2021

# Beyond Mains Water: A Study of Households that are Off-Grid for Water in Regional New South Wales, Australia

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# *Beyond Mains Water: A Study of Households that are Off-Grid for Water in Regional New South Wales, Australia*

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*This thesis is presented as part of the requirement for the conferral of the degree:*

*Doctor of Philosophy*

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Dr Leah Gibbs

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This research has been conducted with the support of the Australian Government Research Training Program Scholarship

University of Wollongong

School of Geography and Sustainable Communities

November 2021

# Certification

I, Carrie Wilkinson, declare that this thesis submitted in fulfilment of the requirements for the conferral of the degree Doctor of Philosophy from the University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. This document has not been submitted for qualifications at any other academic institution.

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Carrie Wilkinson

November 2021

Parts of the following publications completed in my candidature are reproduced in this thesis:

> Wilkinson, C. and Gibbs, L. 2021. Beyond mains water: A study of households that are self-sufficient for water in regional Australia. *Australasian Journal of Environmental Management* 28(2), 149-168.
>
> Wilkinson, C., Gibbs, L. and Waitt, G. 2020. The questionnaire survey as more-than-human achievement. *Area* 52, 354-363.

# Abstract

This thesis offers a new understanding of everyday life for households living off-grid from municipal water and sewerage systems. The thesis argues for household sustainability policy informed by existing adaptive capacities and experiments with alternatives to mains water infrastructure and governance systems in the Minority World. It does so through a research design that combined questionnaire surveys with semi-structured interviews and 'home-insight tours' conducted with participants who live off-grid for water in the Eurobodalla Shire, a non-metropolitan local government area situated on the south coast of New South Wales, Australia. Building on relational ontologies of everyday life, this thesis brings into conversation concepts from social practice theory and embodied feminist scholarship, to conceptualise the more-than-human, discursive, embodied and affective dimensions that shape everyday water practices. Across the empirical chapters attention turns specifically to developing understanding of human-water relations in the non-mains water home through three inter-related everyday water practices: provision, (re)use and disposal. Attention is drawn to the embodied qualities of skills and competencies in managing the material infrastructures of domestic water supply, and the discourses, sensuous bodies and emotions invested in practices of water capture, (re)use and disposal—elements that are often ignored in water policy debates. The thesis illustrates the importance of geographical relational thinking to conceive of domestic water self-sufficiency. Practices of provisioning, (re)using and disposing of water are always contingent upon the situated socio-material arrangements through which people make sense of themselves and home.

## Acknowledgements

I would like to acknowledge the Traditional Custodians and Country where this research was conducted the Dhurga people of Yuin Country. I would also like to acknowledge the Wadi Wadi people of Dharawal Country, the custodians of the lands, seas and skies where the majority of this thesis was written. I wish to pay my respects to Elders past, present and emerging and acknowledge their continuing connection to land, waters, culture and community.

I started this doctoral project in 2015 and there is a very long list of people whose support, input, and friendship has made it possible for me to produce this thesis.

First, a big thank you to everyone who participated in my study. This thesis would not have been possible without you. Thank you for completing my survey, for welcoming me into your homes, and for talking honestly, generously and eloquently about topics that must have seemed very strange and silly. I am very grateful for the time, the cups of tea, the cake and thoughts you shared with me.

My supervisors, Leah Gibbs and Gordon Waitt, deserve very special thanks for their tireless support, unwavering enthusiasm, and generous feedback. Leah I have you to thank for encouraging me to start this PhD journey when I was feeling lost after my undergraduate degree. Thank you for instilling in me a passion for geography and for helping me to find confidence in my writing and myself. Gordon, you have been a central figure in my university studies for a decade now, from undergraduate lecturer, to a supervisor for Direct Studies, Honours and now my PhD. It has been a joy to work with you. I have always felt encouraged and inspired by both Leah and Gordon and I am endlessly thankful to them both.

I consider myself extremely fortunate to be a PhD student in the School of Geography and Sustainable Communities at the University of Wollongong. Thank you to all AUSCCER/ACCESS staff for the great collegial atmosphere. Chantel, Nicole, Pauline, Vanessa, Laura, Michael, thank you for the corridor and tearoom chats. To our amazing support staff, Renée, Liz and Elyse, thank you not only for your help with the technical and administrative work involved in research but for your incredible kindness and generosity. Elyse, your pep talks pulled me out of a spiral more times than I can count, thank you.

I would like to thank my HDR colleagues and friends with whom I shared my PhD journey. Thanks to Rebecca, Susie, Sophie-May, Lance, Kiera, Makrita, Inka, Ville, Teaniel and Freya, for your years of friendship and support. The COVID social distancing restrictions and lockdown of the past 2 years has amplified how much I appreciate your friendship and our lunches, dinners, games-nights, bushwalks and catch-ups. Even as we go our separate ways post-PhD, I'm looking forward to carrying our friendships into the future.

Thank you to my family, near and far, for your love and support. Thanks to my brother Ross and sister-in-law Juliette. Thank you Mum and Dad for encouraging my curiosity and love of research. Even if you didn't fully understand what I've been doing all these years at university or why it was taking so long to submit this thesis, you gave me the foundations and passion for learning and for that I am forever grateful.

Thank you to my in-laws—Lorna and Tom, Nereash, Grant, little Jack and bub, Nonno, and the extended Nicholson and Inzitari families—for welcoming me into the family and for always being interested and excited about my PhD journey and research, even when my own enthusiasm waned.

Thank you Elaine, Nadine, Amber and Anna at TCG for always supporting my pursuit of higher education and research as I tried to balance study and work. Thank you for allowing me to disappear from the office for fieldwork and for always welcoming me back. I will always be grateful for the experience, mentorship and friendship at TCG.

Thank you to Donny, Matt and Felipe for giving me the opportunity to get a foot in the door at DPIE/NPWS with an APR internship during my candidature. Thank you Donny for taking a chance on a human geographer and thank you Bre, Phoebe, Nav and Andrew for welcoming me into the Bushfire Risk and Evaluation team and supporting me through these final months to PhD submission. Thank you Christine for introducing me to and mentoring me in the world of fire, and to Josh and Kat for continuing to support and encourage me in it.

Finally, I would like to thank my husband Zak Nicholson for his unwavering patience and support, who never asked me when I would be finished, and who would tell me whenever I was feeling down that submitting a thesis 'on time' isn't the point, 'What is more important is what you learn and what you do. It's about who you become along the way'. Well I am finished now. Let's go kayaking.

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# Chapter 1
# Introduction

## 1.1 Background to the research

I began writing about the experiences of households that are off-grid for water back in 2014. At the time, I was working at the University of Wollongong as a Research Assistant on a project exploring the experiences of residents threatened by bushfires in October 2013 in the Blue Mountains, New South Wales (NSW), Australia. A large sample of the participants interviewed in the study lived in dwellings off-grid for water. They relied solely on household collected rainwater, stored in water tanks on-site, for both everyday subsistence and firefighting. We found that the availability, or scarcity, of water influenced survival related decisions and outcomes during the bushfires (Wilkinson and Eriksen 2015). Specifically, the resilience and adaptive capacity of non-mains water households to the bushfire threat relied heavily upon two attributes. First, a heightened awareness of high fire danger weather. Second, the foresight to monitor and restrict household water consumption with a view to conserve tank water for firefighting. But my interest in off-grid water practices began long before 2014, with my own childhood experiences with water at home.

I was born in 1991 and raised in the Eurobodalla Shire, a non-metropolitan local government area on the south coast of NSW. For the first six years of my life, I lived in a detached dwelling on mains water[1], with my parents and younger brother, in suburban Batemans Bay. For most of the early years of my life, the southeast of NSW was in

[1] *Mains water* is the term I use in this thesis to describe the centralised piped town-water network managed by a water utility; i.e. the 'water grid'. In the Australian context, *reticulated water* is another commonly used term to describe the piped water network.

drought. From late 1996 to mid-2010, much of southern Australia experienced a prolonged period of dry conditions, known as the Millennium Drought[2] (BOM 2021a). For many communities, particularly (sub)urban communities connected to mains water, the experience of drought manifested in restrictions on water use. Water utilities across the state mandated restrictions on mains water use to avoid critical water shortage as dam levels fell. These restrictions related largely to curtailing outdoor water use—including restricting the methods, timing, and duration of watering gardens and lawns, topping up pools, and washing surfaces and vehicles—and became progressively stricter as the drought wore on. In the Eurobodalla Shire, at one point, garden watering was restricted to before 10am and after dusk and households were permitted to water for a maximum of 60 minutes per day using buckets and hoses with trigger nozzles on an 'odds and evens' system[3].

Some of my earliest memories are from this time of mains water restriction. Even though I was only five or six years old, I can still recall the smell of water evaporating from the dry ground as neighbours emerged from homes at dusk to water wilting gardens and dying lawns on their allocated day. Neighbours would wave over the fence and from across the road in the evening twilight, catching up on gossip and talking inevitably about the weather forecast, garden hoses and buckets in hand. I can recall, at the height of summer, the thrill of it being our day to water the garden, and dashing

[2]The date of the Millennium Drought differs even between official records and states but dates range from 2001-2010 (DPI 2021), 1995-2009 (Head et al. 2014), and 1997-2009 (BOM 2021a), for example.

[3]On an 'odds and evens' water system, odd numbered properties are permitted to water on odd numbered calendar dates, even numbered properties are permitted to water on even numbered dates. The 31st of the month is a watering-free day. For a contemporary breakdown of this restriction regime, refer to Bathurst Regional Council (2020), for example.

outside in swimmers with my brother to be sprayed intermittently with the garden hose as my dad, an avid gardener, tended to the plants.

When I was six years old, we moved out of town to a five-acre property that was off-grid for water. There were two rainwater tanks—one corrugated steel, the other concrete—and an empty dam when we moved in. For the remainder of my childhood and teenage years rainwater would be our drinking water, captured from the roof and stored in rainwater tanks. An on-site septic system with absorption trench system would capture and store wastewater from the kitchen, laundry, bathroom and toilet.

For my parents—having both grown up on farms reliant on rainwater, river water and spring water—being off-grid for water didn't seem like a big deal. But still, ongoing drought conditions necessitated the implementation of restrictions on both our outdoor *and* indoor water use. This time, mum and dad called the shots. A flow restricting showerhead appeared in our bathroom. Shower duration was timed and lingering beyond 3 minutes, and a sharp knock on the door, brought the rude shock of the hot water being cut off as the kitchen tap was turned on. When it came to flushing the toilet, we lived by the adage 'if it's yellow, let it mellow'.

Regardless of these challenges, tank water became our drink of choice. On day trips, we travelled with insulated bottles of our water in our bags, long before it was environmentally savvy to refrain from buying bottled water, so we wouldn't have to drink 'town water'. Whenever we stayed away from home, we travelled with a jerry can of water from the tanks at home. The jerry can would sit on the kitchen bench in whatever caravan park or hotel we were staying in and we'd top up our water bottles from it.

On a family road trip through southern and central Australia in 2003, at the height of the Millennium Drought, my travel diary captures my fascination with water. I was apparently appalled that there were few flow restricting showerheads in the places we stayed, despite signs on the town border and notifications from the manager that water restrictions were in force and to restrict shower time. I also rated shower flow for comfort and water for taste.

By the time I left home at 18, we had another two rainwater tanks installed (both poly-plastic[4]) and the Millennium Drought had broken (**Figure 1.1**). I moved to Wollongong to attend university, whereupon my (re)education in living with mains water commenced. For the last 12 years I have lived in various dorms, share houses and apartments, all on mains water. In this new world of freedom from parental surveillance, I could shower for as long as I wanted (and I did). There was no one policing my water use. Water rates and usage costs have been included in the fixed rent and strata fees of every place that I have lived in Wollongong. I haven't had to pay for mains water use and I'll admit, much to my shame (and my parents chagrin, I'm sure), that my main trigger for ending a shower these days is that the water heater has run out of hot water. But some habits and sensations have been harder to shift. Some of my flatmates left the tap running when they brushed the teeth, prompting a lecture from me. A leaking toilet cistern or tap inspired no sense of urgency to repair in my flatmates—a maintenance ticket would be lodged with the landlord and a plumber would arrive several weeks later, despite my agitation, to replace a simple washer or rubber seal.

[4] Made from polyethylene plastic.

**Figure 1.1:** The rainwater tanks at my family home. Source: Author, 1 March 2016.

I was oblivious to how these memories of water at home, whilst travelling with family and living with friends, would linger, and how I would circle back to my interest in water in time. Reflecting on these experiences now, my relationship with water has changed several times over in my 30 years of life. Even now, as I submit this thesis, it is set to change yet again. My husband and I are leaving our small apartment in Wollongong and moving back down the south coast, hoping to find a house of our own, on acreage, and with rainwater tanks. It is this interest in human-water relations configured through different infrastructures and governance regimes—of rainwater tanks, septic tanks, mains pipelines, dams and water treatment plants, of water bills, water meters, restrictions, landlords, and off-grid—that informs the present research.

This thesis is about everyday experiences of living off-grid for water and sewerage. My focus is on the provisioning and management of water for domestic purposes. I acknowledge but do not engage in depth with the history and implications of changes in demand on water and in water use by agriculture, industry and for energy production (hydroelectricity). Further, my focus is on the water of colonial-settler government agencies, policy makers and engineers. These are the powerful agents, structures and ontologies that have dictated and continue to dictate how water is managed in Australia. This thesis does not attempt to document the diversity and complexity of Indigenous ontologies of water.

In defining this second parameter, I remain mindful that the omission of Indigenous water histories and voices risks perpetuating the silencing and erasure of Indigenous water relations and perspectives (Jackson and Head 2020). I acknowledge, first, that Aboriginal and Torres Strait Islander peoples have lived within the variable limits of water abundance and scarcity on this continent now known as Australia for at least 60,000 years (Clarkson et al. 2017; Nunn 2019). Second, water and watery places help define language and territorial boundaries and ceremonial places (Georges Riverkeeper 2012; Ryan 2014). Third, beliefs and ideas associated with water underpin the beliefs of many Aboriginal groups about how the world attained its present form and shape (Reid et al. 2014; Doak 2021).

In omitting a detailed discussion on Indigenous approaches to water governance, both maintained or more recently proposed, I am mindful of Jackson and Head's (2020, p.46) warning that:

> Any attempt to unpack formative settler colonial state and techno-scientific rationalities must avoid reinforcing the colonial violence of erasure that is enabled by modern water […]. In settler colonial contexts as here, the things that are rendered visible in an account of modern water's development are partly

absences, including historical erasure and the dispossession of Indigenous peoples and their water relations.

I do not wish to perpetuate the silencing and erasure of Indigenous water relations and perspectives, and yet I find myself largely omitting these voices from my thesis. I am not an Aboriginal or Indigenous person—I am a white settler woman descended from convicts—nor was my research conducted through an Indigenous epistemology.

Aboriginal people have ongoing connections to water, with water playing a vital role in communities' cultural, spiritual, emotional and physical wellbeing (Rose 1996; 2004; Barber and Jackson 2012; Marshall and Kirby 2017) and are actively involved in its management (Jackson and Moggridge 2019). However, water is valued not only for what it can provide humans, but also for what it is in itself. Indigenous ontologies recognise the agency of water and watery places, comprising human and nonhuman things and their interrelations (Jackson 2006; Gibbs 2006). There is arguably some consistency between Indigenous and relational ontologies (Gibbs 2013). I take up in this thesis the invitation by Bawaka Country et al. (2015) to think more deeply about *connections,* about *living as part of the world,* about *an ethics of caring.* The relational approach advocated for thinking with water tanks and decentralised water systems in this thesis resonates with Indigenous ontologies of Country and water. These are points that I endeavour to acknowledge and revisit throughout my thesis.

## 1.2 Rainwater tanks and water self-sufficiency in Australia

Australia's climate is characterised by highly variable rainfall and frequent drought (BOM 2020). Approximately 80% of mains water consumed in Australia is derived from surface water resources; that is, rivers, streams, and dams (BOM 2017). In recent decades, Australia's surface and ground water resources across much of the south of the continent have come under pressure through expanding urban populations, increased industrial and agricultural use, the need for water to manage and restore threatened aquatic ecosystems, and the influence of Anthropogenic climate change on regional, seasonal, and annual rainfall variability (Chiew et al. 2011).

Against this backdrop are extensive debate around climate resilient water infrastructure, for securing the provision of water in mains water contexts. Investment in expansion of 'Big Water'[5] infrastructures (Sofoulis 2005, p.452)—namely dams, pipelines, and centralised wastewater treatment facilities (as well as desalinated and recycled water treatment plants)—are at the forefront of discussion (National Water Grid Authority 2020). Despite interest in decentralized solutions for water management at suburban and community scales (City of Sydney 2012), little attention is paid to possibilities afforded by household scale water infrastructures; what I call 'small water' infrastructure (for exceptions see Mankad and Tapsuwan [2011] and Tapsuwan et al. [2014]).

Rainwater tanks are a key non-mains source of water for Australian households. In 2013, for example, the Australian Bureau of Statistics (ABS) (2013) reported that 34.3% of households with a dwelling suitable for a rainwater tank had at least one installed[6]. Of Australian households that had a rainwater tank in March 2013, just half (50.4%) had it plumbed to a tap or outlet *inside* the dwelling (ABS 2013). This figure varied considerably geographically, with a lower proportion of households in capital cities

[5] *Big Water* is the term given by Sofoulis (2005) to centralised, large scale water sources and infrastructures which are controlled by a public (government) or corporate utility.

[6] At the time of writing, more recent national figures are not publicly available.

plumbing tanks into the dwelling (32.7%), as compared to the balance of the state/territory (66.7%) (ABS 2013). These figures reflect not only differences in public perception of rainwater, but legislation, climate, and local mains water quality and availability (Campisano et al. 2017; Chubaka et al. 2018). Significantly, for this thesis, in 2013, 15.8% of Australian households that had installed a rainwater tank did so because they were *not connected* to mains water (ABS 2013). In these off-grid contexts, household-captured rainwater provides the primary or only water source.

This thesis examines the experiences of households that are off-grid for water. These households are not connected to mains water and, in most cases, sewerage grids, relying instead on rainwater tanks and on-site septic tank systems for water self-sufficiency. Being off-grid for water disrupts the normally hidden processes of urban water delivery, treatment, and disposal. In contrast to Big Water, rainwater tanks and septic systems are built and maintained at the household and community scales (Ormerod 2016). Investigating how people live with these technologies provides an opportunity to contemplate and challenge taken-for-granted technologies of centralised water management and to recognise alternative modes of managing and living with water.

This doctoral project builds on insights from a small body of work, largely from North America and the United Kingdom, which examines water use practices and experiences of households and communities that are off-grid for both water and energy (e.g. Pickerill and Maxey 2009; Vannini and Taggart 2014; 2015; Pickerill 2016; 2017; Forde 2020). In terms of water, residents in these contexts take an active role in collecting, storing, (re)using, and disposing of water by becoming physically involved in managing and maintaining infrastructures that channel water into and out of their homes. These include technologies of rainwater tanks, wells and bores, on-site septic systems, and composting toilets. Although the mechanics of water self-sufficiency off-grid are generally uncomplicated, decentralisation involves a commitment by users to a more flexible, interactive and grassroots approach to water and waste management (Ormerod 2016). Off-grid water practices have been described as onerous when compared to mains; householders must engage in the labours of maintaining and repairing tanks, pipes, and pumps and monitoring water quality and use, which can be physically demanding and skilled activities (Vannini and Taggart 2016). That said, research documents how 'hands on' engagement with water and autonomy over its management can be experienced as a satisfying and pleasurable way of life (Vannini and Taggart 2015; Pickerill 2017). This emerging corpus of work highlights how living off-grid for water—relying on the infrastructures of rainwater tanks and on-site septic systems for the provision and management of water—has potential to trigger new values and practices of domestic water use. In sum, residents take *responsibility* for managing water supply and, in doing so, water consumption becomes more conscious and sustainable (Woelfle-Erskine 2015a; 2015b; Vine 2017; Ternes 2018).

I turn to the practices, experiences, and perceptions of households that are off-grid for water in a bid to push further for innovation and adaptation in a time of climate uncertainty. These people's lived experiences as managers of domestic water capture, consumption and disposal, and past endurances of water abundance and scarcity, provide possibilities to rethink everyday life and 'becoming differently modern' in the context of a changing climate (Head and Gibson 2012; see also Waitt 2018). As the water sector looks to diversify sources of domestic water to better adapt to uncertain futures, it is helpful to understand how households already subsist with alternative infrastructures to dam-supplied mains water in everyday life.

## 1.3 Research aims, research questions and conceptual approach

The overarching aim of this thesis is to better understand the everyday lives of households that are off-grid for water in regional Australia. To address this aim, I explore the following research questions:

1) How are rainwater tanks understood as a source of domestic water in Australia in relation to the wider socio-material contexts in which these infrastructures are situated, such as institutions, regulations, and homes, over both time and space? (**Chapter 3**)

2) How do water practices take shape in relation to the human and non-human bodies, materials, technologies, subjectivities and places that make up everyday life in households that are off-grid for water? (**Chapters 4, 5 and 6**)

3) How does understanding human-water relations in off-grid contexts contribute to unsettling dominant understandings of water provision, use and disposal in mains water contexts? (**Chapters 4, 5 and 6**)

To address these questions, this thesis adopts a relational approach to the study of households that are off-grid for water. This analytical framework offers a critical alternative to 'rational choice' models such as the Theory of Planned Behaviour (Ajzen 1991), which dominate water governance (Shove 2010; Browne 2015). This liberal paradigm conceives of households as composed of active rational decision makers in resource use. Intervention in water consumption can be simplified to a linear trajectory of 'attitudes, behaviour, choice' (ABC). That is, to make a rational choice, individuals need to be provided with 'the right' information to assist them with their decisions (Browne 2015). The figure of the responsible, rational consumer is central to liberal climate policies targeting household consumption and behavioural decisions (Dubois et al. 2019). Motivated largely by economic drivers, households are comprised of consumers. Social scientists, including science and technology (STS) scholars and human geographers, have critiqued such 'black box' approaches to understanding households and domestic water use (Lane and Gorman-Murray 2011; Gibson et al. 2013). Missing is how people engage in water use in ways that coalesce around an appreciation of differences in social relations, discursive values, materials, infrastructures and contexts, as well as practices over both space and time (Strengers and Maller 2012; Shove et al. 2012).

