lay, 15.
[17] Ibid.
[18] Cannon, MacFarlane, and Victoria Public Record Office, *Surveyor's Problems and Achievements, 1836-1839*, xvii.
[19] Ibid, xviii.
[20] Wright, 40.
[21] Ibid, 45.
[22] Ibid, 42.
[23] Ibid.
[24] Ibid.

the parish of Doutta Galla, showing the grid of subdivided land encompassing entire sections of the river including both banks.

Figure 124. Parish of Doutta Galla with the Maribyrnong used as a boundary for land parcels. Source: SLV http://handle.slv.vic.gov.au/10381/117438

The order was rescinded twelve months later as it had not been sanctioned from England, where many regulations for development of the colony originated. Then in March

1843 the original order, pertaining to 100-foot reserves was reissued with more detail specifying the reservation of all land within 100 feet of the high-water mark along all navigable rivers, seacoasts, harbours, and inlets.[25] The surveyors were instructed to include the 100-foot reserve or offset in locations they deemed necessary.[26] However, this proved ambiguous for the surveyors, as the government had neglected to establish where watercourse reserves were required or necessary.[27] The area surrounding Melbourne was subdivided with watercourse reserves only placed on surveyed township sites.[28]

The reservation and subdivision of land along and adjacent to Melbourne's watercourses not only provided land for sale; it also further alienated indigenous communities from their land. A report to the Chief Protector of Aboriginals in 1840 describes the value of rivers and creeks to indigenous communities.[29] The report also noted that European squatters assumed entitlement to land without intrusion from indigenous groups.[30] Indigenous inhabitants were being driven from their most valuable resources.

Whether the 100-foot reserves became parkland or were later developed into the built urban fabric, remains unclear. However, by the 1880s land subdivision sale material illustrated property boundaries demarcated by creek banks and in some cases, single blocks divided by a watercourse, as evident in the subdivision advertisements from the 1880s-1890s, shown in images 126 and 127.

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[25] Colonial Secretary's Office, "Land Regulations," *New South Wales Government Gazette* 21,(March 7, 1843): 341-45.
[26] Wright, 42.
[27] Ibid, 42-43.
[28] Ibid, 43.
[29] Symonds, 18.
[30] Ibid.

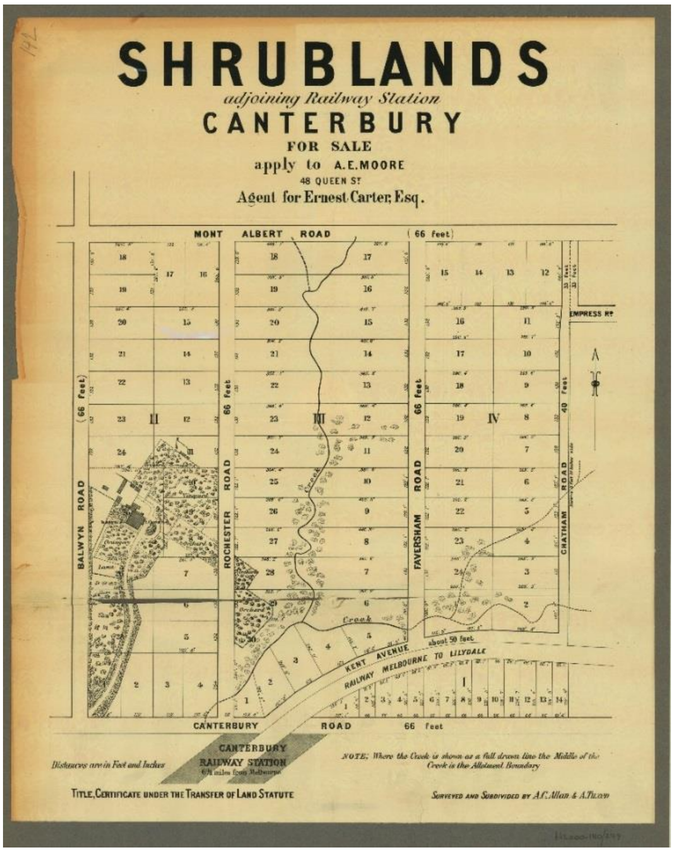

Figure 125. Subdivision plan for Canterbury (c.a. 1880-1890), utilising creeks for property boundaries. Source: SLV http://handle.slv.vic.gov.au/10381/85461

Figure 126. Subdivision along Melville Creek utilising creeks as boundaries. Source: SLV http://handle.slv.vic.gov.au/10381/132000

Following the first land sales within the Melbourne grid, as further land was surveyed and subdivided, substantial expanses were reserved for public purposes.[31] These initially included sites for asylums, schools, churches, and markets.[32] The first land reserved along a watercourse for public purposes was on the Yarra just upstream of Melbourne's main north-south axis, Swanston Street, covering 34 acres (13.8 hectares), in 1839.[33] In 1850, the Melbourne City Council prepared to develop the site as public gardens and pleasure grounds.[34] The area has since become Melbourne's main sporting precinct, with the Yarra largely isolated from the site by major arterial roads traversing sections of each bank.

During the 1840s as surveying and land subdivision continued, surveyor Robert Hoddle reserved land for public purposes and parks.[35] This was backed by the 1842 act for the sale of Waste Lands, which stipulated land be reserved for recreation, health and amusement of the population (earlier reservation was for protection of natural resources).[36] Reserved as crown land many of the sites were progressively developed for low intensity public uses, parks, and gardens.[37] One of the few such sites located along a watercourse was Studley Park (now part of Yarra Bend Park). The site of 203 acres (82 hectares) was originally reserved by Hoddle for public purposes it is to be assumed, due to the topography and rough terrain being unsuitable for building.[38] In May 1852, the Melbourne City Council requested the land be permanently reserved as a park. The reply from the Superintendent of the District, Charles La Trobe, (see chapter four, page 65) stated the land had been reserved from sale and was currently under consideration for use as a water-supply reserve.[39] Another site, now Yarra Bend Park, consisting of 620 acres (251 hectares) upstream on the Yarra near the Merri Creek confluence was also reserved by Hoddle in 1846 for a completely different public purpose, in this case construction of the Lunatic Asylum Merri Creek, (later renamed

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[31] J Harris, "Melbourne's Green Belt and Wedges: A Short History of Open Places and Spaces in the City and Their Strategic Context," (2005): 6.
[32] Ibid.
[33] W. Sanderson, "The Alientation of the Melbourne Parks," *Victorian Historical Journal* 14, no. 4 (1931): 2.
[34] Ibid, 146.
[35] Harris, 7.
[36] Department of Sustainability and Environment, *Non -Indigenous Cultural Heritage and Historic Places on Public Land in Veac's Metropolitan Melbourne Investigation Area*, (Melbourne: Department of Sustainability and Environment, 2009), 12; ibid; *An Act for Regulating the Sale of Waste Land Belonging to the Crown in the Australian Colonies*, (22 June, 1842), 310
[37] Harris, 7.
[38] R.W.L.S., "Old Studley Park," *Age*, 12 January, 1935, 5.
[39] Sanderson, 148.

Yarra Bend Lunatic Asylum).[40] In 1858 patient numbers were 451 and rising, new buildings continually added to the site throughout the period.[41] By the late 1860s, the complex consisted of large bluestone and brick buildings with a farm producing vegetables, milk and meat, surrounded by a landscape of largely exotic trees, with river frontage.[42] The size of the complex is given context by referring to patients per head of population in Melbourne during the latter half of the 1800s. Described as 'insane under detention' the statistics rose from 0.95 per one thousand persons in 1850 to 3.4 by 1880.[43] Construction of a new asylum upstream from Yarra Bend in Kew, resulting in protest from residents and the local council, was commenced in 1856 and after many delays was open in 1871.[44] Yarra Bend Asylum closed in 1925.[45] Figure 127 shows the Yarra, river frontage of the Yarra Bend Asylum, and adjacent parkland c.a. 1873-82.

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[40] Richard Bonwick, P. Morris, and M. Hopwood, "The History of Yarra Bend Lunatic Asylum, Melbourne: A Minor Thesis to Fulfil Requirements for the University of Melbourne Degree Master of Medicine (Psychiatry)" (PhD diss., University of Melbourne, 2010), 27-28.
[41] Ibid, 36-48.
[42] Geoff Lacey, "Yarra Bend Park," *Still Glides the Stream: The Natural History of the Yarra from Heidelberg to Yarra Bend* (Melbourne Australian Scholarly Publishing, 2004), 138.
[43] Bonwick, Morris, and Hopwood, 62-63.
[44] Ibid, 37-47.
[45] Ibid, 59; Lacey, "Yarra Bend Park," 138.

Figure 127. Bridge over the Yarra with the asylum in the background. Source: SLV H83.429

In March 1877, Studley Park was permanently reserved as parkland and placed under the responsibility of the Board of Land and Works and the Boroondara Corporation (Kew City Council).[46] Studley Park is widely known locally for its boat house (currently a dining and reception centre with boating facilities). Established in 1863, it was the first on the Yarra and the oldest public boathouse still in use.[47] Following the closure of Yarra Bend Asylum, Studley Park expanded into a public reserve of 315 acres (127.5 hectares).[48] In May 1929, the Minister of Lands, Henry Angus, proposed naming the park 'Yarra National Park', stating; 'because the first word was obtained from the falls within the area and the second and third

[46] Sanderson, 160-61.
[47] Parks Victoria, "Yarra Bend Park," (Melbourne: Parks Victoria, 2008), 1.
[48] "Old Yarra Bend Asylum Being Removed to Make Way for National Park," *Weekly Times*, 16 July, 1927, 46; Sanderson, 161.

would be truly descriptive of the new park.'[49] The local Kew council had long agitated for a national park.[50]

The use of the term National Park to describe Yarra Bend was confusing. The term defined by Version No. 117 of the National Parks act (1975), (State of Victoria) states: 'Whereas it is in the public interest that certain Crown Land characterised by its predominantly unspoilt landscape, and its flora, fauna or other features, should be reserved and preserved and protected permanently for the benefit of the public'.[51] Clearly the Yarra Bend and Studley Park sites were not unspoiled both due to presence of the asylum buildings and grounds, and stock grazing in the area until the 1960s.[52] During the late 19th and early 20th centuries in Melbourne, the term was used by the newly formed National Parks Association to describe areas of 'suitable land' reserved as sanctuaries for the preservation of native plants and animals.[53] Contrary to this, a large area of Yarra Bend Park was further reclaimed and cleared for construction of a golf course, opened in June 1932.[54] However, in 1938 the trustees of the course proposed creating a small reserve on a bend on the Yarra adjoining the course for the preservation of native animals.[55]

Following the amalgamation of the parks the National Park Committee of the state government's Lands Department appointed Landscape Gardener Hugh Linaker to submit a report on the landscape development of the park.[56] Linaker was a landscape gardener and horticulturist over the period 1889-1938. He was largely noted for his work with the state Lunacy Department, designing the landscapes for Victoria's mental hospitals.[57] His design practice was modernist and the Yarra Boulevard, its curves sweeping through Studley and Yarra Bend Parks is Melbourne's closest example of a modernist parkway.[58] Constructed during the 1930-33 period it was dug by hand as part of an unemployment program during

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[49] "Yarra National Park," *Age,* May 18, 1929, 23.
[50] "A National Park at Kew," *Argus,* March 21, 1888, 8.
[51] *National Parks Act 1975* (Vic), 3.
[52] Lacey, "Yarra Bend Park," 142.
[53] "A National Park," *Advocate,* November 28, 1908, 27.
[54] "National Park Course," *Age,* May 30, 1932, 15.
[55] "Wallabies Playground," *Age,* July 30, 1938, 14.
[56] "River Beautification," *Age,* September 28, 1927, 19.
[57] J Mulhauser, "Hugh Linaker, Landscape Gardener to the Lunacy Department: A Unique Position," *Australian Garden Journal* 20, no. 4 (2009): 12; Richard Aitken, Michael Looker, and Australian Garden History Society., *The Oxford Companion to Australian Gardens* (South Melbourne, Vic.: Oxford University Press, published in association with the Australian Garden History Society, 2002), 371.
[58] Mulhauser, 12.

the Great Depression.[59] A section of Yarra Boulevard is shown in figure 128, with the Yarra River in the gully in the right of the photograph.

Figure 128. Section of Yarra Boulevard in Yarra Bend Park, c.a. 1945-54. The Yarra is to the right. Source: SLV H91.50/1576

Linaker believed part of the Studley Park site was too steep for sports grounds, instead proposing tree planting, including use of specimen trees and a system of walking paths.[60] The *Age* (1928) reported that plans for Yarra Bend and Studley Park proposed by the management committee included a pedestrian bridge over the Yarra, a public golf course, playground, and planting of ornamental trees along the river banks to repair damage created by grazing cattle and horses.[61] In 1930, Hugh Linaker prepared a layout and planting plan for Yarra Bend National Park, see figure 129.

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59 Lay, 178-79.
60 "River Beautification," 19.
61 "A Public Playground," *Age*, March 31, 1928, 15.

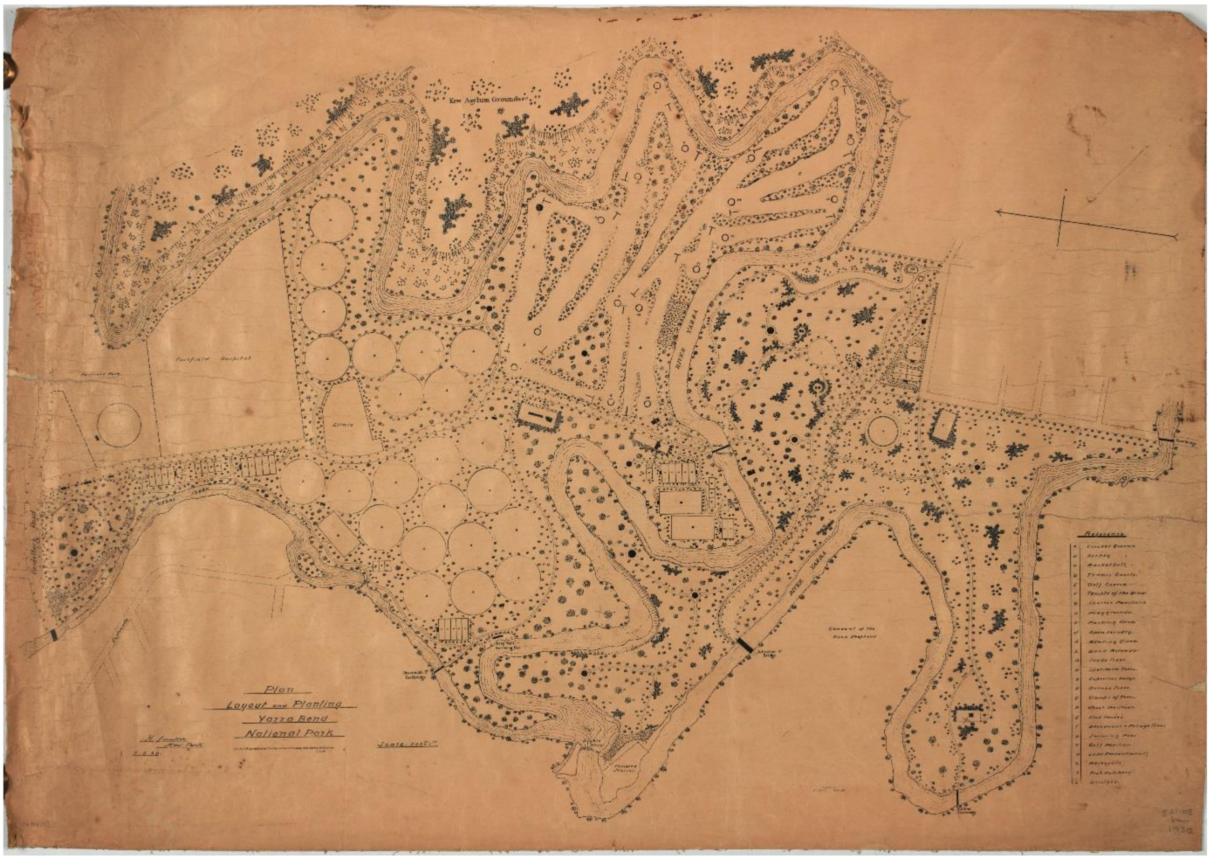

Figure 129. Linaker’s design and planting plan for Yarra Bend National Park. Source: SLV http://handle.slv.vic.gov.au/10381/170444

Linaker’s plan focussed on creation of a recreational resort, providing sporting amenities, including 23 cricket grounds and a golf course. He also proposed large plantings of exclusively introduced trees, use of specimen tree plantings and a fish hatchery to supply stock for angling in the Yarra. The plan was significant for two reasons. It was a large parkland covering both sides of a watercourse and one of the first riverside landscapes to be completely designed by a landscape-horticulturalist. This was opposed to earlier riverside parkland designs such as Alexandra Boulevard and associated parks designed by engineers and surveyors that was an addition to an engineering project constructed primarily for flood management.[62] Linaker’s plan was also one of the few to allow intimate contact with the water through fishing and boating activities. Although he was using the Yarra as an aesthetic water feature, it was also being included as part of the plan for recreation. This integration of

[62] “Upper Yarra Improvements: Boulevard Taverner,” 36.

a watercourse into recreational activities of parkland would be rarely seen again until creation of the MMBW's metropolitan park system developed during the 1970s.

The creation of recreational resorts along rivers featured often throughout the 1920s and 30s. The *Age* (1926) reported the proposal for development of a substantial recreational park on the Yarra at Ivanhoe a middle-class suburb northeast of the city.[63] The park proposed to cover the Yarra's banks and floodplains of the Chelsworth Estate (previously a dairy farm) and included tennis courts, bowling greens, golf course, polo ground, swimming pool, and a car-racing track.[64] The proposed speedway was not realised due to public protest regarding noise levels, the land instead being devoted to passive recreation.[65] As discussed in chapter five (page 166) during the same period the development of parkland and parkways along Melbourne's main watercourses was a major feature of the MTPC's 1920 plan, and overall philosophy of scientific town planning. Aesthetic use of Melbourne's watercourses could be viewed as contradictory to the other use as being main stormwater drains for the city. However, a central argument of the MTPC was that Melbourne lacked public parkland. The city had developed without provision of adequate recreational reserves; a situation the MTPC considered was costly to the health of the population and the city's economy.[66] Despite this, the MTPC's grand idea of parks and parkways was not instituted and major watercourses were managed as stormwater drains. Accordingly, they lapsed into 'unhealthy, unpleasant and consequently unwanted' areas of wasteland across Melbourne's urban fabric.[67]

Prior to the 1929 plan local councils along the Merri Creek, flowing through the northern suburbs, were considering the establishment of a national park within the region.[68] In June 1927, the President of the Reservoir Progress Association proposed a national park along the Merri Creek, the western boundary of the suburb, along the whole reach of that section of creek.[69] The *Advertiser* (1927) described the area as 'particularly rough country…The Merri is a permanent watercourse… the rocks, scrub and fern which cover its banks for well over 100 yards back from the creek in parts give the country an attractively

[63] "In the Suburbs. Speedway Proposed," *Age,* January 18, 1926, 10.
[64] Ibid.
[65] "Ivanhoe Speedway Proposal," *Age,* March 17, 1926, 9.
[66] Metropolitan Town Planning Commission, *Plan of General Development, Melbourne: Report of the Metropolitan Town Planning Commission*, 233-34.
[67] Senior, 414.
[68] "Why Not a National Park in Preston?," *Advertiser,* June 24, 1927, 4.
[69] Ibid, 4.

picturesque appearance.'[70] By July 1927, the proposal came to the attention of the MTPC which backed it on the assumption that much of the land was unsuitable for development, though well suited for park and recreational activities.[71] Figure 130 shows a section of the Merri Creek the Progress Association proposed for parkland.

Figure 130. View along the Merri creek, 1927, of land proposed for a National Park. Source: PROV, VPRS 10281/ P0000, Unit 10

By 1938 Melbourne's watercourses, particularly the Yarra, had been the focus of a range of proposals developed by engineers, surveyors, planners, the MMBW, newspapers and private citizens. The *Argus* (1938) opined that Melbourne did not appreciate the Yarra or its potential and illustrated this through a review of a range of visions and schemes proposed since the 1870s.[72] These involved the creation of parklands and aesthetically pleasing

[70] Ibid, 4.
[71] "Road to Encircle City. Town-Planning Proposal," *Argus,* July 4, 1927, 11.
[72] F De Castella, "The Yarra - as It Might Have Been," ibid, October 15, 1938, 3.

riverside landscapes, reminiscent of European examples. Meanwhile destruction of riparian lands and floodplains continued to be reported by Melbourne's newspapers. In Ivanhoe, the billabongs lining the floodplains along the Yarra were described as having been filled by the railways department with tons of waste rock, while tins from a jam factory were being dumped into another billabong under the direction of a council officer.[73] The filling of billabongs and wetlands for land reclamation had long been practiced across Melbourne. In effect, development of the urban fabric was draining Melbourne's landscape so efficiently it was removing all trace of surface water, channelling it into underground drains that discharged into watercourses. In 1954 floodplain destruction and the filling of the Yarra's billabongs was drawn to the attention of the public by the renowned landscape architect Ellis Stones (1895-1975).[74] Credited with developing an Australian style of landscape design using natural materials and native plants, he was also widely acclaimed for his construction skills with rockwork in landscape construction.[75] Stones highlighted the value of watercourses and bushland parks to the public and demonstrated a new way of thinking and later designing for urban watercourses.

Stones and his family lived in Ivanhoe and frequently utilised the Yarra and its floodplains along the section of the river forming the boundary with the adjacent suburb of Kew.[76] The section of river featured a billabong system, sandy beaches, swimming holes, dressing sheds, bushland and Chelsworth Park.[77] Traversing along the western and eastern boundaries of the park are two underground main drains, Locksley and Irvine Roads' drains, collecting water from the north. The drains discharge into Reedy and Baileys Billabongs before flowing along Reedy Creek to the Yarra.[78]

In 1929, the Ivanhoe Public Golf Course opened next to the eastern side of Chelsworth Park. Due to continual complaints from golfers losing golf balls in the billabongs these waterholes were filled with rubbish, covered and levelled. When the local council took over responsibility for Chelsworth Park, additional billabongs were filled.[79] When one of the

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[73] C. Bailey, "Spoiling River Scene," *Argus*, January 10,1947, 6.
[74] Anne Latreille, *The Natural Garden: Ellis Stones, His Life and Work* (Ringwood, Vic.: Viking O'Neil, 1990), 107-10.
[75] Ibid, xi-xii, 29-35.
[76] Ibid, 103-08.
[77] Ibid, 106-07.
[78] D. Barr, "A Report and Recommendations on the Water Quality of the Drains and Billabongs of Wilson Reserve, Ivanhoe July 2000 to Janury 2010," in *Friends of Wilson Reserve* (Ivanhoe Firends of Wilson Reserve 2011), 4.
[79] Latreille, 107; "New Links at Ivanhoe," *Age*, December 23, 1929, 5.

swimming holes in the Yarra was fenced to stop public access and the draining of a wet billabong commenced, Stones initiated the first public protests and petitions. A letter written by Stones published in the *Argus* (1954) entitled *'Save our bushland'* was an early example of protest directed at insensitive management of Melbourne's watercourses and remaining bushland areas. Stones stated:

> There once existed a beautiful strip of virgin bushland along the River Yarra…Chelsworth Park with billabongs…Unfortunately this is gradually being destroyed…It has long been a recognised sanctuary for native birds, and…platypuses…Surely it is time we, as a nation, begin to preserve rather than destroy.[80]

Stones went on to become the first president of the Ivanhoe River Parklands Protection League, formed in 1955.[81] His activism against the accepted treatment and design approaches towards Melbourne's watercourses, riparian zones and floodplains identified rivers and creeks as valuable features of the urban landscape. Later landscape designs and works by Stones along creeks would result in a new typology in design moving away from the standard engineered stormwater channel.