I adopt a relational framing to explore household water-self-sufficiency because it is well suited to making sense of the entanglements of 'biophysical matter, people, decision-making processes and institutions, infrastructure and other mediating technologies and cultures of daily practice' (Gibbs 2013, p.469). Relational approaches unsettle the notion of water as a discrete and separate entity that exists and behaves in a predictable and homogenous manner across time and space (Walker et al. 2011; Gibbs 2013; Lehman 2013a). Relational approaches 'foreground water as an integral part of social and political relationships, arguing that, rather than being imposed, water's meanings are emergent from these relationships' (Krause and Strang 2016, p.634).

The conceptual and methodological approach adopted in this thesis is underpinned by a relational ontology that while attentive to more-than-human agency does not jettison the importance of the social. I bring into conversation literatures informed by social practice theory and embodied feminist scholarship, for their capacity to conceptualise the more-than-human and affective dimensions that shape household water relations. This conceptual approach draws into focus the embodied qualities of skills and competencies in managing the material infrastructures of domestic water supply, and the discourses, sensuous bodies and emotions invested in practices of water capture, (re)use and disposal (refer **Figure 1.2**).

**Social relationships**

(family, friends, neighbours, colleagues)

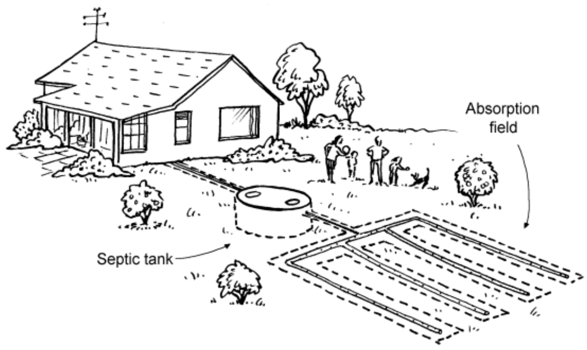
**Everyday practices**

(bathing, washing-up, cleaning, drinking, watering)

**Embodied histories**

**Off-grid systems**

(rainwater tanks, septic systems)




*The off-grid for water household*

**Embodied or tacit knowledge**

(learning through experience)

**Domestic appliances and infrastructures**

(dishwashing machines, washing machines, taps, sinks, showers, toilets)

**Social norms**

(ideas of comfort, convenience, cleanliness etc)

**Place**

(home, proximity to rivers, grass, clouds, sun)

**Discourses and institutional norms**

(learning through information sources – e.g. science, water authorities, BOM, water board)

**Mains water systems**

(water carting, water bills, pipelines, mains water, sewerage treatment plants)

**Figure 1.2:** Diagrammatic summary of the conceptual framework: understanding everyday household water consumption as a site of reciprocal relationships. Source: Author and G. Waitt (central image from NSW DLG 2000).

There is an upswelling of research on human-water relations in the past 20 years. Terms such as the hydro-social cycle (Bakker 2003; Kaika 2005; Linton and Budds 2014), waterscapes (Swyngedouw 1999, 2004), and water assemblage (Gibbs 2013) are used to conceptualise relational understandings of water. What brings these concepts and literature together is that they think beyond binaries and discrete categories. This is enabled by thinking about the relations between and constituting, things, processes, emotions and affects. Bringing the relational approaches and scholarship of practice theory and embodied material feminism into conversation, the off-grid for water home is conceived as a becoming that is constantly being worked at, maintained and reproduced through the movement of proximate materials, bodies and their affects.

I argue that domestic water use is always a relational, more-than-human achievement. In doing so, I contribute to scholarship that challenges the view that household sustainability is best addressed by economic imperatives and policies that leave the current economic and social systems intact. A relational understanding of water draws attention to the various things and circumstances that, in effect, make water what it is. Following Linton (2010, p.30), I argue that water, including wastewater, is not a thing but, rather, 'is a process of engagement, made identifiable by water's emergent properties but always taking form in relation to the entities with which it engages'.

It is important to note, in outlining the conceptual framing of the thesis here, that this thesis does not have a standalone literature review or conceptual framework chapter. Instead, each empirical discussion chapter draws out and foregrounds different threads from a broadly relational conceptual approach and brings these elements into conversation with distinct bodies of literature. This thesis is situated in the discipline of human geography, but also draws upon diverse influences from STS, sociology, environmental history and anthropology. Developments in the thematic literatures are discussed in the introductory sections to the respective results chapters. **Chapter 5** brings together insights from family studies literature, which thinks about families as a process, with scholarship on household sustainability, disposal and the ethics of waste; **Chapter 6** brings into conversation literature on the politics of measurement with research that highlights the importance of everyday embodied practices and knowledge in household resource consumption; and **Chapter 7** draws material geographies into closer conversation with scholarship on relational environmental values.

## 1.4 Research significance and contributions

The significance of this thesis is three-fold. First, the thesis explores the experiences of households that are off-grid for water. Little knowledge exists on off-grid living (Vannini and Taggart 2014). The available off-grid literature is dominated by studies from two empirical contexts. The first is concerned with experiences of residents living in off-grid 'eco-homes' and/or 'eco-communities' (Pickerill 2017; Forde 2020; Vannini and Taggart 2015). These homes and communities are intentionally designed, built and occupied to have less environmental impact than 'conventional' homes. The second is concerned with residents' experiences with off-grid energy resources (e.g. Forde 2017; Hope et al. 2018; Roberts 2020). Indeed, in most cases the expression 'off-grid' is synonymous with being disconnected from mains electricity and gas networks (Vannini and Taggart 2015). Big Water infrastructures, including dams, irrigation systems, mains water networks, and water meters, are often the focus of critical geographical scholarship investigating various water governance regimes and management practices. There is a dearth of research on the everyday lives of households that are off-grid for water relying on decentralised infrastructures—such as rainwater tanks, bores, wells, rivers, dams, lakes and creeks, on-site septic systems and compositing toilets—for water provision and management.

Second, this thesis is concerned with households that rely on rainwater tanks for subsistence in regional and rural contexts. Studies of rainwater tanks *supplementing* mains water supplies dominate the social sciences literature, in both urban and regional contexts (e.g. in southeast Queensland, Gardiner 2009; 2010; Gardner and Vieritz 2010; Mankad et al. 2012; Mankad and Gardner 2014; in central Victoria, Hurlimann 2011; Sherval and Askew 2012; Stebbing et al. 2013; Rogers et al. 2015; in rural South Australia, Pearce et al. 2010; 2012; and in urban NSW, Moy 2012). In these contexts, households are connected to the mains water, and sewerage, grids and rainwater tanks are a secondary source of water, usually for gardening purposes. I argue that 'small water' infrastructures and decentralised technologies that are not part of a reticulated system have not received the same level of attention, particularly in Minority World[7] contexts (see also Sultana 2013). The relative focus in Minority World studies on large scale infrastructure and governance systems may reflect the universalising, unifying and scientific understanding of water under modernity (Head et al. 2018), in which 'local, place-based practices and perceptions of qualities of different waters were deemed 'backward' or 'uncivilised" (Bakker 2012, p.617-618). There is opportunity to learn from alternative models of water provision at the household scale in contexts constituted as regional and rural.

Third, this thesis contributes to the household sustainability and everyday water culture literature. The goal of sustainability research and policy interventions is often to alter everyday practices (Foden et al. 2019). However, Browne et al. (2019) argue that sustainability research tends to focus on policies, infrastructures, communities, and practices that emphasise the 'new' and 'novel' (e.g. Dimpfl and Moran 2014; Lovell et al. 2018). Focusing on new and intentional interventions downplays the capacity for adaptation stemming from peoples' already existing everyday practices (Carr and

[7] I follow Head et al. (2019) by using the terms Minority World and Majority World (rather than First World–Third World, developed–developing world and North–South) because they do not contain embedded geographical inaccuracies (as in North–South) and avoid the implication of inferiority (as in First–Third and developed–developing).

Gibson 2016). The quest to intervene in domestic resource consumption—particularly through technological interventions that automate practices of resource use—can overlook (Mela et al. 2018; Browne et al. 2019) and sometimes even undermine (Dimpfl and Moran 2014) sustainability practices in which people already engage.

Scholars argue that there are considerable opportunities for learning from aspects of daily life where households already make use of diverse 'analogue' techniques and technologies, such as rainwater harvesting, line drying, cycling, and growing food at home (Gibson et al. 2013; 2015). This research asks what kinds of household practices can be retrieved and revived on a larger scale as we look towards a future of greater infrastructural challenges and disruptions to supply (Maller and Strengers 2013). This thesis makes a novel contribution to this research by exploring household practices, experiences, and perceptions that are off-grid for water. I seek insights into how human-water relations (re)configured through dependency on rainwater tanks and on-site septic systems might challenge and productively intervene in discussions about domestic water provision and management in Australia, and the Minority World.

## 1.5 Research context – water self-sufficiency in the Eurobodalla Shire, NSW, Australia

The research context for this thesis is the Eurobodalla Shire, a non-metropolitan Local Government Area (LGA) of approximately 37,232 people (ABS 2016), on the south coast of NSW, Australia (**Figure 1.3**). Set between the Great Dividing Range and Pacific Ocean coastline, two hours east of Canberra and four hours south of Sydney by road, the Eurobodalla Shire covers approximately 3,400km$^2$ of land and is characterised by a mixture of low-density development, farmland, wetlands, rivers, remnant rainforests and bushland. More than 80 percent of the land is either national park or state forest

(ESC 2021a). The Eurobodalla LGA is situated on the unceded lands of the Dhurga people of Yuin Country.

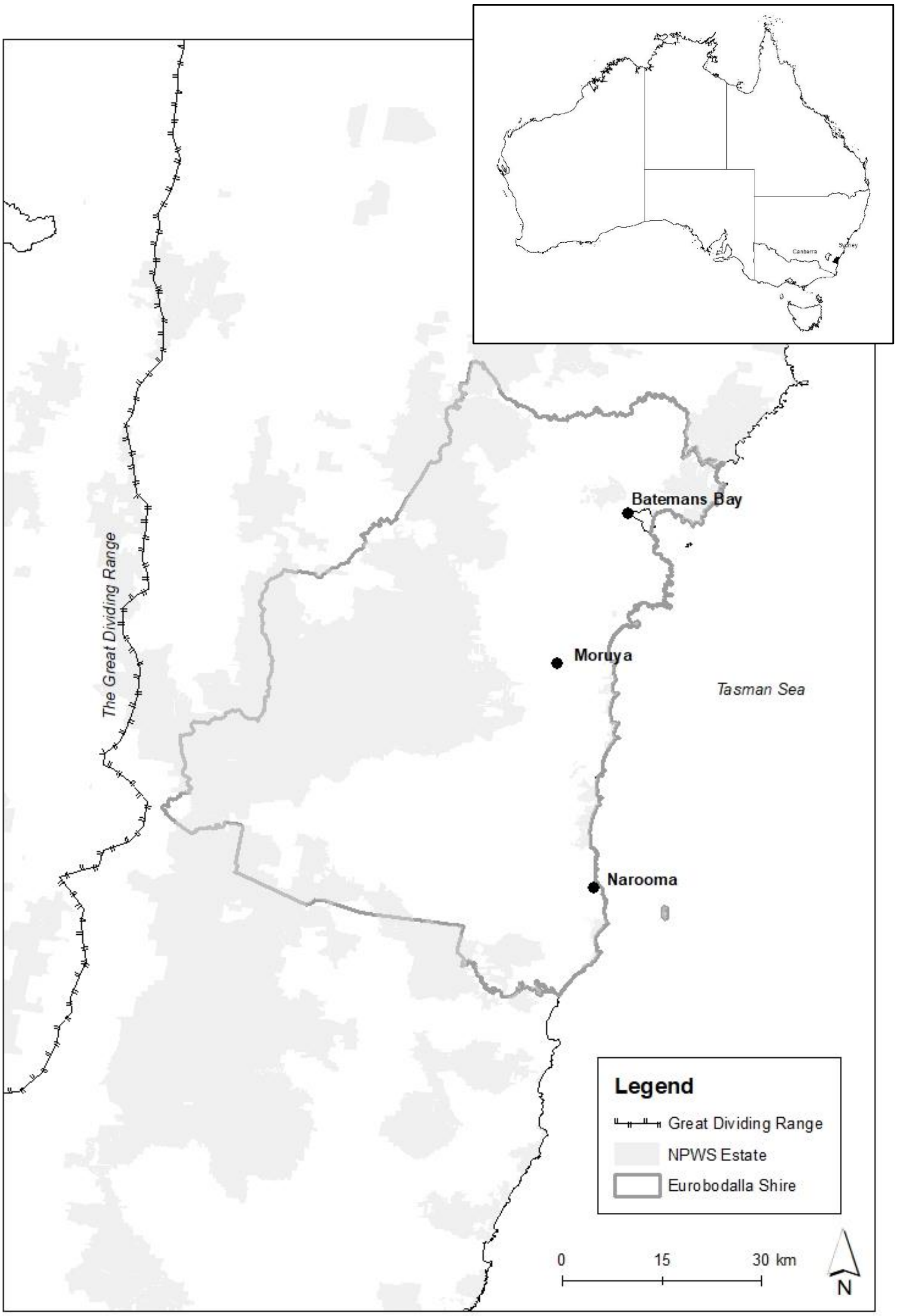



**Figure 1.3:** Map of the Eurobodalla Shire local government area, NSW, Australia. Source: Author.

The Eurobodalla Shire provides a salient case study of households that are off-grid for water for three reasons. First, approximately 16%–18% of dwellings in the Eurobodalla LGA are *not* connected to mains water (Hydrosphere Consulting 2016); slightly higher than the balance of NSW (excluding the state's capital) of 12.6% (ABS 2013). The water needs of households in communities and dwellings not connected to the mains water grid are met predominantly by roof-captured rainwater, stored in water tanks on site. Many households have private bore water entitlements for gardening or irrigation use. During periods of low rainfall and/or high-water consumption, individual households may purchase truckloads of mains water from water carriers operating under the regional utility scheme.

Second, municipal authorities in the Eurobodalla Shire grapple with the trilateral pressures of population growth, low water storage capacity and variable rainfall patterns. A key tourist destination, the Eurobodalla Shire economy relies largely on the seasonal income from tourism; the visiting population is approximately 1.2 million people per year (ESC 2020). The Eurobodalla Shire caters to peak volumes of visitors over the summer, Christmas and Easter school holidays. The Shire's resident population is estimated to triple to approximately 120,000 people during the summer months (ESC 2006; 2010). This influx of people has a major impact on local services and infrastructure, particularly the mains water supply and sewer system (ESC 2010). The average mains water use in the Shire per day is around 8 million litres, which increases to up to 23 million litres each day in the peak summer and Easter holiday seasons (ESC 2016).

The Eurobodalla Shire Local Government Council exercises mains water supply and sewerage functions under the *Local Government Act 1993* (DPIE 2021). The

Eurobodalla's mains water supply system services approximately 20,000 properties, including the major population centres of Batemans Bay, Moruya and Narooma. The reticulated water system relies on flows from the Deua and Tuross Rivers. Currently, one dam (Deep Creek Dam, constructed in 1983) provides storage as a backup for times of low river flows when it is no longer possible to draw water from the river systems. Construction of a second off-stream dam is planned to 'drought proof' the Eurobodalla Shire's water supply in light of recent state government legislative changes, which limit the amount of water that can be extracted from rivers (ESC 2018). In October 2019, the project was approved by the NSW Department of Planning, Industry and Environment (DPIE 2019).

Rainfall across the Eurobodalla Shire is highly variable, both seasonally and regionally (BOM 2021b). However, the Australian Bureau of Meteorology (BOM) reports a marked decline in the average annual rainfall in the region since 1999 (BOM 2020). Despite this broader, long-term decline in average rainfall, the Eurobodalla Shire had no shortages or restrictions on mains water consumption[8] during the fieldwork, which was undertaken in mid-2016. Indeed, in the 5 years preceding the fieldwork (2010-2015) many parts of the region received above average annual rainfall (BOM 2021c).

The third reason for exploring householders' experiences of living off-grid for water in the Eurobodalla Shire relates to my own positionality. As previously discussed, I was born and raised in Eurobodalla Shire and spent my childhood and teenage years with my parents and younger brother living on a 5-acre property that is off-grid for water and sewage. I have come to know the Eurobodalla Shire through travelling for school events and sport commitments, for day trips sightseeing with family, and visiting

[8] I describe mains water restriction regimes in **Chapter 3**.

friends. My parents still live in my childhood home and I frequently returned to visit and for holidays throughout this doctoral project. For almost three decades I have drunk and bathed in household collected rainwater. This familiarity with the study site and being off-grid for water in the Eurobodalla Shire not only allowed me to tap into local networks for recruitment and publicity, but it gave me different insights into the research questions. I discuss this further in **Chapter 2**.

## 1.6 Structure of the thesis

This thesis explores the experiences, practices and perceptions of households that are self-sufficient for water in a regional area of NSW, Australia. The thesis is not intended to provide a definitive, all-encompassing account of life with rainwater tanks and septic systems. Rather, the chapters examine moments in domestic water supply, use and disposal, to help understand how human-water relations are (re)configured through reliance on decentralised water management infrastructures.

The thesis consists of seven chapters, including this Introduction. Chapters 2 and 3 are contextual and set the methodological and historical-discursive contexts of this study. These are followed by three empirical discussion chapters of living off-grid for water in the Eurobodalla Shire, which provide insights into household experiences, practices and perceptions. Punctuated through the presentation of the empirical data and analysis are reflections from my own experiences in the field and embodied history as they shaped the data collection, analysis and writing processes—these reflections take the form of short narratives, or 'ripples', between each results chapter. The final concluding chapter ties the story together, highlights the contributions of this thesis and the opportunities for further research. Here I outline the remaining chapters of this thesis in turn.

In **Chapter 2**—'Methodology: Going with (and against) the flow'—I detail the research methodology. The chapter is structured in three parts: approaching, designing, and doing. Part 1 provides justification for an everyday water sensory ethnographic methodology, which combines survey (postal and online),semi-structured interview and home-insight tour methods. A focus on relational ontologies and the agency of materials in homemaking necessitates a methodology that is alert to the more-than-human world. My methodological approach sits at the intersection of post-structuralist feminist research methods and more-than-human research praxis, which endeavour to amplify and learn from sensory, bodily, and affective registers in fieldwork. Part 2 describes the research methods. I discuss my commitment to procedural ethics and ethics-in-practice; the methods of recruitment and sampling; the survey design and methods; the interview and home-insight design and methods, which incorporated a sketch-mapping exercise; and I provide a description of the interview sample to contextualise the results[9]. Part 2 concludes with a discussion on the analysis of the empirical data, which included a combination of discourse, narrative and sensory analysis. Part 3 outlines what can be learnt when the 'doing' of the research method is thought of as an embodied and reflexive practice. First, I offer insights from reflections on survey delivery and completion, to deepen understanding of how more-than-human agency shapes research method. Second, I discuss the important role of emotions in research-researcher relations, focusing on moments of embarrassment, shame, humour and laughter in interviews. Finally, I illustrate the importance of emplacing research

[9] A description of the survey sample and data are published in the *Australasian Journal of Environmental Management* (Wilkinson and Gibbs 2021) and summarised as an appendix to this thesis.

encounters, drawing on encounters with rainwater and mains water in interviews to demonstrate how knowledge is co-produced socio-materially.

**Chapter 3**—'Constructing rainwater tanks: unpacking the colonial-urban-historical geography of domestic water'—maps the changing discourses that fashion rainwater tanks as a source of domestic water supply in Australia. This chapter is divided into four parts. Each part corresponds with a shift in dominant discourses around rainwater tanks in the history of domestic water in Australia, which served to make them visible or invisible as a source of domestic water. Part 1 discusses positioning of the rainwater tank as 'promise' in the context of European colonisation of the continent. Part 2 examines how the rainwater tank is repositioned as 'villain' in the context of the quest for modernity. Part 3 maps how the rainwater tank is constructed as 'saviour' in the context of the Millennium Drought. Part 4 offers a forward-looking view of rainwater tanks as 'possibility' in the context of a changing climate, population growth and maintenance costs. This chapter addresses research question one and provides important context for what follows in the empirical results chapters.

**Chapters 4, 5** and **6** constitute the empirical contribution of the thesis and, collectively, address research questions two and three. Attention turns specifically to developing understanding of human-water relations in the non-mains water context through practices of water provision, (re)use and disposal. These discussion chapters illustrate how, when domestic water self-sufficiency is conceived as a relational achievement, practices of provisioning, (re)using and disposing of water are always contingent upon the socio-material arrangements through which people achieve a sense of themselves and home. Each chapter pursues its own set of research questions, which inform the overarching thesis questions presented in **section 1.3**.

The discussion of the empirical results begins, provocatively, with a chapter on geographies of wastewater. **Chapter 4**—'Rethinking waste/ing water: family life and everyday water practices off-grid'—reimagines the problem of wastewater through the lens of everyday familial relations. The conceptual framing of this chapter brings together insights from family studies literature, that thinks about family as a process or doing, and household sustainability literature, that emphasises the importance of social practices, materials, ethics and the spatial in everyday consumption. Instead of assuming what comprises 'waste-'water or 'wasteful' water practices, insights are provided into how the dilemmas of sustainability and practices of water-becoming-waste(d) are felt through the process of making families in places that are off-grid for water and sewerage. I ask: How does water become waste in the context of emplaced family relations? Water use happens amongst complex assemblages of everyday practices, subjectivities, materials, values, and routines that make up families and the familial home. My conceptual approach challenges conventional framings of wastewater management and governance that positions waste and disposal as discrete activities at the end point of water consumption. Wastewater is framed by water authorities as a problem to be managed through restricting freshwater consumption. By contrast, most participants in my study framed their decisions about water use in terms of concerns about disposing of wastewater as the starting point. The ordering of this chapter as the first discussion chapter in this thesis is a response to this.

In **Chapter 5**—'(En)Gauging: getting the measure of tank water'—I turn to participants' practices of measuring water in their rainwater tanks and their practices of regulating and restricting water use. I ask two questions. First, how do people who are self-sufficient for water measure and monitor their water supply without a conventional water meter? Second, how do households reliant upon rainwater tanks regulate water consumption when not subject to the governance regimes of external authorities? This chapter brings together critical social sciences literature that attends to the politics of measurement with research that highlights the importance of everyday embodied practices and knowledge in resource consumption. Drawing on this literature, in my analytical approach I introduce and employ the concept *(en)gauge* to understand participants' practices of measuring water and managing water use. (En)gauge brings together 'gauge'—defined as a means or practice of measurement—with 'engage'—meaning to participate or become involved in. Through participants' narratives of measuring, monitoring and restricting water use, I show that people who are off-grid for water know their water use through an *embodied water metric.* This embodied water metric transpires through their ongoing physical engagement with proximate and visible vessels and infrastructure of water capture and storage and translates into an embodied knowledge of water use. This contrasts with mains water contexts where domestic water supplies are typically far removed from the sites of consumption and water use is mediated and abstracted through the metrics and directives of water utilities and materials of water meters and water bills. The narratives presented in this chapter bring to the fore the importance of proximity to domestic water supply infrastructures in making visible the invisible flows of water.

The final empirical chapter, **Chapter 6**—'Immersion: how tank water matters'—extends upon the critiques of reductionist approaches to domestic water management outlined in **Chapter 5**. This chapter builds on scholarship that advocates for relational understandings of *water values* and draws on insights from research that asks what is missed when water is reduced to a purely physical resource that can be measured, quantified, and chemically analysed. In this chapter, I consider what can be gained by instead thinking relationally about values by exploring the ways in which water *matters* to people when talking about the qualities of water. I ask two questions. First, how does water *matter* to households that are off-grid for water? Second, how might these 'ways of mattering' (or values) inform calls for a more diverse spectrum of domestic uses of household-collected rainwater? Water matters to participants through relationships configured, first, by their immersion in water's materiality through the sensations of drinking, bathing and otherwise tasting, smelling and touching. And second, water matters through their immersion in the work of securing water from the sky, rivers and bores through processes of designing, creating, developing knowledge about and maintaining off-grid water infrastructure. By thinking about the ways that water matters in participants' narratives of immersion something more than human perception of water quality is implied. Quality is visceral, moral and aesthetic. Quality is shaped by the agency of water and its associated socio-material infrastructures of supply. Understanding the notion of immersion as always an embodied achievement through consumption and labour, this chapter reveals qualities of water that matter that are not captured by institutions of water governance in Australia.

Finally, to conclude, **Chapter 7** summarises the main findings, arguments and questions raised in the thesis, drawing together threads that describe the complex relations that constitute homes that are off-grid for water. In this chapter I outline the significance of the thesis in how it addresses the research questions. To conclude, I briefly outline further provocations for future research into everyday experiences of off-grid living and human-water-relations. I consider broader implications of my findings and offer some views on the productive possibilities of rainwater tanks and decentralised water management infrastructure for rethinking how societies in Australia and the Minority World might adapt to better live with uncertain water futures.

# Chapter 2
## Methodology: Going with (and against) the flow

### 2.1 Introduction

This chapter offers an everyday water sensory ethnographic method drawing on a combination of survey (postal and online), semi-structured interview and home-insight tour methods. The methodological framework underpinning the research takes cue from post-structuralist feminist and more-than-human geographies approaches to ethnography, which endeavour to amplify and learn from sensory, bodily and affective registers.

The chapter aim is threefold and mirrored in the structure. The first part, 'Approaching', provides a justification for combining questionnaire surveys with semi-structured interviews and home-insight tours in an everyday water sensory ethnography (Pink 2009). The second part, 'Designing', describes the research methods. I discuss: my commitment to procedural ethics and ethics-in-practice; the methods of data collection, recruitment and sampling; the interview sample; and the methods of data analysis. The third part, 'Doing', outlines what can be learnt from research methods when thought of as an embodied process. Insights are offered from reflections on postal survey delivery and completion to deepen understanding of how more-than-human agency shapes research method. The important role of emotions is discussed in interviewer-interviewee relations, focusing on moments of embarrassment, shame, humour and laughter during interviews. Finally, examples are given to illustrate the importance of emplacing research encounters to understand how knowledge is co-produced. In doing so, the chapter offers an important methodological contribution to social sciences research by advocating for how the more-than-human dimensions of surveys have tended to be neglected and for the importance of the embodied researcher.

## 2.2 Approaching

The adoption of an everyday water sensory ethnography approach in this project is, in part, a response to cultural geographies of home that recognise homemaking (and unmaking) as a more-than-human endeavour (Blunt 2005; Gillon and Gibbs 2019). Power (2009, p.1031), for example, describes the home as being: 'irrevocably bound to the various affordances and capacities of the materials, objects, animals and rhythms that inhabit and shape the house-as-home, as it is to the capacities, rhythms and cultures of the human resident'. Geographers have sought to 'forefront relationality and bring discourse-based ways of understanding the world into communication with more materially and affectively based ways' (Boyer 2018, p.34). A focus on relational ontologies and the agency of materials in homemaking thereby necessitates a methodology that is alert to the more-than-human world (Lorimer 2010). One result is the trialling of methods drawing on video and moving image (Spinney 2009; Lorimer 2010; Büscher et al. 2011; Simpson 2011), sound and listening (Duffy and Waitt 2013), creativity and art (Gibbs 2014; de Leeuw and Hawkins 2017), and the visceral (Longhurst et al. 2008; Low 2015; Ash 2017; Wilbur and Gibbs 2020). Designing a methodology that is attentive to more-than-human agencies in the off-grid for water home and household is one aim of this thesis.

Developing everyday water sensory ethnographies is not simply a case of embracing experimental methods. As Dowling et al. (2017, p. 824) argue:

> Recognizing and acknowledging multiple more-than-human agencies challenges researchers to *do* geography differently—to perform, to engage, to embody, to image and imagine, to witness, to sense, to analyse—across, through, with and as, more-than-humans.

The more-than-human project thereby calls for methodological *approaches* staged around the emphases given to embodiment, practice-based thinking, distributional agency, and a focus 'in-the-moment'. Methodology is no longer simply a choice of method, instead the research is alive to how the project design itself brings the object of study into being through *doing* the research (Wilkinson et al. 2020). All methods, to echo Law (2009), are *performative*. In this thesis, I draw on the results of a combination of methods of data collection that have been traditionally framed as 'conventional'—the survey and semi-structured interview. However, taking my cue from post-structuralist feminist research and more-than-human geographies in my execution, or doing, of these research methods, I adopted a sensory ethnography that endeavoured to amplify and learn from sensory, bodily and affective registers. This included, for example, incorporating home-insight and sketch-mapping exercises into the semi-structured interview schedule, which I describe further in **section 2.3.3**.

### *2.2.1 A sensory ethnography of everyday water*

Sensory ethnography engages with the emplaced, sensuous and performative dimensions of doing research. Sensory ethnography is a term coined by Pink (2009) that encompasses a broad range of qualitative research practices that aim to complement and extend on discursive explanations of the world by grappling with embodied and multi-sensory ways of knowing. Sensory ethnography 'does not privilege any one type of data or research methods' (Pink 2009, p.8); rather, sensory ethnographies include the use of multiple visual, auditory, digital, mobile, static, virtual, remote, in situ, reflexive, and embodied methods of data collection. Central here is focus on the *methodological approach* supporting the 'doing' of the research method: 'ethnographic practice entails our multisensorial embodied engagements with others […] and with their social, material, discursive and sensory environments. It also requires us to reflect on these engagements' (Pink 2009, p.25).

Longhurst et al. (2008, p.208), for example, examine the embodied experiences of doing research (in their case sharing food with participants) by repositioning their bodies as a 'primary tool through which all interactions and emotions filter in assessing research subjects and their geographies'. More recently, Bell et al. (2018) have argued for a way of being in the field they call 'engaged witnessing'. Engaged witnessing involves 'a concerted attempt to accept or be open to being changed, moved or shifted' (p.137) by encounters with non-human actors. In recounting practices of encounter with animals on the move and trees, Bell et al. (2018) offer an approach in which the fleshy, sensuous body is receptive and responds to non-human actors as research partners that shape and co-create research spaces, practices and results. This ethnographic methodological approach, of using the body as a research tool to amplify the ineffable, the social, material and intangible elements of everyday life, facilitates a multidimensional understanding of the relationships between people and place (Pink 2009; Bawaka County et al. 2014). This thesis employs a sensory ethnography in the execution of a mixed-methods research design.

### *2.2.2 A mixed-methods research design*

To help generate a better understanding of everyday life in households that are off-grid for water, potential participants were invited to contribute to a mixed-methods research project structured in two parts. These parts comprised 1) completion of a postal and/or online survey, and 2) participation in a semi-structured interview and home-insight tour. These parts ran concurrently and were designed to complement each other. Participants were invited to contribute to either or both components of the project, and in any order. Baxter and Eyles (1997) posit that the mixed-methods research approach is one of the most common ways to enhance rigor in qualitative research. Although potentially time consuming and sometimes laborious, the benefits of mixed methods include how the dependability and breadth of results is enhanced through data triangulation and the acquisition of detail-rich information through prolonged engagement with participants in (and beyond) time physically spent 'in the field'.

In this case, the two-component mixed-methods research design allowed both participants and me, as researcher, greater flexibility in engaging with the project via the potential for multiple research encounters. The research topic was one of which I had ample lived experience but little academic knowledge. Further, this was a low-budget doctoral project encompassing an expansive field site and I was unable to spend any longer than a week at a time conducting interviews with participants in the Eurobodalla Shire given other work commitments at my home in Wollongong[10]. The combination of these methods of data collection, which encompassed a range of face-to-face (interview and home-insight tour) and remote data collection methods (postal and online survey), thereby facilitated a far greater coverage of the breadth of experience and practices of non-mains water households in the Eurobodalla Shire than would otherwise be possible with a single method (Cresswell et al. 2011). The use of multiple

[10] The distance between Wollongong and the Eurobodalla Shire is approximately 200km, and is approximately a 3-hour drive one-way.

research methods and data sources thereby aimed to capture and respond to the temporal, spatial and cultural complexity of human-water relations in off-grid homes whilst taking into account the limits on my own time and financial capacity as a student.

## 2.3 Designing

### *2.3.1 Ethics*

Ethical considerations for this project were formally documented through the University of Wollongong's Human Research Ethics process. Following a review process, the University of Wollongong Human Research Ethics Committee approved the project and research design in January 2016 as HE15/493 (see **Appendix A**). Whilst the formal consideration of ethics is an essential (and often legislative) aspect of rigorous research, a feminist approach to ethics, or 'ethics in practice' (Guillemin and Gillam 2004, p.264), recognises that our involvement goes well beyond the requirements of any research ethics committee.

#### Positionality and reflexivity

Kearns (2016) emphasises that embodied research involves physical participation in the lives of those we wish to learn more about. Our unique and ever-changing positionality as 'researcher', 'participant', 'observer' or 'insider/outsider' (Waitt and Cook 2007; Kearns 2016) or situated in 'inbetweeness' (Nast 1994 in Waitt and Cook 2007) in these social worlds has implications not only for how we conduct ourselves ethically, in relation to participants and place, but how we represent these voices and interpret the research itself.

To grapple with these ethical considerations, feminist scholars suggest that researchers critically reflect upon and make visible our subjective positionings (see England 1994; Baxter and Eyles 1997; Davies and Dodd 2002; Valentine 2003; Reeves 2007; Kearns 2016). Central to this process is ongoing critical reflection throughout the course of a project on the interactions between researcher, participants and place. I have attempted to layout my positionality during the research in the **section 1.1** and through the **ripples** of this thesis. There, I highlight how particular affective moments and embodied histories became enmeshed in the processes of data collection, analysis and writing.

### Informed consent

Informed consent is an essential part of ethical and rigorous research. Informed consent in qualitative research may be understood as consisting of two related activities (Israel and Hay 2006). First, participants need to fully understand what their involvement in a research project entails—this includes comprehension of the potential demands, risks and inconveniences involved. Second, participants must voluntarily agree to participation in the research.

During the recruitment phase, potential participants were presented with a verbal or written Project Description that invited them to participate in either or both stages of the research project. The Project Description (**Appendix B**) outlined the aims and methods of the project, the two ways in which people could participate (by completing a survey and/or participating in an interview) and how to contact the investigators should they have any questions or concerns. An abridged version of the Project Description was circulated in the target communities as a flyer erected on community notice boards and left, with permission, at local businesses (**Appendix C**). A digital version of the Project Description was circulated via local community groups' email lists and social media pages, with the permission and assistance of presidents, secretaries, and administrators. Interviews promoting the project in local print and ABC Local radio[11] media (**Appendix D**) were guided by the information contained in the Project Description.

Informed consent involved a sequence of stages. For people who contacted me to accept the invitation to participate in an interview and home-insight tour—either by contacting me directly or having provided their contact details on their completed and returned survey—a Participant Information Sheet (PIS) (**Appendix E**) and consent form (**Appendix F**) were emailed to them ahead of our meeting. The PIS was designed to provide more detailed information of the project aims and objectives as well as the potential demands, risks and inconveniences to the participants should they consent to participate. The time and location of the interview was pre-arranged through email and phone calls with the participant. It may reasonably be implied that in contacting me to participate in an interview, arranging a mutually convenient time to meet, and inviting me into their home to conduct the interview, participants were providing their consent to partake in an interview.

Prior to the commencement of the semi-structured interview and home-insight tour I provided a verbal explanation of the PIS and consent form to remind participants of the aims and methods of this research stage. Potential participants were given time to read through and reflect on both the PIS and consent form and I sat with them while they read the PIS to provide further clarification, and to answer any questions or concerns. Participants signed the consent form and/or gave verbal consent on the audio recorder

[11] ABC local radio is a network of publicly owned radio stations across Australia operated by the Australian Broadcasting Corporation (ABC).

before research activities commenced. The consent form asked participants to indicate their consent to either the use of their given name or a pseudonym. The provision of this choice acknowledged that some participants may wish to retain privacy through confidentiality. The consent form detailed the terms of involvement and allowed participants to opt in or out of certain forms of data collection (for instance, taking photos that included them or recording the interview for transcription). The consent form also established that participants could withdraw their consent at any time, with no repercussions. No participants withdrew their consent from this project.

For the postal and online survey, a detailed PIS was attached to the survey (in both formats). For the postal survey recipients, the PIS comprised the inner cover page of the survey, and for the online survey the PIS comprised the introductory screen **(Appendix G).** The PIS explained the survey aims and objectives, what participants were requested to do, freedom of consent, and data use. Participation in a survey is a well-known indication of tacit consent. Before commencing the online survey, potential participants must indicate that they have read and understood the PIS and so consent to participate in this project stage before navigating to the next screen. It may reasonably be implied that for postal survey recipients, completing and mailing the survey using the enclosed reply-paid envelope, respondents were providing their consent to participation in this stage of the project.

### Confidentiality and Anonymity

For qualitative researchers, maintaining respondent confidentiality while conveying detail-rich accounts of social phenomena can be difficult (Kaiser 2009). Issues of confidentiality align closely with those of anonymity (Wiles et al. 2006), the goal of the researcher being to ensure that the identity and privacy of research participants is protected (Dowling 2016). Throughout the research, personal details or identifiable information was only collected when volunteered by consenting participants as a means of facilitating contact for interviews. These details, along with the completed postal surveys, audio recordings, interview transcripts and photos, are stored securely in accordance with the University of Wollongong's procedures and conditions of formal ethics approval to ensure the privacy and confidentiality of participants is preserved.

Anonymity of participants was a key ethical consideration. Ethical dilemmas of anonymity emerged through the course of the interviews, transcript analysis and presentation. The ethics of 'anonymity by default' is challenged by critics who argue for the empowering effect that they claim can be fostered through participant identification (Giordano et al. 2007; O'Connor et al. 2018). Lahmen et al. (2015) argue that researchers may apply pseudonyms with little critical thought or deep reflection. Indeed, all bar one interview participant consented to the use of their actual first name; they wanted to be identified with their stories.

That said, interviewees were mainly from one of the four rural villages and communities targeted by the postal survey. These communities are easily identifiable with distinct physical boundaries and relatively small resident populations. While the project did not directly target sensitive issues, questions about household water and sewerage infrastructure and everyday practices of water reuse unveiled infrastructure arrangements and practices that conflicted with council policies. For example, particularly sensitive issues for several participants included the use of grey water[12] at

[12] Household greywater is defined as being the water from hand basins, showers, baths, washing machines, laundry tubs, kitchen sinks or dishwashers (Ryan et al. 2009). Due to drought or constraints on fresh water availability, many households irrigate their gardens and lawns with greywater. I examine the use of grey water by households in more detail in **Chapter 4**.

home. In particular, difficulties in gaining council approval for installing systems to divert grey water from washing machines and kitchen sinks for use on gardens. When talking about ad-hoc infrastructural arrangements and practices for reusing water at home, three interviewees stated that the conversation was to be 'off the record'.

This project relied heavily upon the lived experiences of persons from relatively small communities. The ethics of conducting and presenting research in such a way that confidentiality was maintained was potentially problematic. Even with the use of pseudonyms readers of the thesis could potentially identify participants based on their shared experiences and understanding of localities. Following the advice of Saunders et al. (2015) and Taylor (2015), after much deliberation all exact locations—i.e. suburbs and town names—are withheld, but participants' actual first names are used, where permitted. The use of actual names is in recognition of participants' time and generosity in inviting me into their homes and sharing their water life-narratives. I include photos of consenting participants in the thesis.

### 2.3.3 Method

The survey

I hand delivered printed surveys to households of four regional communities in the Eurobodalla Shire Local Government Area (LGA) identified as not connected to mains water, between 12 and 16 March 2016. These communities consisted of three small regional towns, with distinct urban features fringed by larger lifestyle lots at the rural-suburban interface, and one bounded locality, which consisted mostly of large hobby farm and lifestyle lots with residences dispersed over large acreages. Water is mostly used in these communities for domestic consumption. Across the four communities, postal surveys were hand delivered to 697 households. This reflects approximately 83 per cent coverage of all dwellings in these communities[13].

Hand delivery of the postal survey was required because of uncertainty in the coverage of Australia Post's[14] unaddressed mail service, which meant there was no guarantee surveys would reach or be restricted to the households in the target communities (Australia Post 2021)[15]. I determined the geographical boundaries for the distribution of the postal survey using ABS 2011 census state suburbs, being the most up-to-date at the time.

The postal survey was printed as a B5 paper booklet and delivered in a closed paper envelope, which also contained a reply-paid envelope. As small tokens of appreciation to the survey recipient, and to encourage engagement and response, I also enclosed a teabag and prompt for the recipient to 'enjoy a cup of tea' whilst filling in the survey. 'Rewards', like money and vouchers, have often been used to encourage a higher response rate (Dillman et al. 2009). As an additional incentive, I also stipulated that I would donate $1 for every completed survey returned by 30 April 2016 to the survey respondents' local Rural Fire Service brigade[16].

The delivery of the survey was preceded by a notification leaflet (also hand delivered) (**Appendix H**). Research has shown that pre-notification will improve response rates to mail surveys (Dillman et al. 2009). The purpose of the pre-notification letter is to

[13] Some households did not receive a postal survey due to these residences not having mailboxes. This may be attributed to the high number of absentee landholders in two communities, where secondary homeowners may have mail directed to their primary residence. It may also be attributed to some households on more isolated semi-rural lots not having mailboxes. It is likely that these residences use Post Office (PO) boxes in town.
[14] The government-owned entity that provides postal services in Australia.
[15] I reflect on the challenges and benefits of delivering a survey on-foot in Wilkinson et al. (2020).
[16] The New South Wales Rural Fire Service (RFS) is a volunteer-based firefighting agency. I donated $250 (rounding up from the number of surveys received) across four local RFS brigades.

provide timely notice that the recipient will be receiving the survey (and by extension, an invitation to respond to the survey) over the next 3-5 days. As Dillman et al. (2009, p.244) observe, the pre-notice letter should be aimed at 'engendering enthusiasm and building anticipation rather than providing the details or conditions for participation in the survey'. The survey was further publicised through flyers at community centres in the target communities and in local print media and radio.

The survey was also digitised using the software SurveyMonkey. The postal survey included the weblink to the online survey, thus recipients of the postal survey had the option of completing the survey online or returning the hardcopy via post. The online survey was also promoted through print media and radio in the wider Eurobodalla Shire, the intent being to reach households on streets not connected to the mains water grid, at the edges of major towns and suburbs within the shire, as well as more isolated rural properties.

The mail-out survey was identified as a more appropriate means of engaging participants in the target communities than an invitation to complete a digitised version of the survey online for two reasons. First, there was a history of poor telecommunications coverage, impeding internet access (O'Conner 2015). Second, there are high proportions of absentee landholders, which suggests that householders are likely to miss publicity of an online survey through local, conventional print and radio media: on census night, 31.5% of private dwellings in the Eurobodalla Shire were unoccupied (cf. 9.9% NSW and 11.2% Australia [ABS 2016]).

Scholars have argued that surveys have much to offer qualitative research as part of mixed-methods research design (McGuirk and O'Neill 2016; Parfitt 2013; Hoggart et al. 2014). Surveys have been widely used in the study of practices. Surveys have been triangulated with face-to-face interviews, to investigate everyday household practices, including water consumption in suburban gardens (Askew and McGuirk 2004), and household sustainability (Waitt et al. 2012). Further, Browne et al. (2014) point to the potential of a quantitative survey-based approach to translate practice-based research to policy, where 'numbers count' as 'evidence' in certain institutional contexts.