Despite Stones' activism, the development of bushland reserves and parkland along Melbourne's watercourses was slow and sporadic. The central city area developed during the 19th century had been planned to incorporate many large parks and gardens, with the eastern reach of the Yarra upstream from the city grid, providing large picturesque parklands radiating up from the river's banks.[82] Due to the existence of these parks, inner suburban councils failed to develop parks within their own municipalities.[83] In 1936 the *Age,* which had recently noted a shortage of parks and recreational reserves across Melbourne's inner, middle and outer suburbs, proposed a relationship between rates of juvenile delinquency and provision of playgrounds.[84] In seeking to address the problem, the MTPC's 1929 plan had

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[80] Ellis Stones, "Save Our Bushland," *Argus,* August 13, 1954, 4.
[81] Latreille, 108.
[82] Dingle and Rasmussen, 362.
[83] Ibid, 326.
[84] "The Shortage of Parks," *Age,* October 30, 1933, 10; "Childrens Play Grounds. Lack in Melbourne," *Age,* May 21, 1936, 6.

proposed an average ratio of 65 persons per one acre (0.4 hectares) of parkland.[85] As the plan was not fully realised the outer suburbs continued to develop with little provision for parkland. On the eve of the MMBW taking responsibility for planning the *Argus* reported a member of the state government's suggestion that town planning would have no effect 'unless provision were made for parks in the outer municipalities'.[86] The MMBW's 1954 planning scheme sought to rectify the lack of parks by increasing the ratio to 6 acres (2.4 hectares) of parkland per 1000 people (excluding privately owner recreational facilities such as golf courses and race tracks) to at least 7.5 acres (3 hectares) per 1000 people.[87]

Although the plan had reserved land along the watercourse valleys, few parks were developed and much of the land reserved for a proposed arterial road system (page 175).[88] To the prominent Australian architect and planner John Stevens, Melbourne's disregarded watercourses and adjacent land were ripe to be remade as useful recreational areas including playgrounds.[89] John Gawler's (1963) *A Roof Over My Head* describes Melbourne's smaller creeks as almost entirely neglected, commonly lined with blackberries and scrub.[90] A strong advocate of the MTPC's 1929 parkway plan, Gawler proposed local councils purchase additional land for parks and recreation areas along watercourses, to create assets for residents living in the area.[91] Gawler's comments on developing recreational areas along the Koonung Creek in 1963 demonstrate problems with governance and responsibility of Melbourne's watercourses and his use of the modernist design approach to park development.

> [I]t was suggested that a section of the Koonung Creek and its banks between Box Hill and Doncaster should be developed. A swimming pool, a children's playground, a picnic ground and a pleasant tree lined walk were thought of. The idea came to nothing because neither municipality could face the financial responsibility of either capital outlay or annual upkeep… [92]

[85] Metropolitan Town Planning Commission, *Plan of General Development, Melbourne: Report of the Metropolitan Town Planning Commission*, 189.
[86] "Not Enough Parks, Says M L A," *Argus*, May 5, 1949, 5.
[87] Melbourne Metropolitan Board of Works, *Melbourne Metropolitan Planning Scheme 1954*, 77; Dingle and Rasmussen, 326.
[88] Melbourne Metropolitan Board of Works, *Melbourne Metropolitan Planning Scheme 1954*, 97-103.
[89] C Pascoe, "Wasted Space: Urban Planning and the Child in 1950s Melbourne " in *10th Australasian Urban History, Planning History conference*, ed. D. Nichols, et al. (Melbourne: University of Melbourne 2010): 435-36.
[90] John S. Gawler, *A Roof over My Head* (Sydney: Lothian, 1963), 36.
[91] Ibid.
[92] Ibid.

The proposed parkland development and his preferred park typologies are like those of the MTPC and Hugh Linaker. Modernist ideas however were quite contrary to those of Stones who years earlier, had advocated for the preservation of riparian lands and floodplains and created landscapes emulating natural bushland settings and features. Following Gawler's book, the period saw western countries witness the development of a growing concern for the environment. This concern was in response to an international reaction towards the effects rapid post-war industrialisation was having upon the natural environment.[93] This included contamination of air, rivers, oceans, and the near extinction of large mammals including whales and elephants.[94] These issues were further driven into the public domain and developed into quality of life issues by such works as Rachel Carson's *Silent Spring* (1962) and Murray Bookchin's (1962) *Our synthetic environment*.[95] In Melbourne, sections of the local population became acutely aware of the local environment and the possibility of restoring degraded watercourses.[96] The city once again sought the vision of the 1929 plan of linear parks for recreation, and creation of 'breathing spaces' across the urban fabric.[97]

One of the outcomes of the rise in environmental awareness was a greater appreciation of (what remained of) Melbourne's natural environment, and a shift towards embracing landscapes and philosophies of designers such as Stones. His designs sought to retain and integrate the natural environment and native vegetation into the urban fabric rather than the standard practice of erasure and replacement with introduced plants and engineered topology.[98] This approach was adopted by the Melbourne building firm of Merchant Builders, known locally for houses of distinctive design that incorporated architecture with site conditions, responses to climate and outdoor living.[99] In 1969, Merchant Builders won the tender to develop a subdivision on the former site of the Rosanna Golf Links, in the middle-class suburb of Rosanna.[100] The site contained a small southerly flowing tributary of the

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[93] Peter Christoff, "Environmental Politics," in *Developments in Australian Politics*, ed. Judith Brett, James A. Gillespie, and Murray Goot (South Melbourne: Macmillan Education Australia, 1994), 349-50.
[94] Ibid, 350.
[95] Ibid; Chris McConville, "Dams, Freeways and Aerospace: How Australian Environmentalists Responded to Transnationalism and World Heritage, 1964-1984," *Australian Journal of Politics & History* 61, no. 3 (2015): 381.
[96] Dingle and Rasmussen, 327.
[97] Ibid.
[98] Catherin Bull, *New Conversations with an Old Landscape: Landscape Architecture in Contemporary Australia* (Mulgrave, Vic.: Images Publishing Group, 2002), 21.
[99] Andrew Saniga, *Making Landscape Architecture in Australia* (Sydney: NewSouth Publishing, 2012), 112.
[100] Latreille, 213.

Yarra, Salt Creek, and fifty acres of parkland that had been planned for retention.[101] When the subdivision was first proposed the MMBW wanted to convert the creek into an underground drain.[102] It considered increased run-off flowing from the subdivision's impervious surfaces would accelerate erosion of the creek's bed and banks.[103] Salt Creek flows through a landscape of similar geology to the Koonung Creek, the soils highly susceptible to dispersion and erosion.[104] The City of Heidelberg opposed the MMBW scheme.[105] As Merchant Builders had engaged Stones for site planning and landscaping surrounding the homes, the council also retained him to landscape the adjacent parkland, including along Salt Creek.[106] Much of Salt Creek (Main Drain 4604) as recorded on the MMBW's *Drainage Record Plan* (1975) had been placed in an underground drain except for a section at the headwaters and at the confluence with the Yarra. The longest remaining section open to the surface, as shown on the plan, was 850 metres (2800 feet) flowing through Rosanna Parklands (see also figure 131). Stones had developed a comprehensive knowledge of land use and water, arguing urban runoff should be collected in flood basins and used for public recreation. Based upon this knowledge his first design for Salt Creek involved construction of small intermittent lakes to accommodate flood and high flows in the creek.[107] This design was rejected due to concerns regarding public safety, requiring Stones to develop an alternative design involving basalt rock set along creek banks for erosion control and creation of a small natural flowing creek.[108] Approval for the design from the MMBW had been a hard-won achievement, as since the early 1960s he had been a vocal critic of Melbourne's watercourse management.[109] He strongly disagreed with the MMBW's management practices of placing creeks in underground drains or open concrete channels.[110] He argued that instead they should be retained as natural streams, landscaped to provide retaining basins for flood control and beautified for provision of usable green space and recreation areas.[111] Stones' landscaping of

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[101] Ibid.; Presland, *The Place for a Village: How Nature Has Shaped the City of Melbourne*, 74-75.
[102] Latreille, 217.
[103] Ibid.
[104] Melbourne Metropolitan Board of Works, *Koonung Creek Realignment, Bulleen Road to Doncaster Road, Cities of Camberwell, and Doncaster and Templestowe: Concept Report*, 41,43; Maroondah Inc. Australian Plant Society, *Flora of Melbourne: A Guide to the Indigenous Plants of the Greater Melbourne Area*, 3rd enl. ed. (South Melbourne: Hyland House, 2001), 6-7.
[105] Latreille, 217.
[106] Ibid, 213.
[107] Ibid, 40.
[108] Ibid.
[109] Ibid, 240, 47.
[110] Ibid, 240.
[111] Ibid.

Salt Creek had demonstrated a new approach to watercourse erosion control, which retained landscape value. Previously rock was only used as beaching for erosion control along sections of Melbourne's larger watercourses, creating a channel-like appearance.[112] In 1977 as a response to the public's environmental awareness, the MMBW began landscaping creeks in a similar way to Stones' treatment of Salt Creek.[113] Figure 131 illustrates the remaining open section of Salt Creek, and a remaining section of Stones' original rockwork.

Figure 131. Salt Creek - open section - Rosanna Parklands, landscaped by Ellis Stones and a section of his original rockwork. Author photo (2017).

Over the period 1972-73, the MMBW was planning to underground a severely eroded section of Glass Creek in Kew (see chapter six, page 258) flowing through parkland and farmland between the portal of the already undergrounded section and the embankment of the Eastern Freeway, then under construction.[114] City of Kew's plan to build three sporting ovals on the site included using the land occupied by the creek. The MMBW agreed to council's

[112] Dingle and Rasmussen, 155-56.
[113] Ibid, 310.
[114] Latreille, 240.

request to pipe the creek as it was in a similar eroded condition to the Koonung.[115] The process was well advanced when the residents first heard of the project and responded by forming the Kew Natural Environment Group (KNEG).[116] Other residents responded by presenting the MMBW with a petition of over 1300 signatures calling for the creek to be landscaped and the parkland developed for passive recreation.[117] In June 1973, the KNEG requested Ellis Stones to prepare a submission for landscaping the creek.[118] He recommended creating earth mounds and landscaping the creek with large rocks to dissipate energy generated by flood flows, stop erosion and create a natural landscape effect along the creek.[119] Before being accepted for construction, Stones' design had to be critically analysed by independent consultants. As the MMBW, at the time, had no experience in creek design besides concrete lining, the consultants had no standards or precedent designs to compare or analyse against Stone's design.[120] The consultants eventually discovered the engineers of the State Rivers and Water Supply Commission (SRWC) (a government authority similar to the MMBW, responsible for Victoria's rural water supplies and watercourses) were one of the few organisations experienced in creek design.[121] Stones' design compared favourably with those of the SRWC. It was deemed feasible by the consultant engineers and the MMBW's drainage division.[122] As further deliberations on the project between the MMBW, CRB (which took over construction of the Eastern Freeway) and the City of Kew, (which wanted to cover the creek), Stones was continuing his campaign against the MMBW's treatment of creeks.[123] In a 1973 article, he described the Board's planners as vandals wearing grey flannel suits, systematically destroying the natural environment of Melbourne and turning the many small urban creeks into concrete causeways.[124] The Glass Creek project was finally constructed during January to July 1976 using Stones' original plan with only minor modifications.[125]

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[115] M. H. Kelso, "Glass' Creek and Hay's Paddock: The Background History of a Park" (Masters diss., University of Melbourne, 1984), 1.
[116] Ibid.
[117] Latreille, 241.
[118] Ibid.
[119] Ibid.
[120] Kelso, 58-59.
[121] Ibid, 58.
[122] Ibid, 59, 61.
[123] Latreille, 241.
[124] Ellis Stones, "Vandals in Grey Flannel Suites," *Herald,* November 17, 1973, 4.
[125] Kelso, 66-67; Latreille, 241-42.