The survey served three purposes. The first was to establish baseline information about non-mains water households in the Eurobodalla Shire; that is, to provide insight to the question 'Who are the people living off-grid for water in the Eurobodalla Shire?' To address this broader question the survey included 45 questions (inviting both open and closed responses) grouped into six themes: (1) current water sources, (2) previous experience with water sources, (3) water technologies and practices, (4) water security, (5) reflecting on life with water tanks, and (6) thinking about water scarcity, abundance and uncertainty. Questions were designed to garner insight into the water infrastructures, practices and experiences of households. A Likert scale matrix question asked respondents to rate the importance of various factors in influencing their decision to purchase and/or move to the non-mains water house. Basic demographic information was collected to enable understanding of the sample as representative of the target communities and wider Eurobodalla Shire, and to contribute to cross-tabulations during analysis (see **Appendix I** for full list of survey questions).

The second purpose of the survey was to engage participants in the other stage of the research: the semi-structured interview and home-insight tour. The final page of the survey (in both online and postal formats) extended an invitation to respondents to participate in a semi-structured interview and asked the respondent to include their email or phone number so I could contact them to discuss this. Consequently, the semi-structured interview afforded the opportunity to expand on the themes and responses provided in the survey.

The third aim of the survey was to prompt residents to reflect upon and share insights into their practices, experiences and perceptions of water-self-sufficiency. The survey included a number of open-ended questions that sought to gauge respondents' experiences, practices and attitudes. The results from the survey helped inform the interview schedule, opening and closing lines of questioning and discussion.

### The semi-structured interview and home-insight tour

This research stage made time and space for in-depth conversations about water (in its multiple forms), off-grid water infrastructures and practices in peoples' everyday lives. Interviews are an integral part of the social scientists' qualitative research tool-kit. An 'enduring' method (DeLyser and Sui 2014), the flexibility of a semi-structured interview design can be beneficial in two ways. First, this method allows modification to questions from the schedule as new topics arise. Second, the interviewee is free to elaborate on the issues important to them.

Further, interviews offer insights to non-conscious and embodied dimensions of everyday experience. Through encouraging reflection by sharing stories, people can talk about the embodied and non-conscious dimensions of practices in meaningful ways (Hitchings 2012). This form of storytelling is valuable to geographers because people tell their narratives as embodied geographies in reference to themselves and lived spaces (see Moss [2001], Pile [2002] and Gorman-Murray [2007; 2008] who all advocate for a narrative approach). Indeed, household sustainability research emphasises the importance of a personal life-narrative approach in interviews (Klocker et al. 2012; Head et al. 2013; Groves et al. 2017). Practices are temporally and materially contingent. Research has consistently shown that practices tied to resource consumption and use at home are bound up with changes in relation to a person's life course, both experienced and anticipated, and the life course of those around them (Browne 2015). Carr and Gibson (2015, p.62–63) argue: 'Such moments open up a space for new decisions and behaviours to develop, that in turn impact on housing needs, home-making, and household sustainability'. Examples of transitions or events that precipitate a disruption to existing practices and routines include having a baby, raising teenagers, ageing, retiring, divorcing, living in a share house, living alone or as a couple, renting, becoming a homeowner, living in a unit or a detached dwelling. Previous research has indicated that life-stage has a significant impact on water use (Turner et al. 2010; Pullinger et al. 2013).

Hence, the semi-structured interview schedule sought to generate a 'topical life-history' (Riley and Harvey 2007, p.393), or narrative of the interviewee's life with water (see also Waitt and Nowroozipour 2020). This narrative approach sought to track life-course transitions, which both informed and brought about changes in how water is lived, experienced and practiced by people who live in homes that are off-grid for water. The interview schedule comprised a number of open questions clustered around the following themes: (1) water history; (2) water at home; (3) saving water; (4) using water; (5) maintenance; (6) knowing water (records and lists); (7) learning about yourself; and (8) learning about water. Open questions were employed as starting points and prompts to generate a conversation around individuals' everyday water relations and practices as part of a tank water only household (see **Appendix J** for full interview schedule).

The home was the preferred context for the interview. In this way, the presence of water and water infrastructure became part of conversations, enriching participants' narratives and my understanding of their life with water off-grid (see also Waitt and Welland [2019] and Waitt and Nowroozipour [2020] who advocate for a home-based interview narrative approach in research about domestic water practices). The more-than-human actors and processes that comprise the home become integral to the co-production of knowledge (Hitchings 2003; 2004; Cox 2016a; 2016b; Power and Mee 2020).

During the interview, I asked interviewees to show me where and how they source, store, use, reuse and dispose of water. While talking and walking around with participants, I took photos, with permission, to help contextualise a particular interview moment to assist in my later recollection. This component on the interview, which I termed 'home-insight tour', drew on methods variously termed 'show us your home' (Jacobs et al. 2008; 2012), 'house biographies' (Blunt 2008), 'talking-while-walking' (Anderson 2004; Waitt et al. 2008) and 'knowing-through-showing' (Pitt 2015). These approaches may vary in their scope, methods, and findings but what they share is a call for researchers to become alert to forces triggered by non-human bodies in place. I expand on these ideas in **section 2.4.3**.

A sketching exercise was also included as a prompt in the interview schedule to help facilitate conversation. Guillemin (2004) posits sketching in interviews as an insightful way to explore how people make sense of their world. Participants were invited to map, by means of paper and pencil, the flow of water through their homes (see **Figure 2.1** for example). They were also asked to identify, through sketching, places that were 'significant for water'. This prompt was intentionally left open to interpretation.

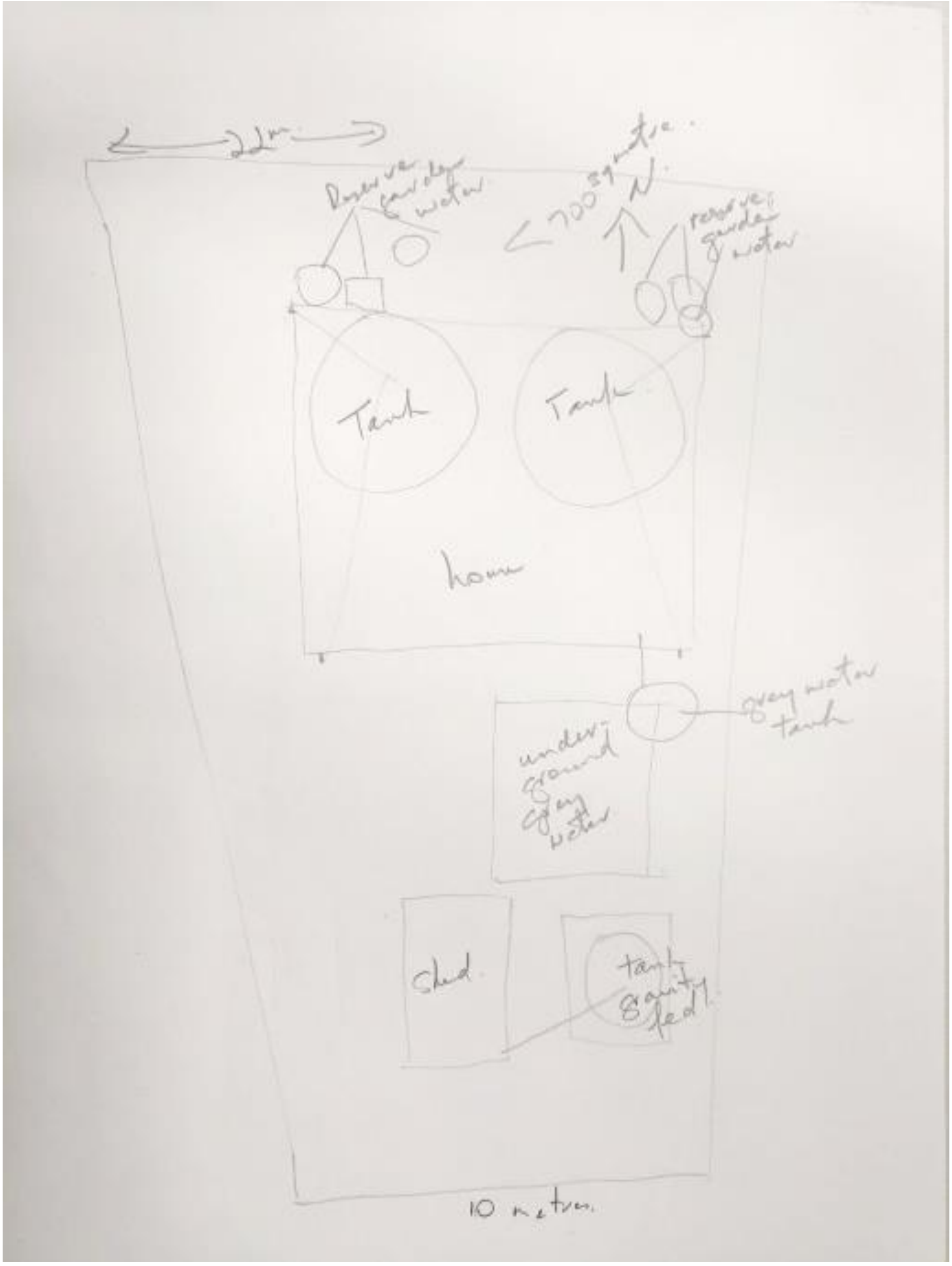



**Figure 2.1:** Example of a participant's sketch map showing flows of water through the infrastructures and spaces of home. Source: Jayne, 17 April 2016.

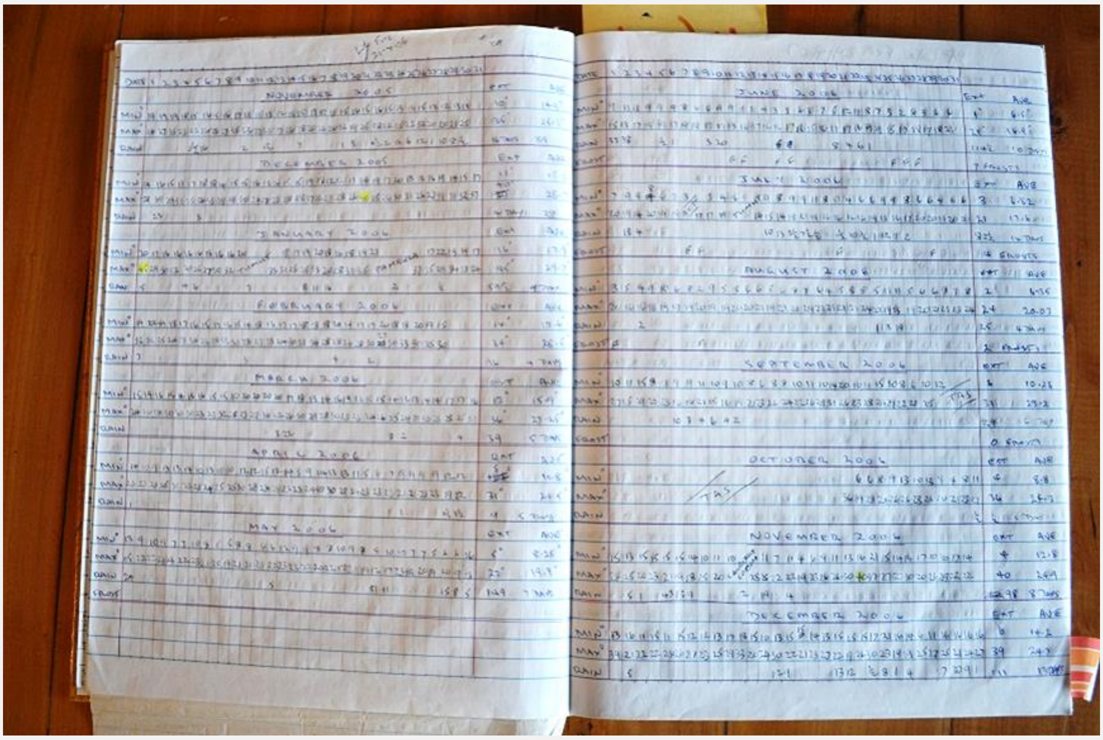
Participants had a variety of reactions to this invitation. Many declined the invitation to sketch, choosing instead to describe the layout of their property and the flow of water verbally. This was not altogether surprising; as Guillemin (2004) observes, in everyday settings we use words rather than images to explain how we feel and think. There were several instances where the participant paused mid-sketch and got up from the table to call me over and show me something that they had been describing in their sketch map. It was therefore not so much the 'complete' map that was most instructive (the map is not a 'static representation', [Barry 2016]). Rather the 'doing' of the sketch map—the thinking, drawing, interpreting, talking, showing—helped participants articulate the spatial and temporal dimensions of water as it trickles, pools, flushes and flows through the material and social landscape of their home.

**Chapter 4** incorporates sketch maps and conversations stimulated by the sketch mapping exercise, where participants explained the layout of infrastructure and practices involved in managing the flow of 'dirty' or 'waste(d)' waters within and outside of the dwelling home. Here, the sketching exercise was a useful medium for some interviewees to identify, reflect upon and share with me the seemingly mundane but nevertheless important aspects of how water flows through their homes, connecting different practices and meanings of water use, reuse and disposal.

A copy of any records participants kept relating to rainfall, water tanks and water usage was requested as part of the consent process. Incorporation of these records was driven by my own experiences growing up in a household that is off-grid for water (discussed previously in **section 1.1**). My father keeps a record of rainfall. At several points in our shared water history, the record has been consulted to guide our household's water use in times and in anticipation of water scarcity and abundance (see **Box 2.1**). Moreover, previous research with non-mains water households identified that the maintenance of home specific rain-records was central to some people's practices and experiences of domestic water use (see also Woelfle-Erskine 2015a; 2015b). In requesting access to participants' water records during interviews, my aim was to understand whether other households adopted a similar practice and, if so, what role records of rainfall played in their everyday lives as a household that is off-grid for water.

**Box 2.1**: **Dad's rainfall record**

Below is an excerpt from my dad's rainfall record. He has kept a record of rainfall (and temperature) at home for as long as I can remember. Since living in a household that relies on rainwater stored in water tanks, this record has incorporated additional notes. These notes mark, for example, the two occasions when we've had to purchase water to top up our rainwater tanks, when we installed a new tank and a new shed to increase our water storage capacity, and when we first installed water-saving shower heads. This rain record is also punctuated by notes on our times away from home—he's noted whenever we've been on holiday or visiting family for more than a few days.



Twelve (12) participants provided records relating to water at the property. All records related to monitoring rainfall, with the exception of two participants who also recorded temperature and another participant who also recorded wastewater levels in a septic tank. Several participants made additional notes on water, including measurements of rainwater tank levels and dates when they purchased water or installed additional tanks to increase their water storage capacity. For those who included annotations on measuring their rainwater use, some noted when they installed technologies such as dishwashing machines and washing machines as they were curious to see whether the new technology had a noticeable impact on their tank water use. Some records were punctuated by notations marking when the household was away from home and rainfall was not recorded, or an entry reflected an accrual of rain over days and weeks and was sometimes reported by a neighbour.

Following Riley (2010) and Riley and Harvey (2007), who advocate for the use of personal 'artefacts' or objects in interviews, rain records embody histories. The dates, rainfall events and periods of abundance and deficit embodied in the figures of these records served to clarify particular points raised in the broader conversation of the interviewee's life with water at home (c.f. de Vet 2013). The histories embodied in, and sometimes annotated in the margins of, the rain records also facilitated reflection around how the home and its occupants had changed over the years—for example, as children grew to teenagers, and teenagers grew to young adults who left home—alongside broader climatic changes. Participants reflected on periods of water abundance and scarcity in the context of how they and the other members of their household adapted to changing practices of rainwater (re)use. **Chapter 5** incorporates insights from discussions stimulated by review of rain records, which pointed to the complex associations between rainwater, tanks, skills, technologies, practices and place in monitoring and managing water use off-grid.

The semi-structured interview and home-insight tour stage of the research project required talking, walking, sitting, listening, photographing, reflecting and moments of silence, alongside drinking tea, eating cake, biscuits and lunch, patting dogs and inspecting rain-gauges and water tanks. All were instrumental in building rapport with participant and starting conversations. The interview and home-insight visits varied in length from 35 minutes to 160 minutes, and were generally 60–120 minutes in duration. With the participants' permission, the entire visit was audio recorded to allow transcription and later data analysis.

### 2.3.2 Recruitment and sample

This thesis is informed by the results of 209 surveys and 50 interviews with residents of households that are self-sufficient for water.

One-hundred and ninety-three (193) postal and online surveys were submitted from the four targeted study sites via post and online between March and May 2016, representing an overall response rate of 27.69 per cent from the 697 postal surveys delivered. An additional 18 surveys were received from residents outside of the four key study sites but within the Eurobodalla Shire LGA; 8 were completed online and 10 respondents had inadvertently received and returned a postal survey. In sum, 211 households completed 'The Living with Water Tanks Survey' between March and May 2016. Of these, two (2) households who completed the online survey indicated that their Eurobodalla address was connected to mains water and so their responses were not included in the analysis. This thesis is thereby informed by the results of 209 valid surveys completed via post and online by households that are off-grid for water in the Eurobodalla Shire.

One-off interviews were conducted with residents of fifty (50) households between March and August 2016. Interviewees were primarily recruited through their participation in the survey, with interviewees from 36 households (72%) recruited through the survey. Interviewees were also recruited through publicity of the project in an ABC local radio interview (n = 8), personal networks and snowball sampling (n = 4), newspaper article (n = 1) and community email lists (n = 1). The final page of the survey (in both online and postal formats) extended an invitation to respondents to participate in a semi-structured interview with 150 survey respondents consenting to being contacted regarding the follow-up interview (72% of survey respondents).

Given time, labour and budgetary constraints, it was impossible to follow up with every survey respondent who consented to be contacted to arrange an interview. Preliminary analysis of the survey data helped to inform the selection of a purposive interview sample (Bryman 2012). Interviewees recruited through the survey were selected to capture a balanced sample of age, gender, household composition, property size, water storage capacity, years of experience, and whether their surveyed dwelling was their primary or secondary residence.

In the remainder of this section, I highlight notable demographic and social characteristics of the interview sample to contextualise the insights presented in the empirical results chapters. This thesis does not present in-depth insights from the survey results. I refer to key statistics from the survey data, where relevant, throughout the thesis to support or contrast insights from the interviews. Insights from the survey data are published in the *Australasian Journal of Environmental Management* (Wilkinson and Gibbs 2021) and are summarised in **Appendix K** of this thesis.

*Observations from the interview sample*

This thesis contains excerpts from interviews with seventy residents (70) from fifty (50) households (**Appendix L**). Twenty (20) interviews were with a couple. Three (3) were with households who had visitors to the home also contributing anecdotes and questions[17] to the conversation. One (1) interview was with two sisters whose families shared a holiday home. Each of the remaining interviews (25) was with an individual. All but one of the interviews were conducted at the participant's home[18].

The broad socio-demographic characteristics, practices, experiences and attitudes of the survey respondents are reflected by the interview sample. Interview participants are a relatively socio-economically advantaged group of older homeowners who predominantly live in detached dwellings on large residential-sized blocks (500-1000m$^2$). Fifty-two percent (52%) of respondents identified as female and 48% as male. Most interviewees identified as Australian-born non-Indigenous (80%) and all spoke English (two interviewees spoke English as a second language). The majority of interviewees were from two-person households (56%, n=28) and the median age range

[17] Non-resident visitors provided verbal consent to being recorded as part of the interview, however interview quotes from these visitors are not included in this thesis.

[18] This interviewee had consented to hosting me at their home for the interview but we had to rearrange our meeting to instead be in town at a café when their driveway was washed out by torrential rainfall and the only way in and out was using 4 wheel drive vehicle. The interviewee later exclaimed during the interview that they could've picked me up at the bottom of the drive and driven me up to the house but neither of us thought of that at the time.

of interviewees was 60–69 years, which reflects the median age of the survey sample and older demographic of the Eurobodalla Shire[19].

That said, within the sample, there is diversity in terms of household composition and experiences with managing water at home. Four (4) interviewees moved to Australia as recently as the early-2010s and seven (7) described childhoods overseas, including in Ireland, England and the Netherlands. Interviewees from seven (7) households had lived in their off-grid for water home for 18 months or less. Ten (10) interviews were with people who lived in households of three to four people, including six (6) interviews with people who headed up families with young children (under 18 years of age) and four with people who lived with young adult children (aged between 18-29 years). Thirty five (35) interviewees were retired. Many participants were in full-time and part-time employment, including nursing, engineering and teaching, and several were self-employed, working as architects, landscapers and artists. Two (2) interviews were with people who gained income from farming on their property—including one who ran a large market garden—and another with a couple whose property included a number of self-contained cabins, which they rented out as short term holiday rental. And yet another interviewee gained income by renting a secondary dwelling on their property to a long-term tenant. Renters are under-represented in the interview sample (6%, n = 3). Approximately one-quarter (24.6%) of occupied private dwellings in the Eurobodalla Shire are rented, which is slightly lower than across NSW (31.8%) and nationally (30.9%).

[19] The median age being 54 years in the Eurobodalla Shire in August 2016, which is considerably higher than the median age of the Australian population of 38 years (ABS 2016).

Importantly, for this thesis, the majority of interviewees moved to their non-mains water home for reasons other than to be in control of their water. Adapting to living off the mains water grid was described by interviewees as a necessity rather than a choice. This characteristic was reflected in the broader survey sample (**Appendix K**); Likert scale results showed that when making the decision to purchase and/or move to their non-mains water house the 'opportunity to use water without council restriction' was not a key motivating factor for respondents (60.23%, 'not at all important'). Of greater importance was 'lifestyle/amenity value' (68.11%, 'very important'), 'affordability of housing/cost of living' (42.23%) and the idea that the local area offered a 'good environment to bring up a family' (35.43%). The insights presented in this thesis thereby stem from a research context where the majority of participants purchased and/or moved to a non-mains water address for reasons other than to be off-grid for water.

### 2.3.4 Analysis

This thesis draws on the integrated results of quantitative, qualitative and embodied research methods. The triangulation of research methods and the richness of the data collected necessitated more than one analytical strategy for interpretation. To do this, different but complementary approaches drawn from biographical and narrative research traditions were utilized to understand the data both thematically, across the sample (see **Chapters 5 and 6**), as well as through individual household case studies (**Chapter 4**). Punctuated through the presentation of the empirical data are ***ripples***—short narratives that offer reflections from my own experiences in the field and embodied water history as they shaped the data collection, analysis and writing processes.

In terms of the survey data, close-ended ordinal and categorical data was analysed using Microsoft Excel and results were reported as percentages of respondents. Open-ended response data were coded, also in Microsoft Excel, using an inductive approach to content analysis (Hsieh and Shannon 2005). The analysis required repeated reading of the text responses to identify emergent latent content as themes and categories (Vaismoradi et al. 2013). This approach resulted in coded data that was then used for quantitative (descriptive) statistical analyses (Srnka and Koeszegi 2007). This involved cross-tabulations between the demographic variables and open-ended response data. Responses to each question were optional, so response numbers varied between questions.

Analysis of transcripts from the recorded interview and home-insight tours followed a combination of narrative and discourse analysis techniques. Narrative analysis is based upon the careful examination and interpretation of a personal story to reveal the situated in-place experiences embedded within (Wiles et al. 2005; see also Fraser 2004; Floersch et al. 2010). The objective of this methodology is to identify recurring themes across multiple 'tellings' of the same event. Narrative analysis unpacked personal watery life narratives to explore how participants created and reproduced particular subjectivities through talk of capturing, storing, consuming, (re)using and disposing of water at home. This process necessitated repeated readings of interview transcripts to identify recurring themes and analysis of similar and different responses to the topics discussed. Taking guidance from Blunt (2003), the interview transcripts were thematically coded by hand. Coding transcripts by hand, Blunt (2003, p.84) argues, is a way to:

> …interpret personal stories and memories in a more nuanced and sensitive way than computer coding would allow[…] reading, and re-reading, transcripts to identify and code themes and sub-themes, to quote extracts to illustrate certain points, and to explore points of conflict and contradiction.

I also adopted a discursive analysis approach to the interpretation of the interview and survey data in this project. Discourse analysis is based on the idea that 'language both mediates and constructs our understanding of reality' (Starks and Trinidad 2007, p.1374). The objective of discourse analysis is to uncover the social mechanisms, or discourses, that give validity to statements about particular people, things, events and places (Waitt 2016). Discourse analysis offers insights into the broader ideas and meanings embedded within speech and the social norms governing the dominant and silenced interpretations of the world. These are the taken-for-granted 'truths' held and reproduced by people and institutions evident through talk of water, waste, tanks, sustainability and self-sufficiency off-grid. In this thesis emphasis is placed not only on the understandings of the world embedded within individual narratives of living with water but on the broader cultural context in which participants' understandings of water, technologies, practices and place occur. In **Chapter 3**, I map the changing discourses of household rainwater tanks produced and circulated by different institutions. Understanding past and present discourses about rainwater tanks are key to understanding their use in everyday domestic life.

The analysis of the data and writing of the results took place over several years. Over this time, I remained cognisant of the ongoing water context in the Eurobodalla Shire. By virtue of being my hometown, where my parents still live in my family home, I found myself returning to the 'field' of my research numerous times throughout the course of writing this dissertation. I observed, through media reporting and conversation with my parents, and experienced, firsthand, periods of drought, fire and flood and their resultant effects on water quantity, quality and practices of (re)use, and household water infrastructure. Following Pink (2009), I was aware that research encounters are not bound only to when and where an interview is recorded or a completed survey returned. Rather, data collection and analysis occur at all stages of the research: in the design, recruitment, data entry and transcribing, reading and 'writing up' (Pink 2009). My experiences from the inception of this project in 2015 to the conclusion in 2021 have no doubt influenced what and how I have chosen to write and publish from the empirics. Analysis was therefore always on-the-go, not something that was separate to data collection.

## 2.4 Doing

In the final part, I explore the liveliness of the research methods through three examples. In the first, I look to insights from reflections on postal survey delivery and completion to deepen understanding of how more-than-human agency shapes research method. Specifically, I demonstrate how more-than-human bodies, materials and processes shape response rates by reflecting on hand-delivering the postal survey and the material condition of completed and returned surveys[20]. In the second example, I turn to what emotions do in research encounters. Attention is given to the work of embarrassment, shame, humour and laughter when talking with interviewees about 'taboo' topics, like going to the toilet. In the final example, I focus on the importance of emplacing research encounters, drawing on insights from drinking water during

[20] These reflections are expanded upon further in a paper titled 'The questionnaire survey as more-than-human achievement' co-authored with Leah Gibbs and Gordon Waitt published in *Area* (Wilkinson et al., 2020).

interviews. In doing so, I add my voice to calls to rethink positionality beyond categories of age, gender, sexuality and ethnicity. Positionality must be thought relationally and socio-materially. Taken together, the discussion in this section contributes to calls for geographers to be attuned to the sensuous and material dimensions of conducting research.

### *2.4.1 The survey as a more-than-human achievement*

In six days, I walked just under 50 kilometres as I hand-delivered pre-survey notifications and survey packets to 697 households. The weather was instrumental in setting the pace for survey delivery. The papery-ness of the survey was at the forefront of my mind; I was constantly alert for situations where the integrity of the paper might be compromised by water and moisture. I spent mornings scrutinising weather forecasts and radar images to check whether rain was forecast before deciding to head out. Several surveys were returned with water damage, suggesting the packet had been in a leaky mailbox for some time. Through the course of survey delivery I became attuned to the materiality of mailboxes as an indicator of whether I should expect potential respondents to receive my survey in a timely manner (let alone whether they would respond to it), before exposure to the weather relegated the survey packet straight to the bin(**Figures 2.2**).

The weather was not the only influence on survey delivery. Encounters with frogs, spiders, slugs and snails occupying mailboxes (**Figure 2.3**) slowed me down as I grappled with the ethical dilemma presented by needing to deliver my survey packet without compromising animal or paper. While career postal workers may have less sympathy for such mailbox inhabitants, I found myself going out of my way to find an alternative spot to place my survey lest I disturbed a much-loved mailbox tenant.


**Figure 2.2:** A rusty mailbox being reclaimed by spiders. Source: Author, 16 March 2016.

**Figure 2.3:** A frog seeks shade in a mailbox. Source: S. Murray, with permission[21], 15 March 2016.

[21] With thanks to the survey participant who took a photo of their resident mailbox frog when my camera phone ran out of charge.

However, sometimes a disturbance was impossible to avoid in the course of my walking; my study sites were isolated communities where the streets are typically quiet. I was working outside the daily routines of vehicle and pedestrian traffic and pet dogs would often react to my arrival at a mailbox. I would freeze, heart racing, at the bark of a particularly aggressive-sounding dog, until I could spy it behind a fence, and weigh up whether it was safe to approach the house. Judging the risk, I would dart quickly up to the mailbox, shove the survey in, before jogging through delivery to the next few houses until the barking quietened down. Sometimes, the barking of an excited (or aggrieved) dog would bring out the occupant, if home at the time, or a neighbour, who would eye me suspiciously until I explained that I wasn't delivering junk mail. These encounters with barking dogs and curious residents facilitated a conversation in the study community about my research, potentially encouraging a response to my survey and associated call for interview participants, through building a rapport with residents[22].

I had further opportunity to reflect on the agency of animals in shaping response rates when handling the completed surveys that had been posted back to me. One survey was returned with tears and edges of paper missing. A handwritten note from the respondent explained that their puppy had 'chewed the mail that was left on the coffee table'. Attached to another survey was an apologetic letter from the respondent explaining that, as the home was a secondary residence infrequently occupied, snails in the mailbox had started to digest the mail in their absence:

[22] Several interviewees in one community commented on how I had become known as 'Tank Girl' amongst the locals.

I have just completed your PhD survey which I came upon recently in our largely unused letterbox at our holiday home. The booklet has been munched on by snails—sorry about that!—and I don't know what happened to the envelope you supplied.

While these two respondents had posted me their damaged but completed surveys (**Figure 2.4**), these examples suggest that more surveys may have been inadvertently damaged or destroyed by non-human actors, in mailboxes and in homes, and thus were not returned. These examples show that it is not just human agency dictating whether a survey is received and responded to; animals, such as snails and puppies, play a role in shaping response rates.

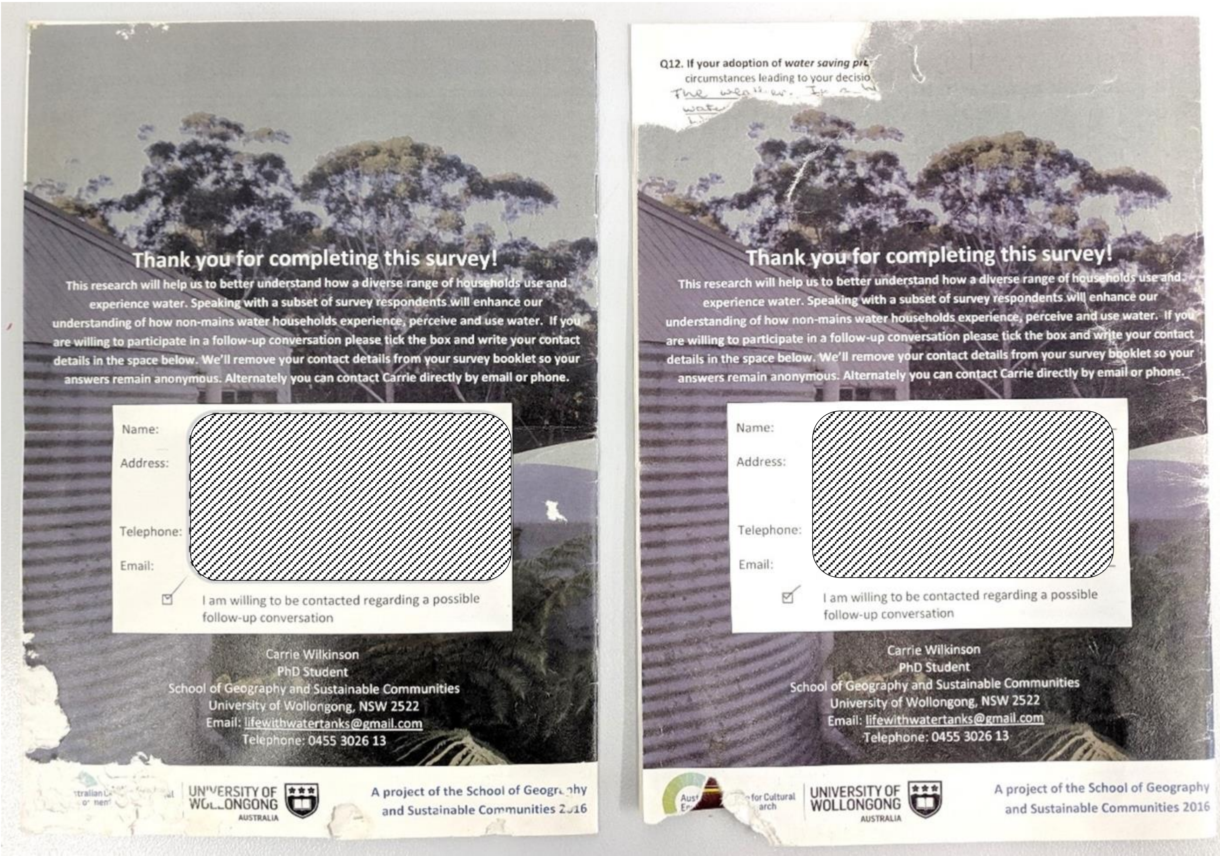



**Figure 2.4:** Two completed surveys, returned with evidence of snails munching on the paper and tears from a playful puppy. Source: Author, May 2016.

These reflections are significant. Survey response rates are usually reported as percentages and scholarly attention turns to how practical elements such as question wording, survey length and format (online, paper, telephone, face-to-face), and social factors including age, social class, education and political beliefs (Dillman et al. 2009; McGuirk and O'Neill, 2016; McLafferty 2016), may improve or limit human engagement with the survey. Response rate is, therefore, usually understood as an outcome of human action and social phenomena. These field insights trouble this assumption by demonstrating how the delivery, completion and return of surveys are tied up with the agency of elements, infrastructure and animals. My encounters with storm clouds, mailboxes, frogs, dogs and spider webs during the course of survey delivery prompted a change in walking pace, a shift from feeling relaxed to anxious, and a conscientiousness and attentiveness to non-human bodies. As a PhD candidate with limited funding and field support, I found that the hours spent 'pounding the pavement'—or, more accurately, of traversing front lawns and loose tarmac at the street verge—allowed insight into how the field and response rates are always an ongoing process of the coming together of the social and material. Arguably, such insights would not be offered by doing an online survey or by driving through. In this sense, and following Bell et al. (2018), I was alive to the non-human agents in the fieldwork of survey delivery while walking.

Furthermore, the *delivery* of a postal survey is not normally conceptualised as a recruitment or data gathering exercise. As a process that is typically delegated to a third party (i.e. Australia Post) a postal survey can become disconnected and disembodied from the researcher and the field site. The postal survey passes through multiple hands once it leaves the researcher's desk before it lands in the mailbox of a potential respondent. By hand-delivering the postal survey and having boots on the ground (Richardson-Ngwenya 2013), connections and disconnections facilitated by the social and material dimensions of the field site, which enabled the delivery and completion of a survey (or not), became apparent. Taking the case of my encounters with barking dogs, the properties and processes of sound, for example, may activate particular meanings, emotions or feelings that worked for and against survey delivery and completion. Following Revill (2016), sound is understood as simultaneously having a social dimension, aligned to emotions, as well as a material dimension, through generating vibrations through the air, bodies and things. Consequently, sounds are understood as socio-material forces embedded in an ongoing process of forming and sustaining associations through which subjectivities and places are stabilised or transformed. In this case, the sounds of barking dogs that interpolated the researcher as an 'intruder' sometimes resulted in fears that prevented delivery of a survey and, in other instances, it allowed connection with concerned and curious residents by facilitating a conversation about the research, potentially encouraging a response to the survey through building rapport. This example points to the importance of being alive to the field as always a relational achievement, where the weather, energy levels, fitness, sounds, animals and different modes of mobility may enhance or diminish the emotional and affective capacity of a person to deliver a survey, for instance, and thus become a researcher.

Extending these observations to other research contexts, thinking about response rates as a more-than-human achievement can help us to think more critically about other methods and research processes, particularly those aspects conceptualised as human-centred, such as interviews (duration and quality), recruitment rates, and structured field surveys. I suggest that becoming alive to the more-than-human dimensions of field sites helps draw attention to the role of materiality, emotions and affects in the wider process of mobilising research and becoming researchers, and underscores the importance of capturing those moments of ephemeral experience.

My reflections confirm observations by Davies (2011), de Jong (2015) and Adams-Hutcheson (2017) of the fundamental importance of more-than-human agency in research *praxis*. Davies (2011, p.295), for example, reflects on the role of the weather and seasons in her efforts to engage interview recruits via doorknocking, concluding that the positive encounters with residents in front yards during the long hours of summer would be difficult to replicate if doorknocking on a cold, dark winter afternoon. Similarly, de Jong (2015, p.80), in describing a failed survey methodology in festival research, highlights the affective intensities of festival atmospheres, weather and other more-than-human forces—such as time of day, soundwaves, and blood-alcohol content—in working against response rates and data quality: 'A second limitation [of the survey method] resulted from elements of the festival assemblage including heavy rain, loud music, large crowds and alcohol. An invitation to complete a survey was unwelcome in this context, particularly in the afternoon'. One of the more detailed examples of more-than-human agency in the research process comes from Adams-Hutcheson (2017, p.15), whose research on the everyday farming practices of sharemilkers in New Zealand highlighted the role of weather and animals in shaping the affective atmospheres of field sites and interview data: 'The cows, Pete [interviewee] and I felt anxious and oppressed by the wind and mud, and it pressed on us stirring mood and feeling […] Thus, the ambience of the interview was cold, hard and intense, just like the weather.'

Collectively, these methodological reflections show how the material, the elemental, and the more-than-human are significant in research processes and outcomes. Rather than understanding response rates in ways that emphasise the design of research methods, apprehending response rates through more-than-human agency draws attention to the sensuousness and fleshiness of the body and its capacity to affect and be affected. Notions of surveys and response rates as 'human-centred' are therefore challenged by consideration of the chewed and weathered postal survey, of the emotional and affective capacities of bodies, and of the socio-material dimensions of field sites. Response rates are, instead, a more-than-human achievement, a collaborative process not only with human research participants, but with the materiality of field sites—in this case, paper, rain, humidity, water, rusted mailboxes, spider webs, snails and dogs.

### *2.4.2 The role of emotions in research*

Talk-based-methods of data collection can be useful in research that explores everyday practice by encouraging reflection. However, proponents of talk-based-methods also caution that not all people can talk freely and that some practices might be more difficult to access through talk (Longhurst 2001; Hitchings 2012; Browne 2016). This may especially be the case in research that aims to access the intimate dynamics of private watery practices that involve bodies and 'dirt', like bathing and washing (Browne 2016), sweating (Waitt 2014a; Waitt and Stanes 2015), doing laundry (Pink 2005), and urinating and defecating (Longhurst 2001; c.f. Fam and Lopes 2015), which are frequently positioned in Western discourse as taboo subjects, tied up in cultural prohibitions. As Longhurst (2001) observes, practices that involve bodily fluids are often positioned as 'dirty topics'.

However, unlike other research, which has grappled with the difficulties of the nervous energy generated by talk of mundane, and often intimate dynamics of 'private' practices (Waitt and Nowroozipour 2020; Waitt and Stanes 2015; Browne 2016), numerous stories about dirt transpired unprompted through participants' broader narratives of managing water (re)use at home. This may be explained, in part, because water and the infrastructures of capture, storage and disposal are visible and ever present in homes that are off-grid for water. The taboo qualities of dirt and bodily waste might not be as entrenched. The notion of taboo is unsettled by the very hands-on everyday water management practices that participants were engaged in through reliance on septic tanks for capturing and storing wastewater (see also Fam and Lopes 2015).

Furthermore, my positioning as someone who had lived for a number of years in a home dependent on the infrastructures of the rainwater tank and septic tank for managing water helped me build rapport with participants and overcome awkwardness or nervous energy in research encounters with intimate everyday water practices (Longhurst 2001; Waitt 2014). This shared embodied history meant there was no sense of shock when ideas about bodies, cleanliness and waste were raised, consistent with ideas about insider/outsider positionality (Waitt and Cook 2007; Kearns 2016). Unprompted, many participants shared details of conventionally taboo topics, like urinating, defecating, showering, and reusing water. Many of the potentially 'shameful' practices around water reuse described by participants were a part of my childhood; in particular, my shared familiarity with the adage 'if it's yellow let it mellow': this saying relates to the practice of refraining from flushing the toilet after urination as a method of reducing water use, even in times of relative water abundance. This familiar practice opened the gate to further discussions about intimate and private everyday water practices. In this way, the research was able to capture and engage with some of the mundane, and potentially awkward, everyday practices of showering, bathing, washing, urinating and defecating, related to resource consumption, (re)use and disposal in the home, and the complex social and cultural dynamics of cleanliness, hygiene and sustainability underpinning them.

Humour and laughter played a crucial role in facilitating conversations about taboo topics by generating positive affects and shifting interviewer/interviewee power relations (Browne 2016; see also Eriksen 2019). In one instance, at my third interview and home-insight tour of the day, I was offered a cup of tea by participants Margot and Ben[23]; I felt obliged to drink it, even though I'd had two cups that day already. Moreover, I was uncomfortably aware of my filling bladder and the closest public toilet being twenty minutes' drive away. I was embarrassed and felt extremely self-consciousness in asking to use their bathroom, particularly as they had just told me how they ask guests to refrain from flushing the toilet as a means of conserving water. My discomfort was ultimately unfounded. They roared with laughter when I pointed out the irony of the situation. In pointing to the awkwardness of the situation we were able to joke and laugh. The laughter helped bring my nervousness to the fore, which was then dispelled by the shared laughter. Upon my return from the bathroom the happy energy facilitated the connection between us. The conversation recommenced with further reflection on their ways of managing the water use practices and expectations of guests. This example illustrates not only the unpredictability of fieldwork, but the work of

[23] Margot and Ben, 60–69 and 70–79, 2-person household, primary address, length of residence 17 years, interviewed 8 May 2016. When quoting or referring to a participant in-text, I include the following demographic details: their name(s), age(s), household size, primary/secondary address, length of residence/length of ownership, interview date.

unforeseen emotions in configuring the relations between researcher and participants (Emmerson 2017).

### *2.4.3 Rethinking positionality*

In this final section I focus in on the importance of *emplacing* research encounters, drawing on insights from drinking water during interviews in different spatial contexts. The recognition that all knowledge is partial and situated (Haraway 1988) has highlighted the importance of place in research encounters. However, Riley (2010), referencing Preston (2003), argue that while place has been 'used metaphorically to indicate a social location, one of gender, race, class or sexuality' (Preston 2003, p.212), such metaphorical aspects have 'arguably elided the material influence(s) of place and methodology' in research (Riley 2010, p.651-652). Burrell (2014, p.137), referencing Anderson and Jones (2009), reminds us 'The emplacement and mechanisms of interviews automatically mean that they are more than word experiences, affecting and affected by home surroundings, body language, the mundane realities of tea drinking, bathroom using and recorder organising'.

I add my voice to calls for researchers to be attuned to the affective forces of materials that enhance or reduce bodily capacities. More specifically, I add my voice to calls to rethink positionality beyond categories of age, gender, sexuality and ethnicity, to think also about positionality relationally and socio-materially, drawing on examples of drinking water during interviews:

> Jan: Would you like a cup of tea?
>
> Carrie: Oh, only if you are having one. I'd love one.

Jan: Or would you like a glass of water to try the water?

Carrie: I don't mind, it's up to you. I'm happy to drink either one. I'll go with what you go with.

*[Debate what to drink; Jan returns with a glass of water]*

Jan: See if you think it tastes salty.

Carrie: Okay, I'll try and see *[laughs nervously] [drinks water].* Mmmm, tastes good to me!