The rise in environmental awareness was also reflected in the MMBW's *Planning Policies for the Melbourne Metropolitan Region* (1971). For the first time in Melbourne's planning history the plan featured a conservation overlay, developed specifically to address the changes and losses to the natural environment.[126] The conservation overlay consisted of two classifications; areas of conservation significance and areas of landscape significance.[127] Conservation areas contained high value habitat and landscapes to be preserved and had potential to be developed as metropolitan parks.[128] Landscape areas had been disturbed while retaining significant patches of original landscapes and could undergo managed development. The overlay identified the watercourses, valleys and adjacent environs of Melbourne's four main rivers and their tributaries as having conservation significance, landscape interest or importance for agriculture.[129] The report also introduced the concept of green wedges, located on land deemed unsuitable for urban development or containing significant landscape features and proposed the retention of open land within proximity to suburban development.[130] Retention of this land would benefit Melbourne's population in two ways: allowing the development of large parks on a scale unachievable by local municipalities and development of informal areas of public open-space and retention of native vegetation as opposed to the more formal European-style parks and gardens of Melbourne developed during the 19th and early 20th centuries.[131] Since the 1954 plan, the MMBW had been purchasing land for provision of parks. This land was added to in the 1971 plan reserving 13 square miles (34 square kilometres), of large tracts for park development.[132] Coupled with the MMBW's long history of developing and maintaining parks around the water-supply reservoirs, the development of a large metropolitan park system for Melbourne was coming into being.[133]

In June 1974, the MMBW established policy to progressively create and manage a metropolitan park system.[134] However, prior to this in 1973 a small group of residents from the middle-class suburbs of Alphington and Ivanhoe initiated a scheme to preserve and

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[126] Melbourne Metropolitan Board of Works, *Planning Policies for the Melbourne Metropolitan Region*, 44.
[127] Ibid, 45.
[128] Ibid.
[129] Ibid.
[130] Dingle and Rasmussen, 327.
[131] Ibid.
[132] Ibid.
[133] Ibid.
[134] Ibid.

rehabilitate 26 hectares (64 acres) of land with the aim creating a park along a section of the Darebin Creek.[135] This is an early example of local resident activism initiating park development along one of the tributaries of the Yarra. The land lay across the boundary of the suburbs, with the Darebin flowing through a large section of the area. The site contained a small local park, a council refuse tip, an area of industrial zoned land and floodplain.[136] The area along the Darebin was primarily used for agriculture including orchards, dairies and market gardens, the creek retaining much of its original landscape as suburban development was yet to encroach on the creek.[137] In 1890, a commercial quarrying company was formed to extract basalt rock, (bluestone) on a commercial scale, from thirty acres (12 hectares) of land along the Darebin at Alphington. The quarry expanded, becoming one of the three largest in the state.[138] Despite this and encroaching suburban subdivisions, the Darebin's valley retained much of its landscape, valued as habitat and a site for a range of recreational activities, with the Heidelberg Shire Council purchasing 15 acres (6.1 hectares) of the former Rockbeare Estate for a natural park.[139] The MTPC's 1929 plan proposed a park scheme along the Darebin consisting of 793 acres (321 hectares) bordered each side by 66 foot-wide (20.1 metre) parkway drives.[140] However, the onset of the Great Depression during the 1930s saw the plan shelved and the land along the Darebin was used by residents for sourcing firewood, fruit, and rabbits.[141] The quarry however experienced continued growth, due to the introduction of government relief schemes for the unemployed including road construction, building projects, and construction of parks, requiring stone, with much supplied from Alphington.[142] By the 1940s suburban and industrial development had further encroached upon the area, willow trees were obstructing the creek and weeds were invading the area, while the quarry expanded further. The previously proclaimed landscape value of the area had been almost erased.[143] By the 1950s, the Northcote side of the Darebin had developed

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135 Lilian Wood and Rockbeare Park Conservation Group, *Darebin Parkland: A Study of a Land Reclamation and Conservation Project at Ivanhoe and Alphington, Victoria* (Ivanhoe, Vic.: Rockbeare Park Conservation Group, 1980), 1.
136 Ibid.
137 Sarah Mirams, *Darebin Parklands: Escaping the Claws of the Machine* (Melbourne: Melbourne Books, 2011), 36-37.
138 Ibid, 38-39.
139 "Aquiring Park Land ", *Argus* October 11, 1928, 18.
140 Metropolitan Town Planning Commission, *Plan of General Development, Melbourne: Report of the Metropolitan Town Planning Commission*, 221-22.
141 Mirams, 49.
142 Ibid, 52.
143 Ibid.

into an industrial area, the creek becoming an open refuse tip. In 1965 quarrying ceased and the Northcote Council leased the site for a rubbish tip and allowed all types of domestic, commercial and industrial waste to be dumped, frequently resulting in rubbish fires.[144]

The idea to rehabilitate the area and create a larger park was originated by two mothers who visited Rockbeare Park.[145] In early May 1973 on one of their visits to the area, they observed the MMBW indiscriminately clearing all vegetation along the creek and burning the waste.[146] The clearance work was a standard maintenance approach utilised to clean up creeks and control flooding and flow velocities (see chapter six, page 274).[147] Incensed at the destruction, and in order to halt further clearing, a range of people and organisations were contacted. These included; the local council; Environmental Protection Authority; a local candidate in the upcoming state election and the local press.[148] Further protest followed drawing up to 100 people at an organised rally and, coupled with increased media coverage, the MMBW finally ceased clearing, apologising for not seeking council approval before commencing the work. The outcome, only several days later, was the formation of the Rockbeare Park Conservation Group, formed with the primary scheme of developing the park. This also included aims for restoring the Darebin's riparian zones, floodplains and associated wetland.[149] The scheme received support from both local councils on either side of the creek, and additional land outside the park boundaries was purchased and tools and equipment provided for weed control work.[150] In 1974, the group consulted Stones, who designed planting schemes and the main entrance to the park.[151] In 1981 the park was renamed Darebin Parklands and had evolved to become of the city's noted land rehabilitation projects, widely praised and used.[152]

Meanwhile the MMBW's metropolitan park system was being developed across Greater Melbourne, as illustrated by figure 132.[153] Land had been reserved close to population hubs, consisting of former agricultural land and remnant bushland, specifically

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[144] Ibid, 61.
[145] Ibid, 69.
[146] Ibid.
[147] Ibid; Melbourne Metropolitan Board of Works, *Koonung Creek Realignment, Bulleen Road to Doncaster Road, Cities of Camberwell, and Doncaster and Templestowe: Concept Report*, 155.
[148] Mirams, 70.
[149] Ibid.
[150] Wood and Rockbeare Park Conservation Group, 1.
[151] Latreille, 247.
[152] Mirams, 89-110.
[153] Dingle and Rasmussen, 327.

along watercourses.[154] The main aims of the park program were the preservation, protection and regeneration of a range of landscape types adjacent to watercourses, while creating recreational areas for active and passive recreation.[155]

Figure 132. The MMBW's first metropolitan parks developed.

Using the original land reserved by the 1954 and 1971 plans, the first parks developed were along sections of the Yarra and Maribyrnong Rivers and Dandenong Creek. The scale varied and included 1040 hectares along the Yarra Valley; 223 hectares at Horse Shoe Bend on the Maribyrnong River; 1300 hectares of Dandenong Creek floodplains and 1300 hectares further downstream along the Dandenong Creek at Lysterfield; 567 hectares at Point Cook; 311 hectares at Braeside.[156] The MMBW had established a separate parks section within the planning branch, consisting of landscape design and park management to establish and operate the parks. The department's work included major ecological restoration, revegetation, weed control, and rubbish removal.[157] In 1976, sections of the first two parks were opened to

[154] Ibid, 328; Marginson, 3.
[155] Dingle and Rasmussen, 328.
[156] Ibid.
[157] Ibid, 329-30.

the public; 50 hectares at Brimbank on the Maribyrnong River and 138 hectares of Jells Park on the Dandenong Creek.[158] By the following year, the success of the parks was evident in the visitor numbers reported at over 200,000 per year.[159] In addition to the ecological focus of preservation and rehabilitation, the parks were also developed to provide a range of recreational and educational activities for all of age groups.[160] A selection of activities catered for at the parks included; fishing, picnicking and barbequing, bush walking, cycling, bird watching, educational sessions, swimming, wildlife study, indigenous culture education, and revegetation activities.[161]

In 1986, following ten years of metropolitan park development the MMBW was celebrating the remarkable success of the parks and programs, with over 10 million visitors since 1976 and further parks in the planning stage.[162] The development and consequent success of the metropolitan park system provided Melbourne residents and the environment with a range of benefits that would have otherwise been largely unrealised. The public had access to an array of activities and programs conducted by park staff in environments city residents would otherwise have to travel beyond the city to access.[163] Rehabilitation of the park sites provided significant habitat and wildlife corridors for native fauna and creation of green corridors with revegetation of indigenous flora. Restoration of watercourses and tributaries flowing through the parks improved aquatic habitat and restoration of floodplains reduced the need for localised flood management infrastructure. Development of the parks also provided opportunity to re-establish landscape conditions to near pre-European settlement.[164] By the early 1990s, the work beginning in 1974 had resulted in providing Melbourne with a range of reclaimed landscapes including rivers and creeks, wetlands and river valleys. The parks also proved a balance between conservation, usage by urban populations and passive and active recreational activities.[165]

The MMBW by 1990 managed and operated seven metropolitan parks, scattered across Greater Melbourne.[166] A year later as part of major restructuring reforms, the MMBW

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[158] Ibid, 330.
[159] Ibid, 378
[160] Melbourne Metropolitan Board of Works, "Getting Away from It All with the Board " *Living City* no. 27 (1980): 15-17.
[161] "Living City Ten Years of Metropolitan Parks," *Living City* no. 35 (1986): 3-30.
[162] R Marginson, "Ten Years of Metropolitan Parks," (1986): 3.
[163] Ibid.
[164] Dingle and Rasmussen, 377-78.
[165] Ibid, 378.
[166] Ibid.

was amalgamated with other water boards located to the south and southeast of Melbourne (indicating a significant rate of urban development) creating the Melbourne Water Corporation.[167] The resulting corporatisation and break-up of the MMBW saw the metropolitan parks transferred to the control of Parks Victoria, the statutory body responsible for managing national parks, reserves and other land controlled by the state government. Following the corporatisation and restructuring the MMBW's metropolitan park, system ideals and programs have been largely lost.[168] In 2016, the Victorian National Parks Association reported that due to years of continual funding cuts to Parks Victoria's operational budget, the management and maintenance of all Victoria's state parks has significantly declined.[169] McDonald and Price (2009) in their research into declining metropolitan park use in Melbourne conducted focus groups and in-depth interviews of metropolitan residents and visitors to the city.[170] The results indicated there was a perceived belief most parks lack variety and did not provide quality activities for children and adolescents.[171] Additionally, most participants also believed parks did not cater for the complete age-range or life-stage for all persons. The range of attributes and facilities provided in parks was also considered significantly lacking. Features such as; signage, shade, picnic areas, bird hides, and provision to participate in a range of passive and active recreational activities were identified as absent or in need of maintenance.[172] Many of these features lacking in Melbourne's contemporary generic parks had been highlights of the MMBW's metropolitan park system.

Give The Yarra A Go: Transforming an industrial river into an urban river

In 1980, while the MMBW was developing the metropolitan park system, cleaning-up, and restoring many suburban watercourses, the public's attention was being diverted to the plight of the Lower Yarra by the *Age* newspaper.[173] The *Age's Give the Yarra A Go* (1980) campaign became a major turning point within the urban environmental history of the

[167] Viggers, Lindenmayer, and Weaver, 87-88.
[168] Ibid.
[169] Victorian National Parks Association, *Rescue Our Parks: Victoria's Parks Need Serious Injection of Funds*, (Melbourne: Victorian National Parks Association, 2016), 1.
[170] Sharyn M. McDonald and Garry G. Price, "Addressing Declining Metropolitan Park Use: A Case Study of Melbourne, Victoria, Australia," *Managing Leisure* 14, no. 1 (2009): 30-31.
[171] Ibid, 31-32.
[172] Ibid, 32.
[173] John Larkin and Peter Ellingsen, *Give the Yarra A Go!* (Melbourne: David Syme and Co., 1980), 1.

Lower Yarra and instigated a renewed interest in the river as a valuable resource. The campaign expressed similar ideas to Saxil Tuxen and the Metropolitan Town Planning Commission during the 1920s. The campaign also led to the initial creation of Melbourne's watercourse trail network and development of further parkland along the river and creek valleys.[174] Cited as one the *Age's* most successful campaigns for the last 50 years, the media engagement and public interest it created prompted an almost immediate response from the State Premier, Mr Rupert Hamer, that the government would provide financial support and cooperation to address the clean-up of the Lower Yarra. [175] This section of the river, from Dights Falls to its mouth at Hobsons Bay, had remained an industrial sewer. It also contained the most exposed reach to public view, along the southern edge of central Melbourne. Consequently, this section of river caused Melbournians the greatest consternation throughout much of the city's urban history. Since Melbourne's establishment, the city has experienced a type of symbiotic relationship with the Yarra, the river portrayed as a symbol of the city to both positive and negative effect. In 1850 an anonymous author published in *The Australasian*, discussing the Yarra regarding Melbourne's planning stated:

> Our ideal town should have a noble river, margined with massive quays and public and private buildings, which, sweeping round with windings of the stream, should charm the eye with all beauty of evanescent lines and ever-shifting perspectives…It has a river; but the lines of houses on the banks, instead of gracefully sweeping round with the stream, run off at a tangent from it…the only skill exhibited in the plan of Melbourne is that involved in the use of square and compasses. We have planned our metropolis as we should plan a coal pit.[176]

The city's relationship with the Yarra has been described by Dingle (1999) as always being one of unease, the river perceived as a joke or embarrassment by locals and visitors alike.[177] Comments such as Melbourne being the only city in the world where the river flows upside down or that Yarra water was 'too thick to drink and too thin to plough' dominated

[174] Brown and Clarke. Facility of Advancing Water Biofiltration, 18.
[175] M. O'Regan, "New Age Guy" in *The Media Report* (ABC Radio National 2004).
[176] "Melbourne as It Is, and as It Ought to Be," *The Australasian* 1, no. 1 (1850): 8; Dingle and Rasmussen, 36.
[177] T. Dingle, "Melbourne and the Yarra: An Uneasy Relationship," *Historic environment*, no. 3 (1999): 5; Larkin and Ellingsen, *Give the Yarra A Go!*, 1.

popular perceptions of the river.[178] For well over 100 years, the Yarra was not only the focus of such comments and jibes; it was also subject to a range of disparaging quotes and graphic descriptions. For example, journalist Edmund Finn (1888) described the river as: 'a foetid, festering sewer, befouled midst the horrors of wool-washing, fellmongering, bone-crushing, and other unmentionable abominations!'[179] It was the emotions contained within these perceptions the *Age* (1980) sought to capture and capitalise on in attempt to prompt interest in the river that would eventually lead to improving the health, quality, and overall image of the Yarra's city reach.[180]

In February 1980, the *Age* launched the campaign *'Give the Yarra A Go'* above the by-line *'TODAY 'The Age' opens a campaign to restore the Yarra to the people'*.[181] Considering the Lower Yarra by 1980 had experienced over 100 years of intensive use and abuse as an industrial river and remained generally inaccessible to most of Melbourne's population, the *Age's* statement was rather bold. The campaign progressed over six consecutive months from 23rd February until 4th August 1980, highlighting the condition of the Yarra while also proposing several main aims for improving the river.[182] In the first article to launch the campaign, Editor Michael Davie declared the Yarra should be as important to Melbourne as the Seine was to Paris and argued Melbourne's only natural asset was victim to great apathy between it, the people of Melbourne, and the inattention of the managing authorities.[183] He cited more than 30 government agencies concerned with administration of the river and singled out the MMBW for officially referring to the Yarra as a 'drain.' Due to this apathy and ineffectual management, Davie reported the campaign's aims had been developed to be completely practical, achievable, and inexpensive to implement. He also indicated the *Age* realised the entire river could not be cleaned-up, nor could public access be opened-up along the entire reach to its banks.[184] Six main aims were developed. These were: replacing the river edge Batman Carpark with a garden; improving the water quality; creation of a riverside path linking the city with Dights Falls; proclaiming the Yarra and its banks a river park to be managed by one authority; returning small pleasure

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[178] Jan Smith, *An Ornament of Grace* (Melbourne: Sun Books, 1966), 67; Larkin and Ellingsen, *Give the Yarra A Go!*, 1.
[179] Finn, 497.
[180] Larkin and Ellingsen, *Give the Yarra A Go!*, 1.
[181] M. Davie, "Give the Yarra a Go!," *Age*, February 23, 1980, 3.
[182] Larkin and Ellingsen, *Give the Yarra A Go!*,1-43.
[183] Davie, 3.
[184] Ibid.

craft to the river; and creation of a maritime park at South Wharf.[185] Overall, the *Age* sought to instigate the improvement of public access and recreational space along the Lower Yarra and improve the water quality by highlighting pollution entering the river.[186]

The level of public interest generated by the campaign resulted in a prompt response from the Premier, Rupert Hamer, just 12 days following its launch.[187] The Premier announced the State Government had agreed to regenerate the Lower Yarra from Dights Falls to Hobsons Bay and additionally pledged financial support and cooperation to accomplish the campaign's six aims.[188] On the 8th of March, the *Age* reported initial steps taken by the government included negotiations with City of Melbourne for transforming Batman Carpark into parkland and establishment of a feasibility study for development of a path along the river.[189]

A final article published about the campaign's outcomes, dated 14 January 1981, reported on the launch of a three-million-dollar restoration plan for the Lower Yarra that included landscaping the riverbanks, development of Batman Park, and a maritime park on former port infrastructure.[190] However, water quality of the river remained poor, and provision of facilities for small pleasure craft had not been achieved, both due to a lack of funding and staff within the responsible government agencies.[191] Despite this by 1885, construction of Melbourne's first riverside trail, along the Yarra, was completed.[192] This led to creation of a trail network linking all main watercourses with the Yarra trail and funding for a range of programs to restore many watercourses across Melbourne.[193]

Conclusion

This chapter has traced the development of parkland and park networks along Melbourne's watercourses, throughout the city's urban history. Although State Government agencies were instrumental in proposing and developing parkland along watercourses,

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[185] Larkin and Ellingsen, *Give the Yarra A Go!*, 3.
[186] Brown and Clarke. Facility of Advancing Water Biofiltration., 18.
[187] John Larkin, Peter Ellingsen, "Yarra Revival Wins Premier's Support," *Age,* March 8, 1980, 4.
[188] Ibid.
[189] Ibid.
[190] John Larkin and Peter Ellingsen, "$3 Million Facelift for the Yarra," January 14, 1981, 5.
[191] Ibid.
[192] Brown and Clarke. Facility of Advancing Water Biofiltration, 18.
[193] Ibid,18-19.

sections of the public and media also played pivotal roles in creating parks. In reserving watercourses and riparian land for recreation, these areas were also conserved and restored to become key features of the urban fabric for recreation, provision of habitat and protection of the landscapes of watercourse valleys.

Chapter Eight - Conclusion: Revaluing watercourses - the continuing urban environmental history of Melbourne's rivers and creeks

> Once upon a time, in almost every industrial city, countless rivers flowed. Why did they disappear? How? And could we see them again?[1]

Introduction

This thesis has interrogated and developed an urban environmental history of watercourses. In doing so, it has used the main rivers and creeks of Melbourne, the capital and largest city of Victoria, Australia, as a case study. The urban development of Melbourne, as with similar industrialised cities globally, resulted in watercourses being transformed from functioning natural ecosystems into highly engineered and designed channels, featured above or below ground. For example, former Blind Creek at its entrance into the Yarra River, both engineered for different uses and reasons to fit within the urban fabric, its portal into the Yarra shown in figure 113.

[1] Catbird Films, "Lost Rivers," news release, 2012.

Figure 133. View from undergrounded Blind Creek into the Yarra. The creek was progressively barrel drained from 1850s to 1930s. The Yarra River has undergone extensive engineering for flood mitigation. Source: Author photo (2017).

The quote at the start of this chapter is from the media release for the 2012 documentary *Lost Rivers*. It refers to the evolution of change urban watercourses have undergone, globally, since the rise of urbanisation, and its unprecedented growth since the 18th and 19th century industrial revolution in Britain. The quote also highlights the expressed desire within sections of populations of contemporary affluent cities to re-establish lost watercourses and create new links with these vital resources. Although primarily referring to the countless rivers and streams placed underground during urbanisation since the Middle Ages, the statement could also describe the numerous surface watercourses that have been heavily modified beyond recognition from natural ecological and landscape states.

An urban environmental history of watercourses

This thesis, at the time of writing, is the only in-depth examination of the urban environmental history of Melbourne's watercourses. It explores the use and abuse of the area's main watercourses since the establishment of Melbourne in 1835. One of the primary outcomes of this examination has been the collection of a range of historical and contemporary information about Melbourne's rivers and tributaries. This information has been specifically gathered for the first time to focus upon watercourses. Traditionally the history of urban watercourses has been treated as background to other forms of history: social; personal; public health; water engineering; maritime and ports; economic development; and urban water supply, to list a few. Unlike other branches of history, urban environmental history seeks to understand contemporary environmental problems, and develop solutions, knowledge of the material and intellectual aspects of the past are essential.[2] Urban environmental history has also allowed the demonstration of the notion that the development of urban networks, (including water, transport, drainage and energy) create environmental, social and cultural effects extending far beyond the initial period of creation and implementation.[3] This has been illustrated throughout, for instance in the example of erosion control projects undertaken along many of Melbourne's watercourses. Figure 134 showing bank erosion control work along a section of Gardiners Creek in 2014. The modification and use of main watercourses as stormwater drains has resulted in the need for such projects to protect stream banks and beds.