(Jan, 80–89, 2–8-person household, secondary residence, length of ownership 12 years, interviewed 12 March 2016)

My exchange with Jan was not a one-off event. The interview and home-insight commonly took place over a glass of water or a cup of tea. I drank litres of water and tea throughout the course of the fieldwork. Accepting the offer of a drink was an important way to establish a comfortable affective atmosphere and enabled participants to perform the empowered role of host. I was always aware that the participants were closely watching me drink the water. I was anxious as I didn't want to seem insincere in my appreciation of their water—after all, I was a guest in their home—but it was hard. Taste is a visceral response. Being mindful of my visceral response to drinking the tea or water was important because of how emotion modulates encounters. Therefore, how we taste water and comment on its 'quality' is more than a biological achievement, and includes social and material relations that help make sense of ourselves, places and relationships.

By comparison, at Aisla's interview, which took place in a local café in town, I had no hesitation leaving my glass of water half-full. There was a heady chlorination to the mains tap water we were drinking, which tasted stale. The discomfort made me long for my drink bottle—filled with rainwater from our tank at home—that I had left in the car. Looking to the half-drunk glasses of water in our hands, the conversation turned to the taste of Ailsa's tank water at home:

> Aisla: Well I'm drinking town water *[contemplates the glass of water provided at the café in her hand].*
>
> Carrie: Does it taste different to you?
>
> Aisla: A little bit yeah. Ours is really, really pure. Maybe there's sediment down the bottom but I don't know. I reckon your immune system is boosted by being exposed to some of this stuff. I think tank water is actually quite good. And this thing *[referring to the glass of town water]* has these chemicals which they think they know all about but maybe they don't. I mean rainwater is the most natural thing in the world and you shouldn't have to add any of these things to it, but you do.
>
> (Aisla, 1-person household, primary address, length of residence 20+ years, interviewed 3 March 2016)

Thinking about the acts of drinking water together with participants, affects and emotions circulate between bodies, which can change the mood of the atmosphere or offer insights to social norms through bodily responses. We learn from Aisla's visceral discomfort from drinking tap water about the social norms of tank water. This discussion extends arguments around positionality. Longhurst et al. (2008, p.208), for example, argue that whilst researchers often position themselves in terms of age, gender, sexuality and ethnicity, other aspects of research encounters such as 'smells, tastes, gestures, reaction, clothing, glances and touches often slip away unnoticed and/or undocumented'. Echoing this sentiment, Riley (2010, p.659) calls for 'a retheorization of space within the research encounter that moves beyond space as a metaphor for social relations'.

Conceptualising place as both a medium for and topic of discussion can thereby help shift attention away from a face-to-face encounter with a single, lead narrator (in this case the interviewee) (Riley 2010). Others—including more-than-human materials, bodies and processes—can be drawn in or out of the narrative construction when in place. In asking participants to 'show me their home' as part of the semi-structured interview, the environment—including cups of tea and glasses of water as discussed in these examples, but also taps, pipes, pumps and gutters, as I show in later chapters of this thesis—became an agent in the research in prompting participants to illustrate performatively the mundane elements of life with water tanks and septic systems.

## 2.5 Summarising

This chapter has outlined the methodology adopted in this project. The chapter was structured in three parts.

Part 1 outlined the *approach*, providing a justification for a mixed-methods research design, which combines survey and semi-structured interview and home-insight tour methods in an everyday watery sensory ethnography.

Part 2 outlined the *design* of the project, including ethical considerations, methods of recruitment, survey and interview samples, and methods of data analysis. The section includes an overview of notable socio-demographic characteristics from the interview sample to contextualise the results. This section ends with a discussion of analysis. In conceptualising analysis as embodied and ongoing, the section reflects on how the decisions made across the approaching, designing and doing stages of the research are central to interpreting empirical data through narrative, discourse and reflexive analytical strategies.

Part 3 provided insights from *doing* an everyday water sensory ethnography. This section makes a novel contribution to discussions about embodied and reflexive research practices. I extend conversations about more-than-human agency shaping research methods, emotions in research-researcher relations, and relational positionality.

Taken together, this chapter contributes to calls from geographers to be attuned to the liveliness of research methods; that is, to the sensuous, performative, embodied and material dimensions of conducting research.

# Chapter 3

# Constructing rainwater tanks: Unpacking the colonial-urban-historical geography of domestic water

## 3.1 Introduction

This chapter maps the changing discourses that fashion the historical geography of rainwater tanks as a source of domestic water supply in Australia. This thesis incorporates a chapter on the changing narratives framing rainwater tanks and household-collected rainwater use for four reasons. First, mapping changing discourses is useful to explain how present-day values and behaviours towards domestic water provision and consumption are formulated, shaped and renegotiated by events, political choices and policy regimes, and socio-technological arrangements of the past (Davison 2008; Morgan 2010; Shove et al. 2012).

Second, colonial social relations with water set the historical context for building and managing water infrastructure and continue to manifest in postcolonial and contemporary water governance (Cathcart 2010; Gibbs 2013; Das and Skelton 2019; Jackson and Head 2020).

Third, the theoretical and methodological approach adopted in this thesis is underpinned by a relational ontology that while attentive to more-than-human agency does not jettison the importance of the social. Dittmer (2014) makes a case for a return to historical analysis in more-than-human research, specifically attending to the sets of ideas behind existing infrastructural and governance arrangements that arise from situated encounters between human and non-human bodies.

Finally, this chapter provides important context for what follows in the empirical discussion chapters, where I examine other historical geographies of domestic water supply and management in Australia. **Chapter 4** relies upon understanding of the historical antecedents of wastewater infrastructures and centralised wastewater treatment plants, which underpin a pervasive ethical blindness to flows of dirty water and waste to natural water bodies. **Chapter 5** relies upon understanding how centralised water systems naturalised national standards for water accounting and household water metering. These resulted in the conceptual abstraction of water bodies and flows into litres and dollars through mathematical formulae. **Chapter 6** relies on appreciation of the legacy of historical bans on rainwater tanks in urban areas and perceptions of what comprises 'good' and 'bad' sources of domestic water. This historical geography examination of discourses surrounding household rainwater tanks is thereby an important prelude to the remainder of the thesis.

The chapter aim is to map the changing discourses of household rainwater tanks. The chapter title—'*Constructing* rainwater tanks'—is a play on words. The title speaks to domestic rainwater tanks and household-collected rainwater use as both material and discursive constructs. Rainwater tanks are not just household objects. 'Things' (dams, pipes, pumps, water tanks), to follow Bakker (2012, p.621):

> [A]re not merely pre-given substrates that enable and constrain social action; rather they are themselves historically and geographically produced in a way that is simultaneously socio-natural and socio-technical.

Past and present discourses produced and circulated by different institutions about rainwater tanks are key to understanding their use in everyday household practices (Delaney and Fam 2015). This chapter contributes to a substantial body of literature concerned with the history of infrastructures of water, both in Australia (Allon and Sofoulis 2006; Cathcart 2010; Gibbs 2009; Morgan 2015; Beeson 2020) and internationally (e.g. in the USA [Worster 1985], in Spain [Swyngedouw 1999], in the UK [Bakker 2003], and in Greece [Kaika 2005]). I adopt a multi-scalar lens to the discursive mapping, sometimes working at the Australian level, sometimes the state (NSW), and sometimes the capital (Sydney) or the urban or the household-level. Mapping discourses across multiple scales attempts to consider variations across time and space that nevertheless work together relationally to connect and become part of the specificity of places (Çağlar and Schiller 2021).

The remainder of this chapter is divided into four parts. Each part corresponds with a discursive shift in the historical narrative of Australian domestic water provision. In each part I discuss the discourses around household collected rainwater and water tanks that serve to make them visible and invisible as a source of domestic water. In part one, I discuss emergence of the rainwater tank as 'promise' in the context of European colonisation of the continent. In part two, I discuss how the water tank is apprehended as 'villain' in the context of the quest for modernity. In part three, I chart how the rainwater tank is constituted as 'saviour' in the context of the Millennium Drought. In part four, I offer a forward-looking interpretation of domestic rainwater tanks positioned as 'possibility' in the context of discourses of climate change, population growth and maintenance costs.

In mapping the discourses that frame rainwater tanks as a source of domestic water provision, the chapter helps explain why the ongoing presence of rainwater tanks in rural and regional areas is silenced. Experiences with rainwater tanks beyond the metropolis remain largely invisible due to political concerns with water supply for cities. Limited scholarship looks beyond the history of domestic water provision and water tanks in urban and mains water contexts. In regional and rural areas, households and communities have subsisted through history with decentralised and limited water resources and infrastructures. There are important lessons to be learned from these contexts for living with variable and limited water supplies.

## 3.2 Rainwater tanks as 'promise'

Water plays a pivotal role in the colonisation of Australia (Gibbs 2009; Cathcart 2010; Lawrence and Davies 2012; Morgan 2014). Since 1788, with the invasion of the First Fleet at Warrane[24] (Sydney cove), European settlers have been preoccupied with finding and securing reliable supplies of fresh water for establishing and expanding towns and cities. The skills of colonial engineers were therefore initially employed in the supply of water for people and livestock: this included pumping, storage and attempts at filtering water from creeks and streams (Ridgway 2008), as well as bore-drilling and river diversion (Gibbs 2009). Prior to this, Aboriginal people had lived within the variable limits of water abundance and scarcity for at least 60,000 years, and continue to manage locally available water sources sustainably to meet their needs and those of Country (Skatssoon 2006; Harper 2019; Frangos et al. 2020).

For the first 40 years of settlement, the small village of Sydney relied on water sourced from sunken wells or the Cadigal Stream (**Figure 3.1**), a freshwater tributary that provided water and sustenance for the Cadigal (Gadigal) people of the Eora Nation for millennia. Water quickly became an issue for the fledgling settlement, with the stream proving to be more intermittent than originally thought. As the settlement grew,

[24] The local Aboriginal name for Sydney Cove, as recorded in a number of First Fleet journals, maps and vocabularies, is *Warrane*, also spelt as *War-ran*, *Warrang* and *Wee-rong* (Sydney Barani, 2013).

drinking water was supplemented with wells and cisterns. During the summer of 1789–1790, the flow in the stream slowed to a trickle. In response, Governor Phillip ordered holding tanks to be cut into the sandstone rock along the stream banks to capture and store water for drinking and domestic purposes (North 2011). Each of these was approximately the size of a modern backyard swimming pool (Beeson 2020). The colonists called these reservoirs 'the tanks', an Anglo-Indian term derived from the Gujarati word *tankh*, meaning reservoir (The Australian National Dictionary 2016, p.1577). Cathcart (2010, p.28) summarises:

> And so, the Cadigal watering place became the 'Tank Stream', a name that spoke, not of England, but of the empire. It was Australia's first government-funded hydro-engineering project.

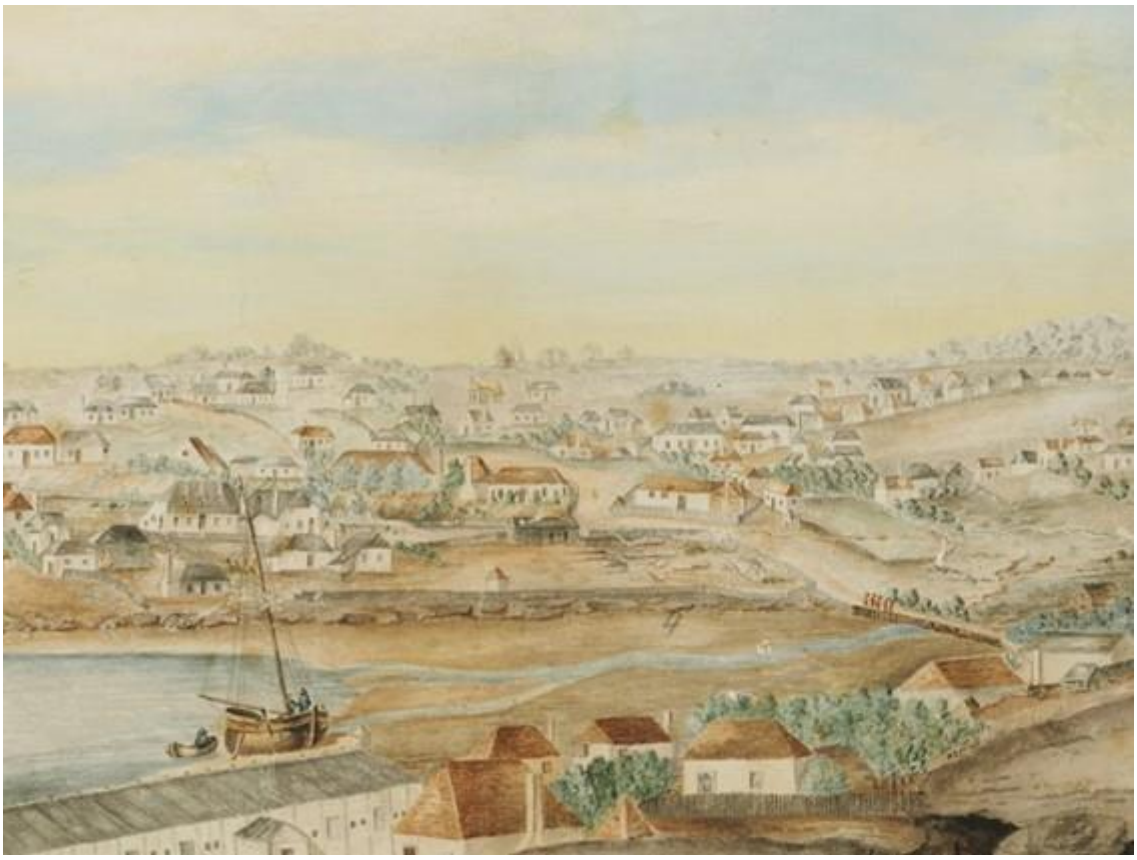


**Figure 3.1:** The mouth of the Tank Stream in Sydney Cove circa. 1803 (Evans, 1803). Source: State Library of NSW.

The Tank Stream served as a dubious source of drinking water for the settlement. The Tank Stream was not only intermittent in flow but frequently polluted by sewage and effluent from businesses and houses lining the stream (**Figure 3.2**). Columns and letters to the editor published in the *Sydney Morning Herald* and *Sydney Gazette* between 1802 and 1860 capture the decline of the Tank Stream, from life giving substance to an open sewer:

> The Town gangs are employed in clearing out the Tanks, which have long been filled with sand washed in by heavy rains. By the nuisance of people washing linen at and about these basins, the long prevailing drought has been severely felt, as many persons chose rather to send twice the distance, or submit to scarcity, than run the risque [sic] of being choaked [sic] with soap suds, or poisoned with infectious filth. (*The Sydney Gazette and New South Wales Advertiser* 12 February 1810, p.2).

> The tanks has been an old subject with us; but so long as all the filth from slaughterhouses, and other couvenieccies [sic], are suffered by the inhabitants themselves to become emptied into that reservoir of water, so long must the Sydney folks be content to slake their thirst from this purified 'effluvia'. Every inhabitant of George-street and Pitt-street who allow any kind of filth to be carried out from their premises by the rivulet which terminates in the tanks ought not only to be ashamed of themselves, but what is more, they ought to be indicted severely for a nuisance, and such a process would soon bring them to their senses. (*The Sydney Gazette and New South Wales Advertiser* 23 January 1828, p.2).

Persons who are in the habit of passing the lower portion of Hunter Street must have been frequently annoyed and surprised at the offensive odour caused by the neglected condition of the Tank Stream. This has been a standing complaint for several months past, during which time those residing in the neighbourhood have been subjected to the pestiferous influences of this open sewer. (*The Sydney Morning Herald* 6 January 1860, p. 4).

**Figure 3.2:** Looking downstream along the Tank Stream to Sydney Cove circa. 1852 (Henderson, 1852). Source: State Library of NSW.

Pollution of the Tank Stream became endemic despite repeated orders by the Governor's House to stop fouling the water by people and livestock. This is not surprising. At the time, there was no organised sanitation system in English towns and cities. In London, raw sewage and refuse from hospitals, slaughterhouses, soap works and factories ran down the streets and alleys of London in open drains to the River Thames, which also provided the city's drinking water. No effort was made to protect the Thames from pollution or to filter the water until well into the nineteenth century (Beeson 2020). By 1826, people in Sydney had stopped using water from the Tank Stream for drinking (Aird 1961). Efforts to rehabilitate the Tank Stream were abandoned. Instead, the Tank Stream became a sewer emptying into the Sydney Harbour:

> City Improvements – A substantial stone tunnel, built along the old Tank Stream, which had been for many years an open sewer, was completed three weeks since, and has greatly improved that part of the city. (*The Sydney Morning Herald* 21 September 1860, p. 4).

Today the Tank Stream lies underground, a storm water channel managed by Sydney Water (**Figure 3.3** and **Figure 3.4**).

**Figure 3.3:** The Tank Stream in 2015. Source: Donegan 2015.

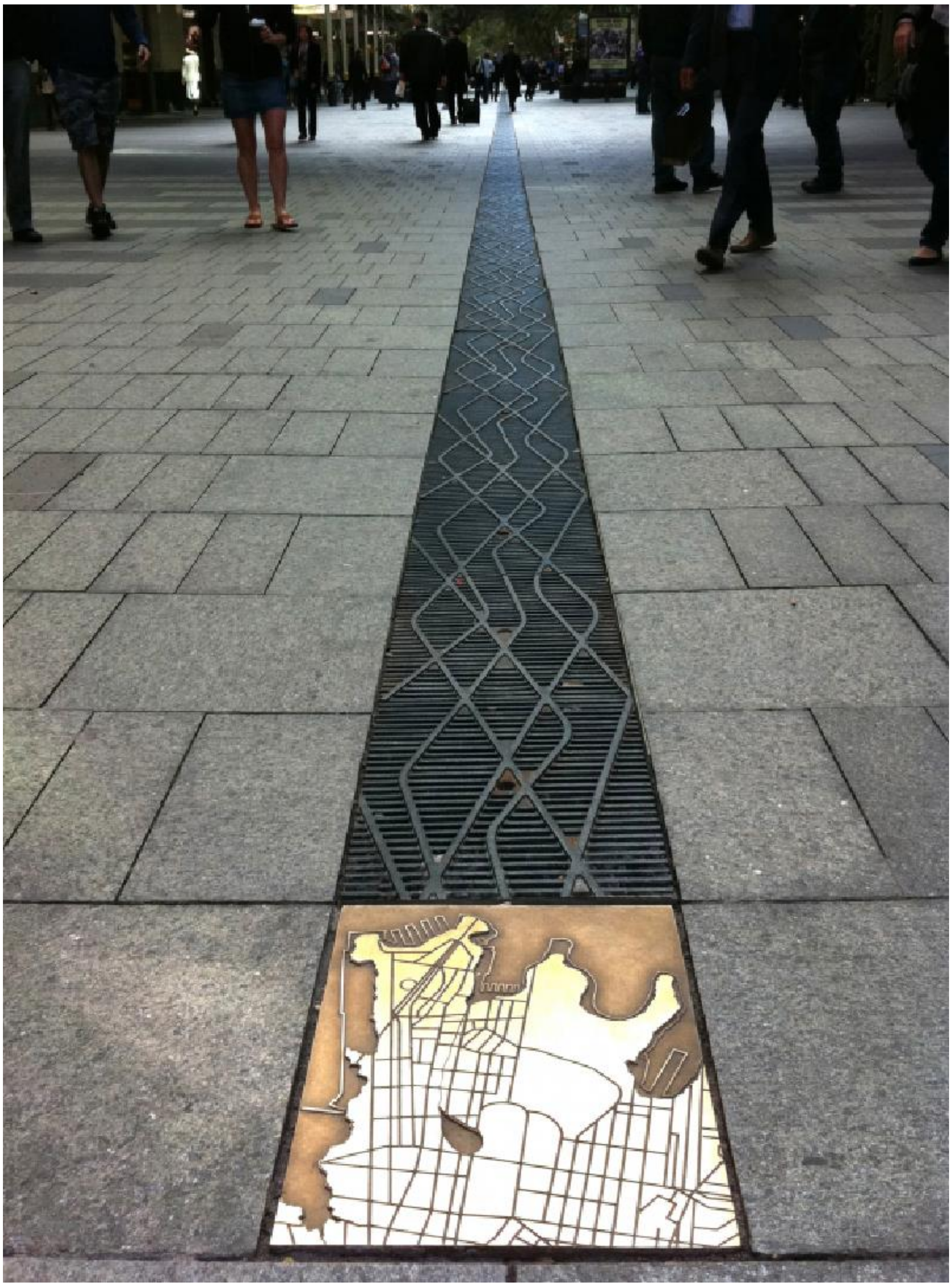


**Figure 3.4:** The Tank Stream as it appears above ground today in Pitt Steet Mall, Sydney[25].

Source: Boardman 2013.

[25] Efforts have been made to make publicly visible the now subterranean Tank Stream through public art and community tours. In 1999, the City of Sydney council commissioned an in-ground art installation using coloured glass modules, which were lit from below, and stainless steel lines to mark the course of the Tank Stream through five key sites through the city (City of Sydney n.d.). The work was deaccessioned in 2019. Sydney Living Museums with Sydney Water continue to offer biannual public tours through a 60-metre section of the Tank Stream (Donegan 2015)—the tours are so popular that tickets are balloted.

Other sources of water had to be found. In 1827 work commenced on a new water source, called Busby's Bore. An underground water tunnel was built by convicts from Lachlan Swamps (in Centennial Park) to Hyde Park (**Figure 3.5**). The project took ten years to complete. Lachlan Swamps served as Sydney's main water supply from 1837 to 1859 and, for many years, residents depended on water carted from the swamp or from wells at high expense (Beeson 2020). But there were problems. On completion, Busby's Bore delivered approx. 1.5 million litres of water to Sydney per day, more than half the capacity of an Olympic swimming pool, but barely enough to satiate the growing population, which had risen to 20,000 (Beeson 2020). Further, there was no sluice gates on the tunnel nor a reservoir at Hyde Park and there was no way of stopping the flow of water from the swamps; water flowed from the marshes continually and poured into the harbour unused (Beeson 2020). Overtime the swamps dried out.

**Figure 3.5:** Busby's Bore in Hyde Park circa. 1840s (Woolcott, n.d.). Source: State Library of NSW.

Colonists imported with them environmental theories and associated management practices from a land of comparative water abundance (Gibbs 2013). The First Fleeters were 'wet-country people' (Cathcart 2010, p.8), from a land with large perennial rivers and streams and reliable rainfall. However, in their new country rainfall was unpredictable and varied widely, both seasonally and geographically, such that water was often in short supply (Gibbs 2009; Lawrence and Davies 2012). The returning droughts and the draining of the swamps delivered salutary lessons on marginality and the concessions required to cope with the seasonally extreme rainfall deficits and events that characterise Australia's climate.

It wasn't until the late 1800s that colonists had the material resources available to make above ground tanks to capture rainwater. By rolling corrugated roofing iron into a circle and then riveting and soldering the joints, a large watertight container could be made (Morgan 2012). It was not uncommon for two or three of these vessels to be lined up against the side of a house on a tank stand, capturing rainfall from the roof (**Figure 3.6**). Up until this time, runoff from roofs was diverted into small, repurposed wooden cases, barrels and iron tanks from ships (Pearson 1992). Those with access to such private supplies as water tanks were arguably more resilient to rainfall variability and water scarcity, as well as price gouging from water carters (**Figure 3.7**) (Beeson 2020), than those who relied on the increasingly polluted streams and wells and rudimentary attempts at a piped water network (Morgan 2012)[26].

[26] For a comprehensive, historical overview of the development and management of Sydney's water and sewerage system refer to Hector (2011).

**Figure 3.6:** *Whitewashed house with corrugated iron roof and water tank, Hill End* (American and Australasian Photographic Company c.1871-1876). Source: State Library of NSW.

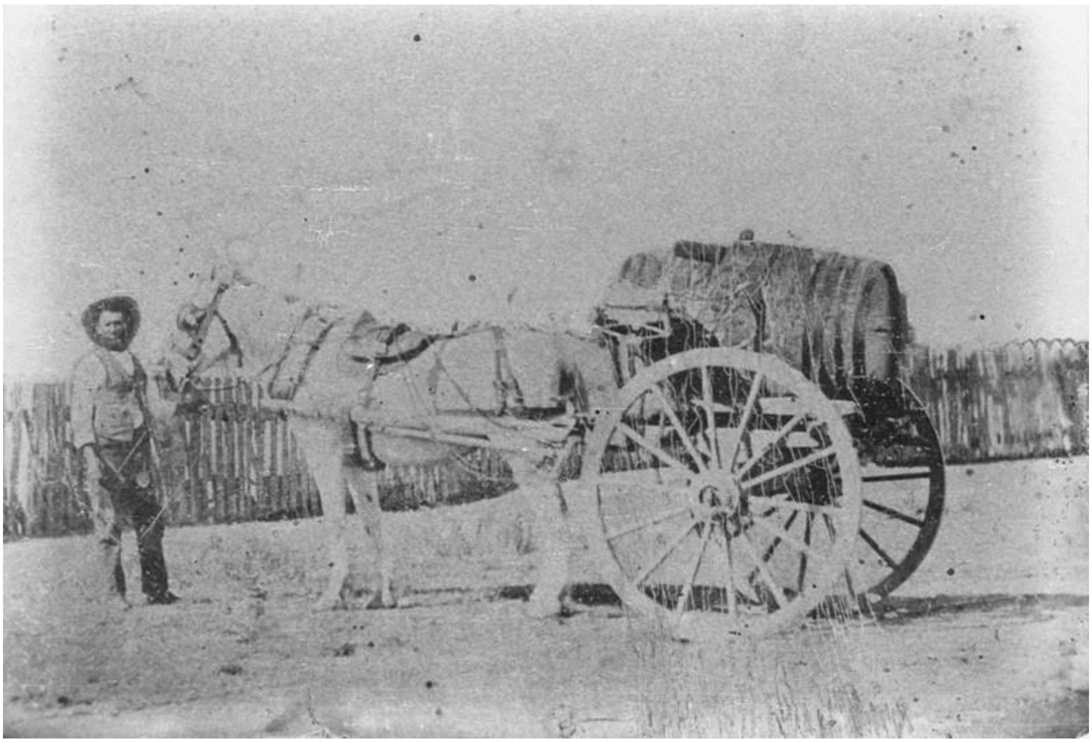


**Figure 3.7:** *Albury water cart before water was connected 1885 –Albury NSW.* Source: State Library of NSW.

By the late nineteenth century, the growing colony of Sydney had all but exhausted three supplies of fresh water: the Tank Stream and the Lachlan Swamps, as well as the Botany Wetlands (Beeson 2020). Large rainwater tanks offered the promise of survival or at least a continuing, albeit tenuous, grip on the land whilst bigger, more permanent, water sources were explored and tapped. The control and redirection of water was an integral part of establishing settler dominance over the land (Gibbs 2009; Lawrence and Davies 2012). In 1869 a Royal Commission into the water crisis recommended damming the catchment of the Upper Nepean (Aird 1961). And so began a pattern of water engineering in Australia, which mirrored colonial settlements around the world. Dam building lasted the best part of the next century. Whereas rainwater tanks offered survival, dams offered prosperity.

## 3.3 Rainwater tanks as 'villain'

From the late 1800s, rainwater tanks became repositioned as 'villain' in the context of ideas that aligned dam building with the notions of modernity and the nation-state. Dams are an example of 'Big Water', the term given by Sofoulis (2005, p.452) to centralised, large scale water sources and infrastructures that are controlled by a public (government) or corporate utility. Big Water exemplifies political ideals of liberal models of governance and citizenship that underpin designs and universal prescriptions of infrastructure development (Furlong 2014). Such prescriptions are symbolized by the development of water and sewer grids composed of large dams, concrete pipelines, and centralized water and wastewater treatment facilities (Banister and Widdifield 2014; Meehan et al. 2020).

Big Water is an expression of *modern water* ideologies, a highly influential set of discourses, politics and practices associated with scientific and Western models of water management (Meehan et al. 2020; Linton 2010; Banister and Widdifield 2014). Modern water is a particular way of knowing, accounting for and representing water as external to its social context, an 'operation of abstraction, reduction, and representation' that reduces water to an object that can be represented as '$H_20$' and shown as circulating in the hydrologic cycle (Linton 2014, p.111).

The modern water ideal dominated how many Minority world societies, including Australia, conceptualized infrastructure networks and water services over the 19th and 20th centuries. Big Water became the accepted norm for domestic water provision that promised to deliver to everyone endless 'potable'[27] water at low cost across cities and regions (Graham and Marvin 2001). Various political institutions draw on sets of ideas from capitalism, science and public health to configure water as a resource and object comprised of chemical components. According to Banister and Widdifield (2014, p.37) the abstraction of water as $H_20$ is:

> [A]n attempt to render water 'legible,' creating a conceptual purification by which it may seem easily controllable and extractable for the apparently apolitical ends of public health and urban expansion.

Universal management and quality as part of Big Water systems generated the category of 'potable water'. Potable water was safe, clear and 'pure', a new object of technological

[27] 'Potable water' is generally understood to be water that is intended for use as drinking water, cooking or personal bathing.

and political control that colonial governments invested a fortune to capture, extract, and deliver (Banister and Widdifield 2014).

By contrast, household collected rainwater was beyond the control of governments. As the availability of mains water became more widespread in urban areas, domestic rainwater tanks were banned (Smit 2018). The government needed consumers to pay off the debt for the capital works and ongoing operating expenses of establishing and expanding centralised piped mains water networks. Coombes (2002) notes that the reluctance of large parts of the community to part with their rainwater tanks in the late 1800s and early 1900s threatened the economic viability of the emerging centralised water supply paradigm. Legislated mandatory fixed charges on water service and use ensured that citizens used mains water in preference to household rainwater tanks. In 1892, for example, the *Hunter District Water Supply and Sewerage Act* came into effect. All properties in the Lower Hunter region (NSW) were required to pay for a recently completed mains water supply (the Walka water supply) even if they did not use it (Coombes 2002, citing Armstrong [1967] and Lloyd et al. [1992]). This measure is replicated by some utilities in operation to this day[28].

Local government and water utilities further actively discouraged the use of rainwater tanks in (sub)urban areas as mains water networks extended. First, via stormwater drainage standards (enHealth 2011; Waitt 2018). Second, by circulating advice that water tanks were dangerous to public health as potential breeding grounds for mosquito-borne disease (Coombes 2002). Drinking water quality could not be regulated

[28] While there is variation between utilities, in some areas a water service charge is payable by a landholder where a mains water line comes within a certain distance of a property, even when the property is not connected to the mains line. In the Eurobodalla Shire, for example, if a mains water line comes within 225m of your home (ESC 2021b), you pay council rates on water, even if your property is not connected to the pipeline.

or assured by governments. Residents of Wollongong in NSW remember pulling down corrugated steel rainwater tanks and discarding them at the local waste depot after water authority staff visited their houses to demand their removal (P. Jones 2018 personal communication, 7 June). By effectively forcing consumers to connect to and pay for mains water, governments wrangled responsibility for water away from private citizens and homes. The onus of responsibility for providing water and managing quantity and quality shifted from the individuals to large state- and local government run water utilities, with lasting impacts.

Dams form the cornerstone of Big Water and modern water aspirations in southeast Australia[29]. Dams are constructed on rivers and water is transported via pipes across large distances to meet the water demands of growing urban populations (Coombes 2002). Dams are tremendous feats of engineering, human power and will. Dams are central to the production, metabolism and expansion of modern cities (Kaika 2006). As Sofoulis (2005, p.454) observes, 'Big Water projects like dams and pipelines are part of colonial and nation-building processes and ideologies'. During the post-World War II period, the need to secure additional water supplies was a function of rapid urban population growth (Davison 2008), with an economic focus on industry and agriculture resulting in dramatic increases in the demand for water. In the post-World War II era, dams are also nation (re)building projects—examples of what Linton (2010, p.148) terms 'Hydronationalism'—that could be celebrated with much fanfare. Dam construction rapidly accelerated from the 1960s to the 1980s (McMahon and Petheram 2020) (refer **Figure 3.8**). For example, Sydney Water—the state-owned water utility that supplies water to more than 5 million people in the Greater Sydney and Illawarra

[29] Most Australian dams are located within a 200-km band along the eastern and south-eastern coastlines of Australia (McMahon and Petheram 2020).

regions of NSW—boasts that their customers are supplied with water from 249 different reservoirs through a network of more than 22,400 kilometres of water pipes (Sydney Water 2021a).

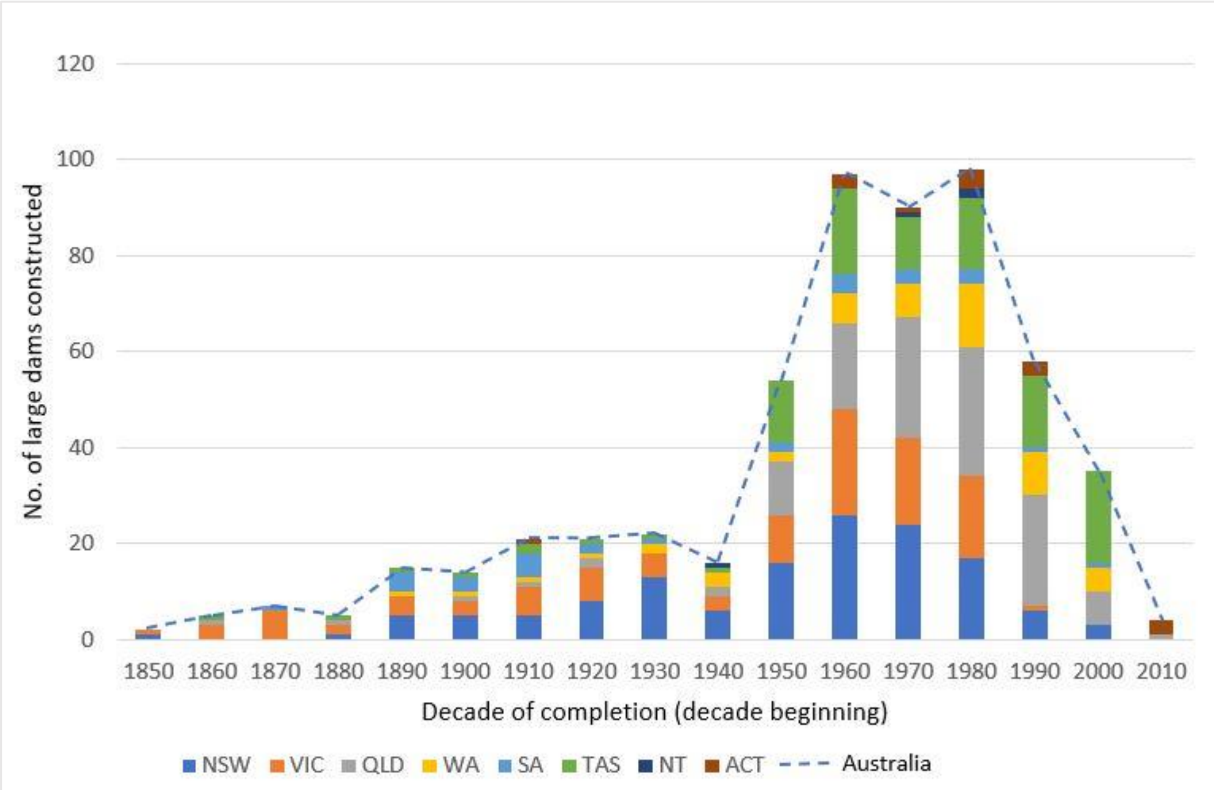



**Figure 3.8:** Large dam construction in Australia (1850 – 2012). Source: Adapted from ANCOLD (2012) by author.

In conceptual terms, dams encapsulate the desire to order, master and transform nature and unruly water. Kaika (2006), who writes extensively on the iconography of dams, observes that dams are part of 'the 'collective sublime' of modernity (p.278); that is, 'the quest to conquer and urbanize nature' (p.277). Tanks work against this quest. Yet, it is important not to romanticise rainwater tanks. Coombes (2002) notes that in times of drought in the late 1800s, domestic rainwater tanks would empty and sewage remained in the streets and household yards because there was not enough rain to wash it away. At these times, citizens would call for a reliable water supply and sewage disposal system, reflecting not only advances in knowledge of disease transmission but broader aspirations of modernity, of sanitised nature and clean urban spaces.

Importantly for this thesis, dams and Big Water infrastructure transform thinking and practices towards water (Gibbs 2009; 2013). For example, Linton (2010, p.18) points to the 'placelessness of modern water'; that is, the 'transfer of water control to placeless discourses of hydrological engineering, infrastructural management, and economics'. The abstraction of water as the substance $H_2O$, circulating in the hydrologic cycle, consumable by humans in kilolitres as reported by utilities through water meters and bills, stripped its social meaning and contextual specificity (Meehan et al. 2020). As Kaika (2003, p.921) summarises: 'A blissful, commodified relationship became established with what was now believed to be a perfectly tamed nature'. The location of dams beyond city limits further reinforced the culture/nature dualism that characterised modern water. Water became distant and unknown.

It is well understood that invisible infrastructures that supply a consistent flow of water shape unconscious, habituated, routine, and everyday household consumption practices (Browne 2015). Big Water promised a seemingly constant, reliable, uninterrupted supply of water to peoples' homes through underground pipes from distant dams and treatment plants. According to Sofoulis (2005), from 1950 to 2005, Sydney's population doubled, with per capita water consumption tripling to become one of the highest in the world. As Morgan (2011) summarises, 'By virtue of the piped networks of the suburbs, water became invisible yet everywhere and consumption inevitably climbed'.

Hand-in-hand with the shift in water provision systems in urban Australia, the introduction of new consumer domestic technologies meant that domestic water became more than drinking water, a basic need for good health. Instead, water became a tool in creating new expectations and norms about the ideal standards of comfort, cleanliness and convenience that underpinned ideas of a modern life (Hand et al. 2003; Shove 2003; Askew and McGuirk 2004; Davison 2008; Morgan 2015). Households could no longer rely on their rainwater tanks to reliably supply the volume of water required for the 'good life' furnished by flush toilets, hot water systems, and water intensive appliances, like washing machines and dishwashing machines (**Figure 3.9**).

In summary, domestic rainwater tanks became villainised as something that could not enable household practices embedded in the aspirations of modernity. Rainwater tanks were understood through political discourses that depicted them as outmoded and outdated and their contents as dangerous and dirty.


**Figure 3.9:** Advertisements and covers from The Australian Women's Weekly 1940s–1950s showing appliances of convenience. Clockwise from top-right: Hot Water 'Magic' by Rheem (1948); The Automaticmagic Healing Thor Combination Washer (1950); Family Bathroom (1951); Stampco All Electric Clothes Washer (1956) Source: The Australian Women's Weekly (1948, 1950, 1951, 1956).

## 3.4 Rainwater tanks as 'saviour'

Big Water infrastructure and models of governance, and the political and economic arrangements entailed in them, were built around rainfall and streamflow loads arising from a period of relative climate stability in the early 20th century (BOM 2020). That is not to say that Big Water 'drought proofed' the nation. Even with the expansion of Big Water infrastructure, periods of water scarcity continued to effect urban areas. Sydney residents endured rigorous water restrictions due to drought in 1901–02, when the use of water hoses, buckets and watering cans was banned (Beeson 2020). Strict water restrictions returned to NSW during the then record World War II drought of 1938-1942 (Water NSW 2012) (**Figure 3.10**), and were recurrent during short, intense droughts in many areas of the state in 1965/68 and 1982/83 (BOM 2021a) when dam levels fell to critical levels.

As the growth of Sydney and NSW continued into the twentieth century, water authorities continued to battle to keep up with demand for fresh water (Beeson 2020). Nevertheless, the policy ban on rainwater tanks for households supplied by piped mains water was largely upheld until the early 21st century.

The Millennium Drought of circa 1996–2010 once again reconfigured dominant ideas around rainwater tanks in the domestic life of urban Australia, this time as 'saviour'. Multi-year droughts are not unusual for southeast Australia—meteorological records document several multi-year droughts over the 20th century (BOM 2021a). However, unlike previous droughts, the Millennium Drought was characterised by a lack of reprieve in below average rainfall conditions (**Figure 3.11**). The Millennium Drought was, to date, Australia's longest period of rainfall deficit on record (Head et al. 2014).

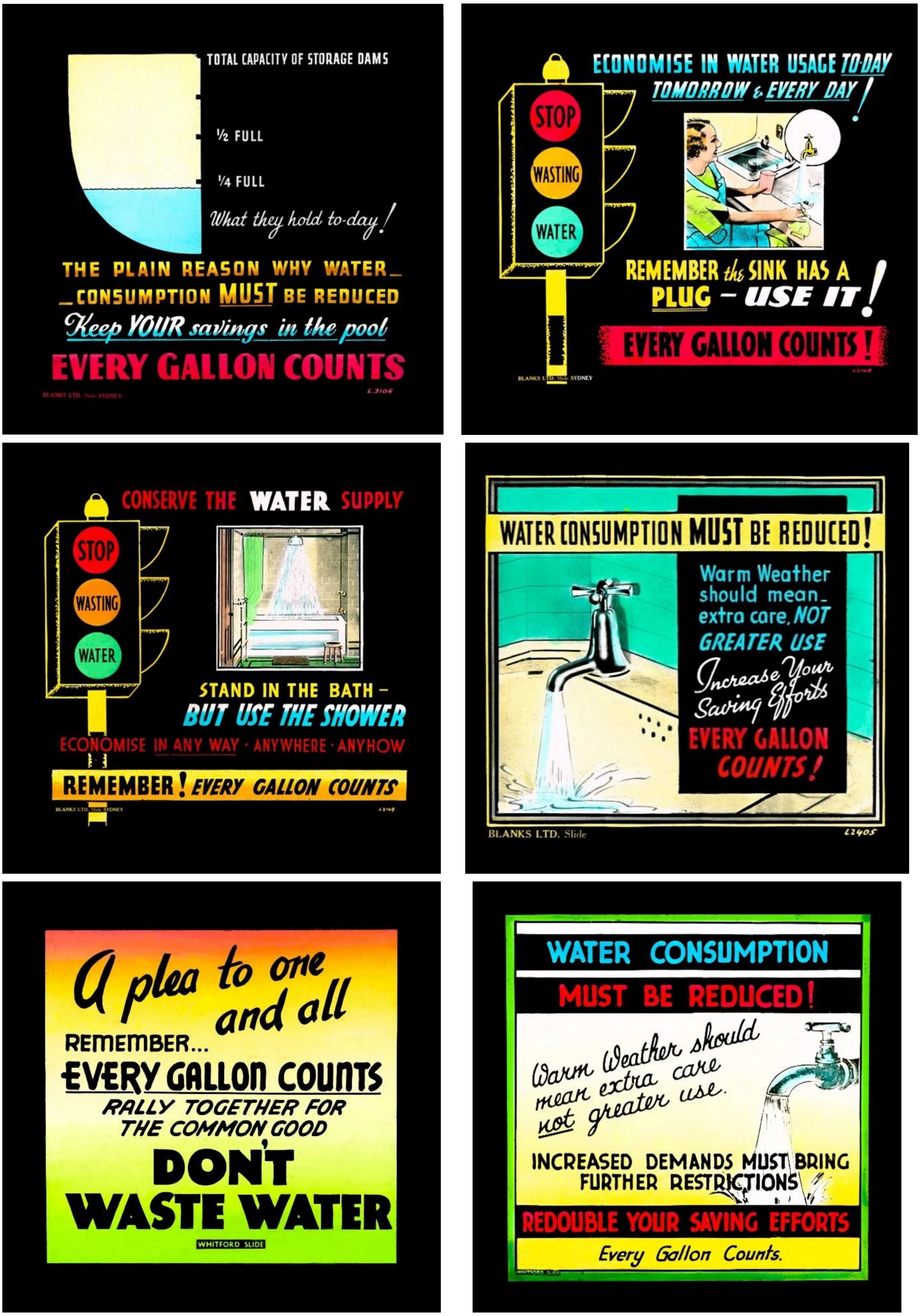



**Figure 3.10**: A selection of newspaper and theatre advertisements promoting water conservation shown in cinemas in Sydney during the World War II Drought (Metropolitan Water Sewerage and Drainage Board circa. 1937-1945). Source: Sydney Water/WaterNSW Historical Research Archive, with permission.