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[2] Petra J.E.M. van Dam and S. Wybren Verstegen, "Environmental History: Object of Study and Methodology," in *Principles of environmental sciences*, ed. Lucas Reijnders and Jan J. Boersema (New York: Springer, 2009), 30, http://link.springer.com.ezp.lib.unimelb.edu.au/book/10.1007%2F978-1-4020-9158-2.
[3] Dieter Schott, "Urban Environmental History: What Lessons Are There to Be Learnt," *Boreal environment research* 9 (2004): 526.

Figure 134. Erosion control works along a section of Gardiners Creek, 2014. Source: Author image (2014).

Unlike historical modes which tend to treat watercourses as separate and unconnected or as components to other urban networks, this thesis has positioned watercourses as an individual, interconnected urban network, used as a component in other forms of urban infrastructure including drainage, parks and roads. Watercourse valley networks also function as environmental corridors hoisting a range of habitats and landscapes. Understanding urban watercourses as an individual network is the first step to further considerations of their value, use, importance and place within the urban fabric. An example of perceiving watercourses as a separate, connected system at the time of writing is the Rivers of the West Campaign, reported by the *Age* (2018). The campaign is seeking development of planning laws to protect the Maribyrnong and Werribee River catchments, including tributaries, as an interconnected network of watercourses flowing through Melbourne's western suburbs and plains.[4]

[4] Clay Lucas, "Push for Tougher Laws to Protect Rivers of the West," *Age*, January 6, 2018, 6-7.

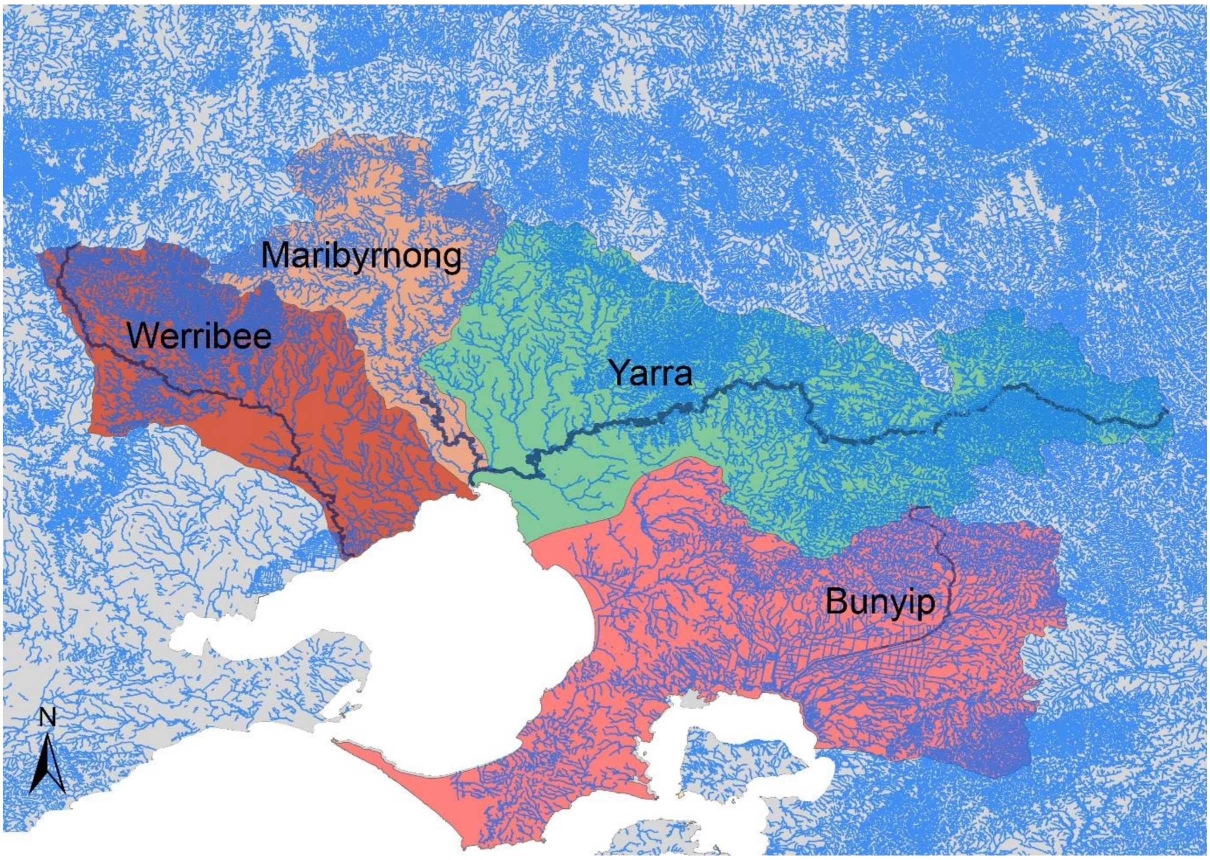

Figure 135. Melbourne's main river catchments. The Werribee and Maribyrnong subject to the 2018 Rivers of the West Campaign.

A second attribute of this thesis is the identification of urban watercourses as being positioned between the natural and designed, with both characteristics combined to form a typology of contemporary urban watercourses. As detailed within the earlier chapters, the urban development of Melbourne, and similar industrialised cities, by the late 20th century had resulted in the engineering of watercourses enclosed within urban fabrics. They had been designed to fit within, beneath, above, or against urban infrastructure for a range of evolving uses and roles. These were decided by certain uses, available technologies, and societal and government perceptions during specific periods. For example, the engineering of a section of the Darebin Creek, flowing through Melbourne’s northern suburbs, for flood mitigation. The photograph in figure 136 shows a section of the Darebin Creek in 1975, prior to modification for flood mitigation. Figure 137 shows the creek following the excavation of a trapezoid channel. Figure 138 is the creek in 2018 as comparison showing trail system and revegetation works.

Figure 136. A section of the Darebin Creek in 1975-subject to ongoing flooding. Source: PROV, VPRS 8609/P0021, Unit 477

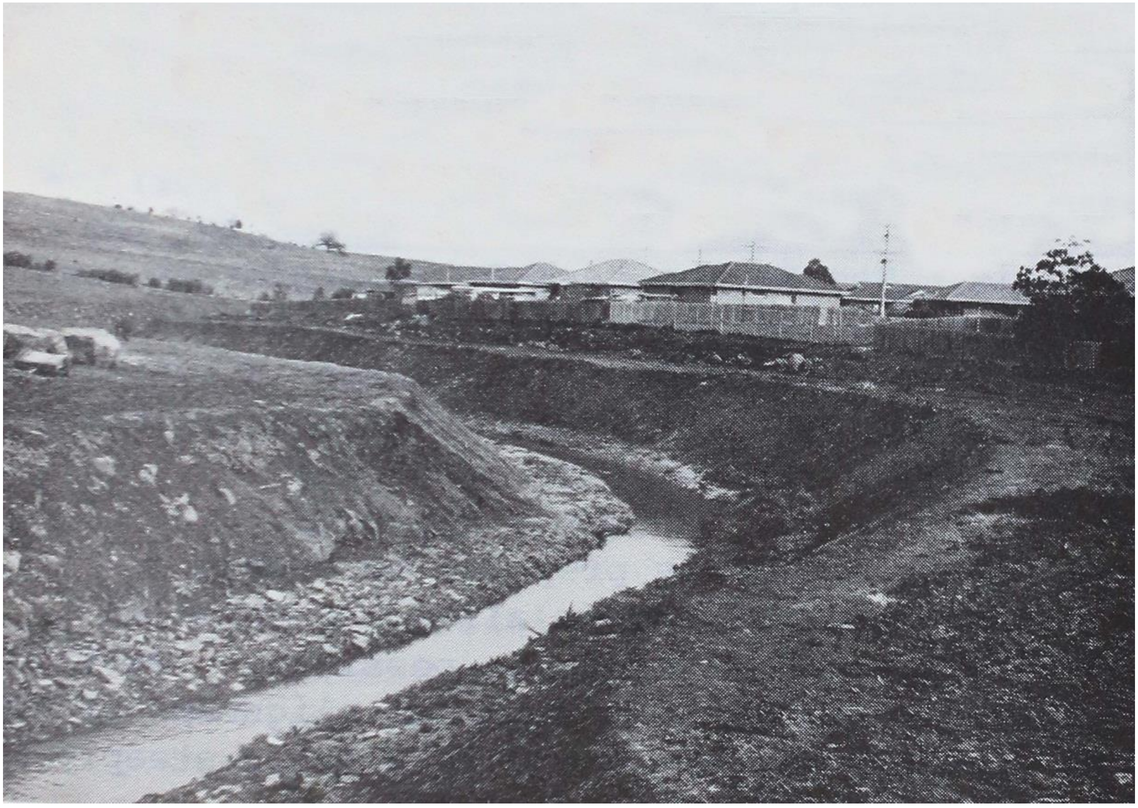

Figure 137. The same section of creek following modification for flood mitigation and control. Source: PROV, VPRS 8609/P0021, Unit 477

Figure 138. The same view in 2018, with a trail system and revegetation works-the designed and the natural. Source: Author image (2018).

Following a century or more of engineering calculated to ensure waterways flow predictably within urban fabrics, the last 30 years of the 20th century saw a shift towards revaluing ecological and natural environment characteristics of watercourses. Many affluent cities and communities began a renaissance towards restoring the lost natural environment to urban watercourses. Since that time many have had the water quality improved, the banks and beds revegetated, and stream corridors restored. Many river managers regard the most radical restoration projects as involving the daylighting of previously piped or culverted watercourses to return the stream course back to the surface. Despite this trend, restoration projects in Melbourne remain in the realm of design. All planting, landscaping and revegetation works along watercourses are subject to approval by Melbourne Water and must conform to their planting and landscape design specifications.[5] Therefore, this thesis situated

[5] Melbourne Water Corporation, "Plant near Sewers, Drains, Waterways and Water Mains", updated November 2, 2017, https://www.melbournewater.com.au/planning-and-building/apply-to-build-or-develop/plant-near-sewers-drains-waterways-and-water-mains.

urban watercourses between the natural and designed with attributes of both combining to create a water system designed to fit within, beneath or against stable urban structures and fabrics. An example from the time of writing is shown by the image figure 139. Many watercourses flowing through contemporary urban fabrics are designed drains for flood alleviation and stormwater removal while at the same time providing ecological habitat and, although designed, environmental landscapes within constructed urban fabrics.

Figure 139. Restoration of the last 100 metres of a previously undergrounded, un-named tributary of the Moonee Ponds Creek. Engineered for stormwater drainage using designed wetland system with indigenous vegetation to filter the water and create habitat. Source: Author image (2017).

This thesis also illustrated the predisposition of successive urban populations, governments, management authorities and design professions to perceive, and treat, urban watercourses as expendable commodities. This view commenced in full, from the 19th century in Britain, when modern urbanism linked public health and sanitation with water.[6] Linking human health with water, in conjunction with the development of engineering led to the perception watercourses could be readily modified or erased. They were engineered to

[6] Shannon and De Meulder, 5.

control pollution and flooding, and covered or erased, the land used to accommodate other more valued urban systems and structures. Examples of treating watercourses as expendable included: the conversion of many of London's rivers to underground combined sewers during the 19th century; and Melbourne accountant Francis Dixon's unrealised 1920s scheme for diverting the Yarra River away from the city.[7] Dixon envisaged removal of the Yarra would enable all main north-south streets to be connected straight into South Melbourne, removing the need for traffic to be funnelled into four bridge crossings.[8]

An example of a Melbourne watercourse that was modified as an expendable commodity is Elster Creek, flowing through, and beneath, several southeast suburbs. As the suburbs developed, the area was subject to ongoing flooding, while refuse and noxious drainage accumulated in low-lying areas and the creek.[9] In seeking to solve these problems modification to the Elster, commenced 1924 through to the 1970s with large sections of the upper and middle reaches progressively placed underground, as illustrated in figure 140. Figure 141 shows the portal of the undergrounded section.[10]

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[7] F. Dixon, *Proposals for the Relief of Traffic Congestion in the City of Melbourne*, (Melbourne: F.E. Dixon, 1925), 2.
[8] "The Melbourne of the Future. Civic Improvement," *Age*, October 21, 1925, 12.
[9] Melbourne Metropolitan Board of Works, *The Development of the Elster Creek Drainage System* (Melbourne: Melbourne Metropolitan Board of Works, 1979), 4-5.
[10] Ibid, 15-20.

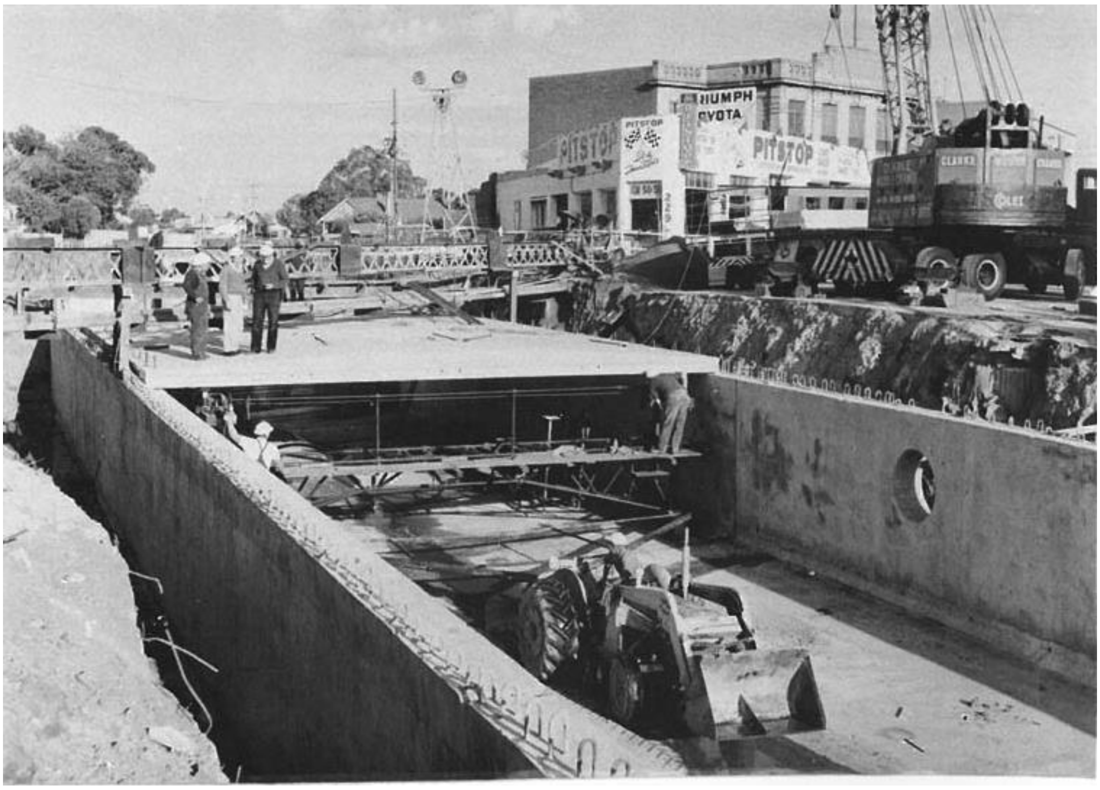

Figure 140. Section of the Elster Creek culvert in 1967. Source: Melbourne Metropolitan Board of Works (1979).

Figure 141. Elster Creek. Source: Author image (2017).

Revaluing urban watercourses – redesign to fit environmental aspirations

Pinkham (2000) describes modern urbanism's approach to urban watercourses as: 'not…kind to streams. As human kind…clustered into cities…we have polluted streams, diverted them, confined them in concrete channels, put them into pipes…used and abused them, often beyond recognition.'[11] During the 1970s, this approach to urban watercourses was dramatically challenged. The first urban streams to be daylighted and returned to the surface were in North America.[12] A section of Napa Creek in San Francisco was uncovered and the headwaters of Embarrass Creek in Illinois were uncovered and restored.[13] These projects demonstrated changing perceptions towards urban watercourses, developing globally, in improving and restoring watercourses and realisation of the ecological services they provide to urban populations.[14] While stream daylighting can be viewed as a major turning point in perceptions and approaches towards urban watercourses globally, the practice is yet to receive the same level of interest in Melbourne. As detailed in chapter six (page 213) as late as 1979 residents in the suburb of Pascoe Vale were protesting for a section of Westbreen Creek to be barrel-drained and covered.[15] Development of a separate sewerage system in Melbourne, resulting in many larger watercourses remaining open to the surface is perhaps the most pertinent reason daylighting has not been a turning point for Melbourne's watercourses. Vancouver, (Canada) developed along same lines as Melbourne, by 2017 had only two streams of at least 50 flowing on the surface, the rest undergrounded as combined sewers.[16] However, in December 2017 work commenced on daylighting 830 metres (2723 feet) of a section of Dandenong Creek flowing through Melbourne's eastern and southern suburbs.[17] This is the first major daylighting project in Melbourne. The major change in public perceptions towards Melbourne's watercourses almost certainly derived from reaction to the visual results of realigning the Moonee Ponds Creek to accommodate construction of the Tullamarine Freeway (see chapter six, page 265-76). Figure 142 shows the section of

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[11] Pinkham, IV.
[12] Ibid, 17.
[13] Ibid, 17,28.
[14] Sophia Jane Findlay and Mark Patrick Taylor, "Why Rehabilitate Urban River Systems?," *Area* 38, no. 3 (2006): 312.
[15] Leigh and Melbourne Metropolitan Board of Works, 132.
[16] Vancouver Street Stories, "Lost Streams of Vancouver", accessed February 23, 2016, http://vancouverstreetstories.com/lost-streams-of-vancouver/. (Site discontinued).
[17] Melbourne Water Corporation, "Daylighting Dandenong Creek", updated January 22, 2018, https://yoursay.melbournewater.com.au/enhancing-our-dandenong-creek/daylighting-dandenong-creek.

infamous concrete channel that many people perceived, during the 1970s and 80s, as the future for many creeks within Melbourne’s network of watercourses.

Figure 142. The infamous concrete channel of Moonee Ponds Creek. Source: Author photo (2016).

Although realigning the Moonee Ponds from its original course into a concrete channel still attracts public comment, concern over the condition and treatment of Melbourne’s watercourses can be traced back as far as 1906. At that time the Essendon River League, the first public activist group advocating for a section of the Maribyrnong River, was formed (see chapter four page 29).[18] The league worked between 1906 and 1965 on improving a section of the Maribyrnong River and its adjacent, riparian lands with tree planting and landscaping, and monitored the general health of the river.[19] The league, formed by the Mayor of Essendon, included members of the public, local business and the council.[20] It was an historical forerunner to contemporary management committees and ‘friends of’ groups,

[18] Keilar, 1.
[19] Ibid, 1-6.
[20] Marilyn J. Kenny, *The Essendon River League 1906-1966* (Moonee Ponds, Vic.: Essendon Historical Society, 2006), 8-9.

formed in Melbourne since the 1980s. These groups advocate, restore and care for many watercourses across Melbourne.[21]

The concrete channel of the Moonee Ponds Creek was designed as an engineered solution for erosion control and flood mitigation. It became a standard design feature, with variants constructed along sections of many watercourses across Melbourne.[22] The Moonee Ponds Creek channel was highly visible, out on display for all to see, located as it was (and is) along the freeway route carrying people to and from Melbourne's International Airport. It was not hidden away behind back fences within suburban developments or disguised with revegetation and parkland. In addition, the Moonee Ponds realignment was completed just prior to Melbourne's first anti-freeway protests and a rising environmental awareness amongst specific groups of the public. These factors aided in directing public perceptions of Melbourne's watercourses away from being only stormwater drains, and convenient places to dump refuse.[23]

A similar, though larger scaled example and engineering marvel of the 20th century, is the Los Angeles River in North America. Describing the river's contemporary form landscape architect Gary Strang (1996) stated: 'the structure of the Los Angeles River is indistinguishable from the urban and residential structure of the city.'[24] 77 kilometres (47.9 miles) of the river's 82-kilometre (51 mile) length flows within a concrete channel, designed for extensive flood mitigation and protection of Los Angeles' urban fabric.[25] Since the 1990s however, sections of the public and various communities along the river developed an interest in revitalising the river and its corridor.[26] At the time of writing, the river was subject to a range of revitalisation plans and projects produced by the City of Los Angeles in conjunction with local community and river interest groups.[27]

As is the case with many if not most or all western cities since the 19th century, enormous change has taken place in Melbourne's waterways. This thesis has shown the course and implications of much of this change in the Melbourne context, much of it

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[21] Keilar, 1-2.
[22] Leigh and Melbourne Metropolitan Board of Works, 110-11; Victorian Public Interest Research Group and Ian D. Bishop, *The Merri Creek Study: A Review of Urban Creek Management, Past, Present, Future* (Parkville, Vic.: Victorian Public Interest Research Group, 1975), 94.
[23] Senior, 414-15.
[24] Strang, 10.
[25] Gumprecht, 174,227.
[26] Ibid, 3.
[27] "Los Angeles River Revitalization," City of Los Angeles, updated April 16, 2017, http://lariver.org/los-angeles-river-revitalization-0.

applicable globally. However, its extent is exemplified in a comparative study of the same place in the late 19th and early 21st centuries. In obtaining a contemporary (2017) snapshot of the use, management, public perceptions and general health of Melbourne's watercourses, a section of the Lower Yarra flowing from the confluence with Merri Creek to the eastern edge of the central business district will be examined. This reach of the river experiences similar problems to many rivers and streams across Greater Melbourne, and many cities globally. Part of this examination involves comparing the same reach of river with its reported condition in 1881. This is one of the few instances where a specific description of a reach along a river was written. Firstly, a day tour along this reach of the Yarra conducted in 1881 will be examined, and then exactly 136 years to the day, a contemporary tour of the same reach, as illustrated in figure 143, will be examined to compare conditions, uses and changed physical locations.

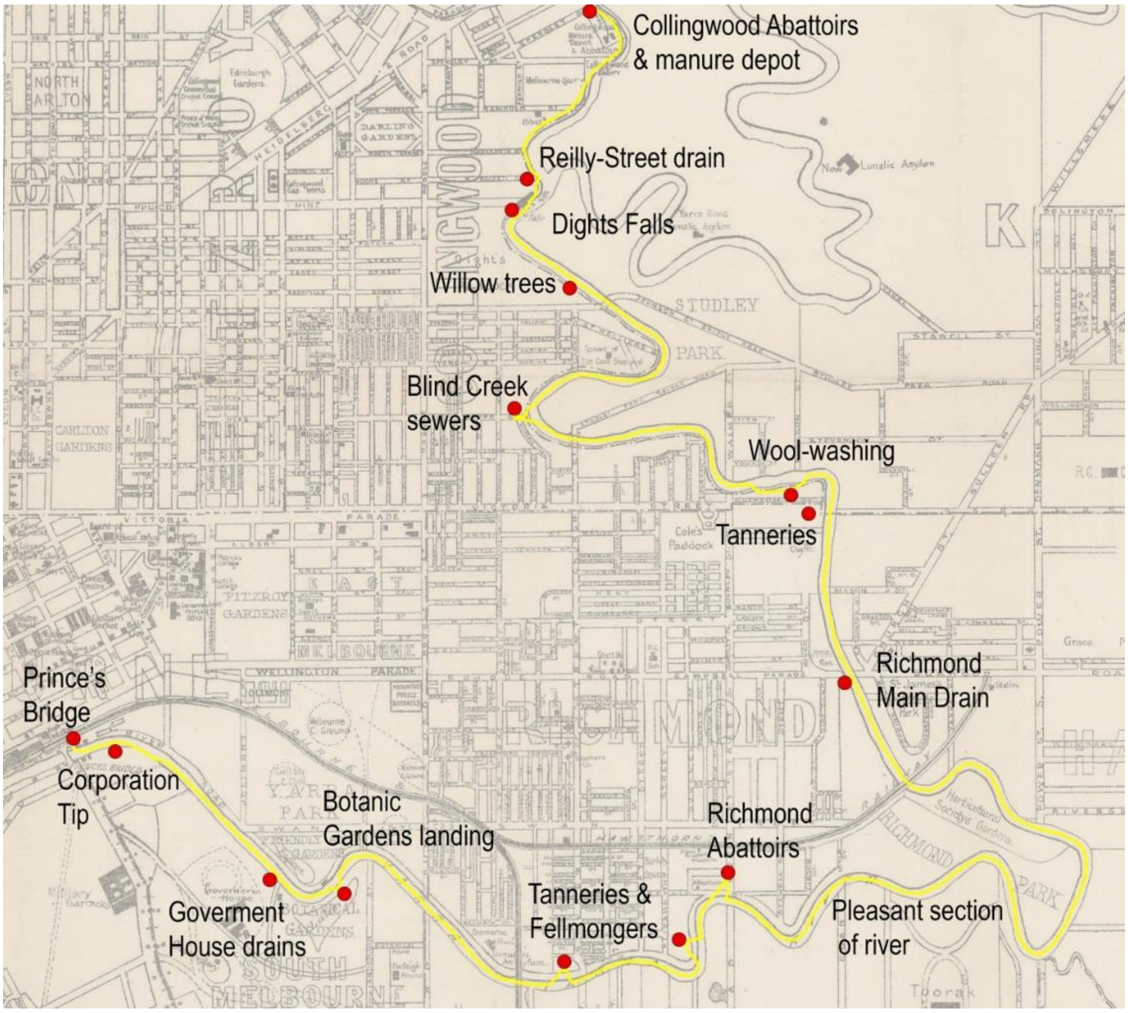

Figure 143. The route the City Council Health Committee took along the Yarra in 1881. Source: Base Map-SLV http://handle.slv.vic.gov.au/10381/115286 - tour route-Argus (1881).

On the morning of 8th April 1881, the Health Committee of the City of Melbourne commenced a tour of inspection along the Lower Yarra River with the aim of discovering the cause of pollution in the river.[28] Commencing on the Merri Creek at Collingwood, just upstream from the Merri's confluence with the Yarra, the committee's visual and olfactory senses were assaulted by a range of horrors; the first in a succession as they rowed down the river. The first site inspected contained abattoirs next to a night soil depot and adjacent to several basalt rock quarries.[29] So appalling was the condition of the abattoir, none of the committee would venture inside to inspect the works.[30] Waste from the works was heaped along the creek bank, to eventually flow into a bubbling pond, then on into the creek.[31] The infamous Reilly Street drain was inspected next, the committee forced to stand downwind of the discharge due to the repulsive smell emitted from the large amounts of filth flowing into the creek.[32] An earlier inspection of 1869 reported red-patches of filaments along the creek bank, assumed to be a species of waterweed.[33] On closer inspection, the filaments were identified as groups of thousands of parasitic intestinal worms that infect humans and animals.[34] Upon reaching the Yarra, the committee boarded a boat below Dights Falls, to view dead dogs and other refuse collected by low-hanging branches of introduced willow trees, planted to control bank erosion.[35] Access to the river was restricted to boats only, due to absence of paths or roads along the riverbanks and much of the land being in private ownership. The next sight to horrify the committee was Blind Creek, a small west flowing tributary, flowing black against the putrid river water. Two large underground drains discharged into the Blind with a third under construction, all draining the industrial suburb of Collingwood.[36] Passing downstream the committee observed a range of noxious industries including fellmongers, wool-washers, tanneries and more abattoirs, discharging mixtures of solid and liquid wastes into the Yarra. Just upstream from the eastern boundary of the city, the committee experienced the drains from Government House discharging into the river and runoff from the City of Melbourne's refuse dump, further adding to the noxious cocktail of

[28] "The Yarra Pollution," *Argus,* April 8, 1881, 7.
[29] "Pollution of the Yarra," 11.
[30] "The Yarra Pollution," 7.
[31] Ibid.
[32] Ibid, 7.
[33] "The Round of Yarra Pollution," 7.
[34] Ibid.
[35] "The Yarra Pollution," 7.
[36] Ibid.

Yarra water.[37] The committee's conclusion; since the causes of pollution were outside the City of Melbourne's boundaries, they were powerless to control or instigate any profound change to how the Yarra was being used and abused.[38]

On the 8th April 2017, the starting point of the 1881 tour is now public parkland with a range of sport and passive recreation facilities. The upper and lower banks of the Merri Creek have been extensively revegetated, and the creek area is classified under the 2017 Victorian Government Planning Scheme as: land subject to inundation; designated Public Park and recreational zone; and an area of environmental significance. The 2017 planning map of the Department of Land, Water, and Planning, indicated suburban development has been set back from the creek and a public trail system (Merri Creek Trail) traverses both sides of the creek that connects with other trails along watercourses. The Reilly Street Drain is now the Alexandra Parade Main Drain, named by the Drain Clan, an urban exploration organisation developed in 1986, as Great Oversized Drain.[39] The evolution of urban exploration groups, and sub-groups known as drainers, has occurred since the 1980s globally.[40] The popularity of such groups indicates changes in public interest and perceptions towards hidden urban infrastructure and undergrounded watercourses. The use of urban watercourses as stormwater drains is a major ongoing source of pollution and cause of degradation (see chapter two, page 30-1). Downstream from the confluence of the Merri Creek and Yarra River, Dights Falls are observed spanning the river. A vertical slot fish way was constructed in 2012, replacing an original rock ramp fish way constructed in 1992, to allow native fish passage around the falls.[41] Most native fish in the Yarra are diadromous or require access to and from salt water for their breeding cycle.[42] The construction of both fish ways signified engineering priorities was no longer the only issue behind managing Melbourne's watercourses.

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[37] Ibid.
[38] Ibid.
[39] D. Richter and Atlas Obscura, "Exploring the Storm Drains of Melbourne, a Secret Labyrinth of Tunnels and Creepy-Crawlies",accessed October 19, 2014, http://www.atlasobscura.com/articles/exploring-the-storm-drains-of-melbourne-a-secret-labyrinth-of-tunnels-and-creepy-crawlies.
[40] Bradley L. Garrett, "Undertaking Recreational Trespass: Urban Exploration and Infiltration," *Transactions of the Institute of British Geographers* 39, no. 1 (2014): 6.
[41] D. Borg, J. O'Connor, and M. Jones, "Evaluating the Effectiveness of the Dights Falls Fishway in the Yarra River, Melbourne Australia," in *7th Australian Stream Management Conference,* ed. G. Vietz, I.D. Rutherfurd, and R. Hughes (Townsville, Queensland: River Basin Management Society, 2014), 211.
[42] Ibid.

The next problem observed by the Health Committee in 1818 was refuse and debris caught in overhanging willow trees. Due to many willow species being classified as Weeds of National Significance, the trees are the subject of ongoing weed control and removal programs as part of Melbourne Water’s watercourse management practices.[43] Willows are no longer seen along the Yarra; however, litter caught in overhanging branches of indigenous vegetation, and litter entering the river in general, remains a major ongoing and costly management problem, as evident from the litter traps, as in figure 144, regularly moved along the river.

Figure 144. Litter trap on the Yarra near a main drain outlet. Source: Author photo (2016).

The noxious industries reported by the committee have long left from the Yarra, with many the sites developed for residential apartments. The wool-washing site’s wharf has been restored and incorporated into the Yarra Main Trail, used as a short-term landing for small boats. The remaining section of the Yarra toured in 1881 is within a strip of parkland that

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[43] L Pope et al., “Controling Willows Along Australian Rivers,” in *River and Riparian Land Management Technical Guideline* (Canberra: Land & Water Australia, 2006), 17.

continues downstream to the southern edge of the city, with the Main Yarra trail alternating from traversing both to one bank, depending on the extent of private land boundaries along the banks. Construction of the South Eastern freeway (now CityLink) in stages since the 1960s removed bends in the river and covered sections of the bank, infringing into the river in several sections.

Since the 1881 tour, the Lower Yarra has evolved from an industrial sewer into an important environmental and recreational asset for the city. As evident in the preceding chapters, the Yarra has always been the first watercourse to undergo modification, changes in uses and management practices. In February 2017, this tradition continued with the state government releasing the Yarra River Action Plan. The plan was developed for the long-term protection of the Yarra, its environs and adjacent parklands.[44] The plan outlines five main objectives to direct the development of legislation and reform of managing authorities to ensure protection of the river.[45] It aims to improve the health of the Yarra and riparian land; improve and recognise parklands along the river as a single network; identify, protect and promote the river's heritage values; protect river corridor from inappropriate development, while also recognising the economic importance of the river; and align the actions and decisions of all managing authorities involved with rivers management.[46] Once the plan is developed in full, a model will be developed and expanded to protect Melbourne's other major rivers, environs and parklands.[47] Development of the Yarra Action Plan was largely the result of a media campaign orchestrated by the not-for profit Yarra Riverkeeper Association in response to the lack of planning and environmental controls for the river.[48] As detailed throughout the previous chapters, many of the changes at policy and governance levels regarding the use and management of Melbourne's watercourses arose from public activism and avocation. Although attitudes towards watercourses by governments and the public have dramatically changed since the 1970s, the Riverkeeper campaign is a reminder government often require significant public response and action before policy changes are enacted.

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[44] Melbourne Water Corporation, "The Yarra Strategic Plan", updated January 3, 2018, https://www.melbournewater.com.au/about-us/our-customers/yarra-strategic-plan.
[45] Land Water Planning Department of Environment, Victoria, *Yarra River Action Plan: Wilip-Gin Birrarung Murron* (Melbourne: Department of Environment, Land, Water and Planning, 2017), 27.
[46] Ibid, 7.
[47] Ibid, 29.
[48] "Protecting the Yarra Must Be a Priority," *Age,* November 5, 2014, 22.

Conclusion

Since surveyor Charles Grimes became the first European to discover the Yarra River and area where Melbourne was later established, the region's watercourses have undergone rapid and dramatic modification. Although Melbourne is less than two centuries old, the waterscape of the area has been subject to the greatest changes. This thesis has detailed an urban environmental history of these watercourses, utilising data and records not before used in the specific study of watercourses. Identifying Melbourne's stream network as an individual urban network, positioned between the natural and designed, has provided a highly detailed examination of these vital resources. As illustrated within the preceding chapters and evident in many cities globally, urban watercourses have been commonly considered expendable commodities, readily modified for a range of uses including: combined sewers; stormwater drains; shipping channels; and freeway routes. Although the modification of watercourses for all types of uses and roles continues by the design disciplines throughout cities globally, the example of the current Yarra Plan and Rivers of the West campaign, strongly suggests public and government perceptions of urban watercourses are changing. Melbourne as with many affluent cities has recently come to value its urban watercourses as complex urban ecosystems. As an urban network, watercourses provide a range of landscapes and habitats within the harsh hardscapes of the built environment. This urban environmental history has proven just how vital watercourses have been for the sustained growth of countless cities globally and allowed the development and expansion of Melbourne within a region perceived by the first European explorers to lack vital sources of fresh-water.

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