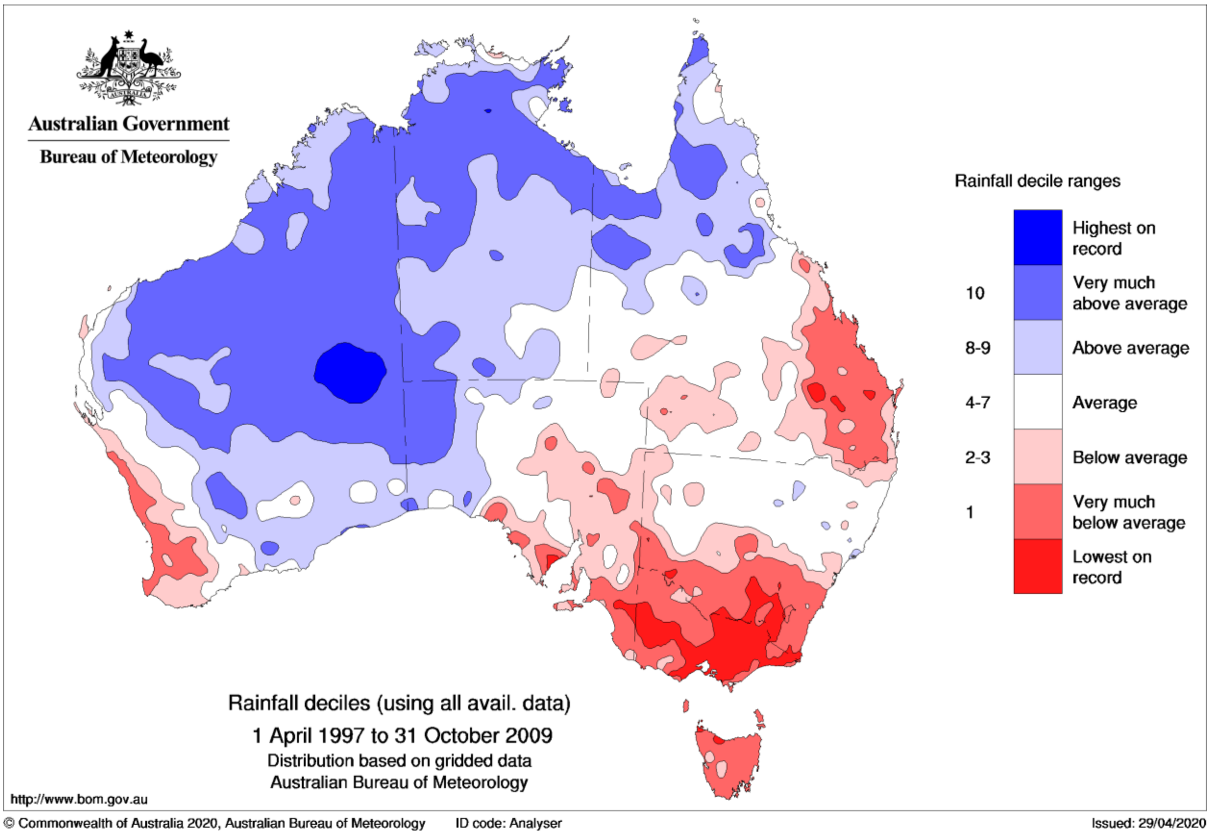



**Figure 3.11**: Australian rainfall deciles during the Millennium Drought showing below average rainfall across southern and eastern Australia during the period of 1 April 1997 and 31 October 2009. Source: Australian Bureau of Meteorology (BOM 2021a).

The longevity of the drought triggered a breakdown of the longstanding political and public belief in Big Water infrastructure as providing an endless supply of potable water (Allon and Sofoulis 2006). The duration of the drought prompted the implementation of clearly defined water restriction regimes, as a means of regulating household mains water consumption (Pearce et al. 2012). Typically, these restriction measures target discretionary domestic water use in the outdoor area of the home, and govern the type of water use activity, the time-of-day of activities and the technologies permitted. Water restriction rules vary throughout Australia due to local requirements and are set by the governing water utility[30]. Although the classification levels of water restrictions in NSW

[30] The Australian Bureau of Meteorology's, Water Restrictions website (BOM 2021e) summarises the water restrictions and water savings measures currently in place across the States and Territories of Australia.

vary widely, the restrictions regime outlined in **Table 3.1** are comparable to many imposed-on households throughout NSW during the Millennium Drought. In 2007, 80% of people in urban areas nation-wide were subject to some level of water restrictions (Allen Consulting Group 2007).

**Table 3.1:** NSW domestic water restrictions (adapted from Wilkinson and Eriksen 2015).

| **Level** | **Waterwise Guidelines*** | **1** | **2** | **3** | **4** | **5** | **6** |
|---|---|---|---|---|---|---|---|
| Garden watering | Watering before 10am and after 4pm recommended | Sprinklers allowed 2 hours a day | Sprinklers banned; Hand-held hoses allowed 2 hours a day | Hand-held hoses 2 hours a day | Hand-held hoses 1 hour a day | Buckets only | Reused water only |
| Swimming pools (private) | Filling and topping up pools permitted | Filling of pools prohibited; topping of pools allowed | | Filling and topping up of pools prohibited | | | |
| Wash paved areas a roofs | No restrictions | | Buckets only (except as required by law) | | | | |

* Also known as Permanent Water Conservation Measures

During the Millennium Drought, rainwater tanks were espoused by governments as a potential 'household scale solution' (Burgin and Webb 2011, p.237) to the biophysical and social impacts of water scarcity in many regions of Australia. Principally, rainwater tanks were promoted as providing a supplementary source to mains water. Household level rainwater collection and storage allowed consumers to avoid restrictions on mains water use, which dictated how and when mains water could be used outdoors (Moy 2012). Allon and Sofoulis (2006) argue that drought triggered the reallocation of the responsibility for maintaining water supplies from the utility to the consumer through consumption regulation. Rainwater tanks allowed consumers to continue the water-intensive practices that they had become accustomed to over the preceding decades (Sofoulis 2015).

Since the mid-2000s, domestic rainwater tank installations across Australian urban settings steadily increased in response to drought, restrictions on consumption of mains water, and changes to development regulations and subsidies (Gardiner 2010; NSW Planning Portal 2021). In 2013, for example, 34.3% of Australian households with a dwelling suitable for a rainwater tank had at least one installed, up from 24% in 2007 (ABS 2013)[31].

Planning and development legislation helped to discursively normalize rainwater tanks as a 'saviour' in mains water contexts. Many Australian states introduced regulatory requirements and incentives for the installation of rainwater harvesting systems in new residential developments and certain renovations to help mitigate drought effects on the sustainability of available water resources over the long term. The regulatory mechanisms and incentives relating to rainwater tank installation and water use differ between states and territories (see Chubaka et al. 2018 for summary). For example, in NSW, the Building Sustainability Index (BASIX), which was introduced in 2004, is used to mandate reductions in household water (and electricity) use by setting minimum performance targets for new and renovated dwellings (NSW Planning Portal 2021). While the BASIX target for water varies between LGAs, a score of '40' is the minimum standard for compliance for 90% of new residential development in NSW. This score means the building is designed to operate using 40% less mains-supplied potable water compared to the average dwelling constructed pre-BASIX[32]. While BASIX regulations do not mandate rainwater tanks for new dwellings, the majority of new detached housing

[31] As flagged previously, at time of writing these are the most recent publicly available figures.
[32] Water consumption reduction targets are based on the average pre-BASIX home benchmark of 90,340 litres of water per person per year, or 247 litres per person per day (BASIX 2021).

builds in NSW are opting for small rainwater tanks to meet their water reduction targets (NSW Planning Portal 2020).

The discursive construct of rainwater tanks as 'saviour' is integral to planning discourses in bushfire prone peri-urban contexts through building codes that mandate their installation as a measure for bushfire protection. Post-fire inquiries identified clear connections between drought conditions preceding a bushfire and water shortages reducing household fire-fighting capabilities (Wilkinson and Eriksen 2015). As part of the construction and retrofitting of buildings in bushfire prone areas, including mains water connected areas, rainwater tanks are mandated as a dedicated water supply for firefighting purposes (NSW RFS 2019).

The re-emergence of domestic rainwater tanks in urban contexts is not only a factor of drought, water restrictions and legislative changes. Three additional sets of ideas are identified in the literature. First, Po et al. (2003) attribute the reappearance of domestic water tanks to nostalgia and their perception as a settler Australian tradition (**Box 3.1**)(see also Kingspan Water and Energy 2020).

Second, Askew and McGuirk (2004) discuss the perception of rainwater tanks as a badge of 'green' identity. Installation of a rainwater tank for gardening purposes became part of a public show of attitudes and practices around a pro-environmental agenda (Askew and McGuirk 2004; Head et al. 2013). The prestige associated with sustainable living is reflected in the increasing number of score-based sustainable building accreditations available in Australia and internationally. Reducing and optimising water consumption forms a key performance criterion in prestigious sustainable residential and commercial building accreditation schemes such as Green Star, Well, Climate Active, NABERS and Living Building Challenge.

**Box 3.1: An Australian icon**

Cricketing folklore attributes the batting prowess of Australian cricketing icon Donald Bradman, at least in part, to the hours he spent in practice as a child, repeatedly hitting a golf ball with a cricket stump against the curved brick base of the family water tank (Cannane 2017). Bradman, widely acknowledged as the greatest batsman of all time, would construct Test matches in his head where he, as the batsman, would pit himself against the unpredictable balls delivered by the water tank (Bradman Foundation, n.d.).

Donald Bradman shown at home practicing his batting against the family rainwater tank. Source: Bradman Foundation (n.d.)

Third are ideas that underscore the improved material aesthetics and durability of water tanks. Urban tanks of the mid- and late-20th century, were generally made from rolled sheets of galvanised corrugated iron, cylindrical, and prone to leakage and rust (Courtney 2004; BlueScope 2013). Previous research illustrated that apprehension over the size and style of rainwater tanks is a barrier to their uptake in urban areas (Askew and McGuirk 2004). Technological innovations in the manufacturing of steel for water tanks in the late 1970s (Team Poly 2018; Pioneer Water Tanks 2021) and polyethylene plastic (poly-plastic) tanks in the mid-1980s, has transformed the look and durability of domestic rainwater tanks. Water tanks of the 21st century are slim, lightweight and come in a variety of sizes, attractive colours and materials. Food-grade, poly-plastic tanks dominate to now hold approximately 78% of the rainwater tank market in Australia (Bushmans Tanks 2017, personal communication, 1 October)[33].

The Millennium Drought and long-term water restrictions led to and reinforced material changes in house design, including the installation of rainwater tanks, alongside dual flush toilets and flow restricting showerheads. These material changes were accompanied by changed competencies and meanings around rainwater tanks for domestic water supply and consumption (Lindsay and Supski 2017). Rainwater tanks became back in vogue—they were a practical, relevant and acceptable way of diversifying the urban water network.

While rainwater tanks saw a resurgence during the Millennium Drought for urban households, they were essentially a stopgap measure while Big Water alternatives to dams were established. The Millennium Drought resulted in a new drive to ensure continuity of supply and led to seeking a diversity of water sources through Big Water technological and infrastructure 'fixes' (Kosovac 2021). To avoid a future of water shortages wastewater recycling and desalination plants were built to supplement surface-water sourced reticulated supplies, including for drinking water[34]. As Gibbs (2013, p.482) argues: 'Ideas about nature imported through the colonial process continue to influence thinking and practices towards Australian water'. In Sydney, desalination is 'the first line of defence' against falling dam levels: the desalination plant in Sydney is activated when dam levels reach 60% (Sydney Water 2021b)—water

[33] For an overview of materials commonly used in the manufacture of rainwater tanks sold in Australia today refer to Turner (2018).

[34] In no location was recycled wastewater or desalinated ultimately used to augment drinking water before the drought broke (Radcliffe and Page 2020). Perth was the only exception. Major desalination plants built and operationalised in 2006 and 2013 supply desalinated water used in the drinking water system. Desalinated water is the major individual source of urban water supply for Perth and contributed 47 percent of Perth's water supply in 2019–20 (BOM 2021d).

restrictions are not imposed until dams fall to 50% (Hair 2019). The breaking of the drought allowed the deferral or rejection of alternatives and resulted in policy complacency (Radcliffe and Page 2020).

## 3.5 Rainwater tanks as 'possibility'

Most recently, rainwater tanks are framed by Infrastructure Australia (2017) and Bureau of Meteorology (BOM 2017) as offering 'possibilities' of water security in the context of ageing mains infrastructure, population growth and increasing climate variability. Reports published by Infrastructure Australia—the national independent infrastructure advisor to governments, industry and the community—highlight the ageing state of mains water and sewerage grids across Australia. Much of Australia's mains water and sewerage infrastructure was built before the 1970s, for very different cities of a much smaller scale, and many water assets are reaching the end of their expected 50-year lifecycle (Infrastructure Australia 2019) (**Figure 3.12**). Risks associated with ageing infrastructure are compounded by the pressure caused by population growth—including a rise in the number of single-person occupied homes—and the impact of increasingly frequent extreme weather events (Infrastructure Australia 2019). Further, historic underinvestment in maintenance means that repair and renewal costs of mains grids are likely to increase over the coming years. Excluding expenditure on desalination plants during the Millennium Drought, the urban water sector reported a period of disproportionately low investment (Infrastructure Australia 2017).

**Figure 3.12:** A burst mains water pipeline outside my apartment in Wollongong in October 2018 (left) and again in January 2020 (right). Source: author.

Scientific discourses point to the possibilities of rainwater tanks in the context of climate change to address water storage limitations. Since colonisation, successive governments have pursued Big Water development agendas, constructing large dams to buffer variable water supplies through wet and dry seasons and years. However, in Australia, construction of large dams boomed in the 1960s-1980s and petered out in the 1990s, consistent with global trends (McMahon and Petheram 2020). As new dam construction declined, overall water storage capacity flatlined whilst populations and demand for water for domestic consumption, industry and agriculture continued to grow.

Dams need reliable water inflows and are inevitably linked to the climate in which they are constructed. Rainfall supplies the rivers and streams that flow into dams. Australia's rainfall is inherently unreliable both temporally and spatially. Illustrative of this phenomena, the dam capacities in Australia need to be, on average, ten times larger than those observed in Europe to deliver an equivalent level of supply reliability due to variations in stream flow and high surface evaporation rates (Cooper and Crase 2016; McMahon and Petheram 2020).

The possibilities offered by rainwater tanks are made visible in reports of falling dam storage levels during drought. Surface water—supplied from rivers, streams, and dams—has been and remains the dominant water source in most states and territories in Australia. Approximately 80 per cent of water consumed in Australia is derived from surface water resources (BOM 2017). These sources are under increasing pressure because of climate change and increasing demand for water by population, industry and agriculture. Long term average inflows into river systems supplying Big Water in many parts of NSW have declined by 20% (Nguyen et al. 2020). The water challenge in Australia is not so much the amount of rainfall but its extreme temporal and spatial variability (Dey et al. 2019).

The ongoing challenge of water (in)security became apparent in many parts of east and south-eastern Australia in 2019. Extended dry periods between 2017 and 2020 resulted in months of low dam inflows and high evaporation resulting in precipitous reductions in dam storage levels across large areas of NSW, Victoria and Queensland (**Figure 3.13**). Low streamflow to surface water reservoirs saw an increasing number of regional and rural towns face severe mains water shortages and restrictions, with water needing to be trucked into some towns (Park 2019; Siossian and Cavanagh 2019; Tatham 2019). For regional towns, their water utilities often rely on a single supply source, with no physical link to an alternative bulk water supply (Radcliffe and Page

2020). In late 2019, conditions were so severe in the central west of NSW that the state government estimated that upwards of 90 towns could be evacuated because of dwindling mains water reserves (Perinotto 2019).

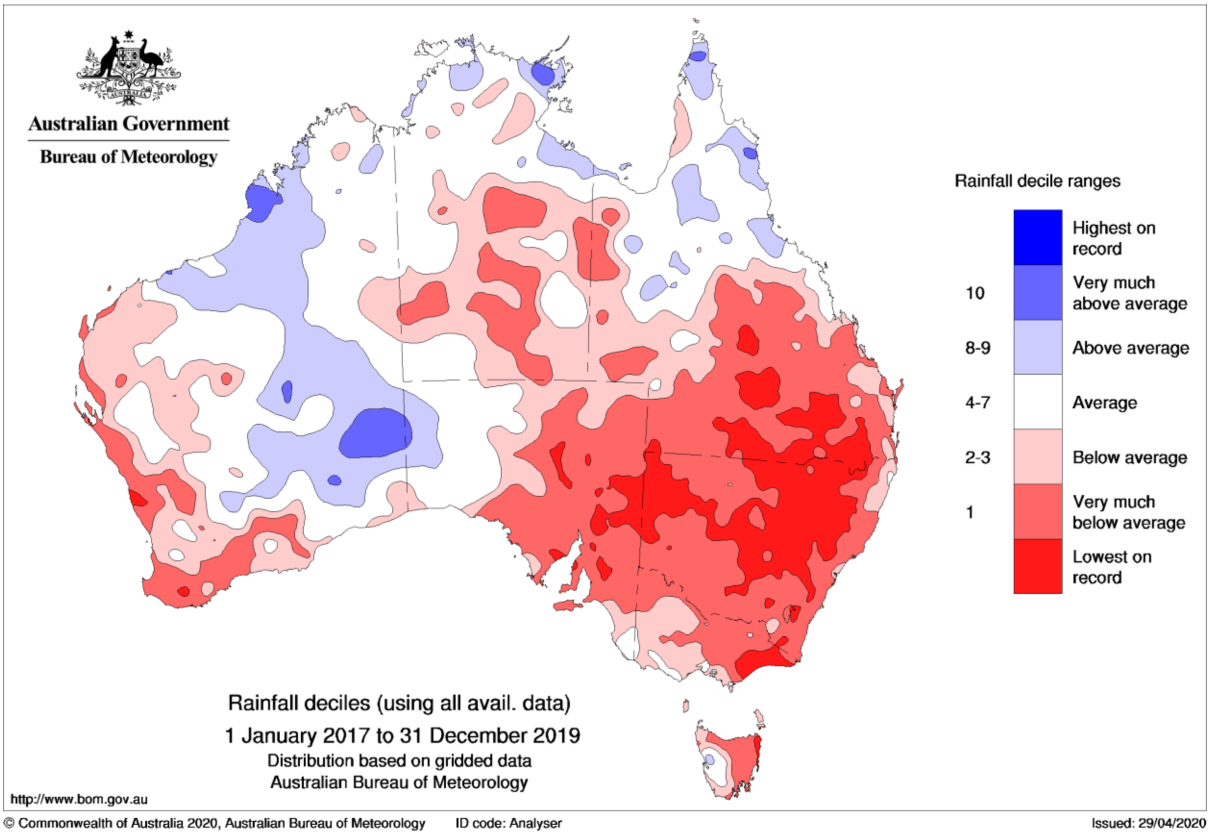



**Figure 3.13:** Australian rainfall deciles during the drought of 2017-2019, showing very much below average rainfall across southern, central and eastern Australia during the period of 1 January 2017 to 31 December 2019. Source: Australian Bureau of Meteorology (BOM 2021a).

The possibilities of rainwater tanks are again made visible through reports documenting the impacts of natural disasters on mains water supplies. Alongside the drought, the 2019–2020 Black Summer bushfires exposed the vulnerability of surface water reservoirs to climate change as fires impacted on densely vegetated water catchments. Bushfires burnt through more than 5.5 million hectares of land in NSW alone (NSW RFS 2020) and intense rain and flash flooding following the bushfires washed silt, ash and debris from burnt catchments into reservoirs raising concerns about water yield and quality. Water NSW temporarily stopped using Warragamba

Dam[35] as Greater Sydney's mains water source due to fire and flood debris running into the catchment (Nguyen 2020). Several fire-impacted towns on the NSW south coast were forced to rely on carted water for several weeks as flooding made the mains water catchment's supply undrinkable (Cox 2020).

The 2017–2019 drought—and the heatwaves, wildfires, and floods that punctuated and followed it—provide salutary lessons for a future of increasing water uncertainty under climate change. The challenge of meeting future urban water demand is, however, unlikely to be solved by building or expanding Big Water projects alone. Increasingly, scientific discourses surrounding climate change point to the possibilities of rainwater tanks in the context of fading national discourses that align dams, and other Big Water proposals, with security and progress. Since the 1980s, the peak of dam building in Australia, the public sentiment towards dams have changed radically. Large dam projects are no longer the vision or aspiration of modernity and are an increasingly unpalatable option for voters because of their environmental and cultural impacts. What were once opened with much fanfare as nation building projects are now heavily scrutinised for their environmental and social impacts and met with public opposition, best represented by the Franklin hydro-electricity Dam controversy and blockade of 1982–83 (Buckman 2008). Other Big Water infrastructure proposals—such as building desalination plants and raising existing dam walls—have been met with similar public resistance (e.g. Leckie and Neindorf 2021; Thompson 2021).

Against the largely urban focused politicising discourse of rainwater tanks as 'villain' and 'saviour' in the narrative of Big Water and modernity, tanks persist as an essential source of domestic water for many regional and rural households and communities

[35] Warragamba Dam supplies 80% of reticulated water in the Greater Sydney region.

throughout Australia. People living in rural and remote communities are less likely than residents in capital cities to have a reliable, reticulated water supply. The absence of economies of scale put the cost of conventional systems beyond the reach of many rural and regional water authorities (Centre for Appropriate Technology 2005). For households not serviced by mains water—or where potable supplies of water are of an unpalatable quality (see further discussion in **Chapter 6**)—rainwater tanks fill an essential gap in domestic potable water provision. Rainwater tanks provide a significant source of water in even the most arid zones of Australia. In South Australia, the driest state (Department for Environment and Water 2021), 56.5% of dwellings suitable for a rainwater tank use rainwater tanks within the state and 85% of dwellings outside of the state capital (Adelaide) have a rainwater tank installed (ABS 2013)[36].

Medical discourses acknowledge the possibilities to drink rainwater collected in water tanks. Current guidelines on the use of rainwater tanks stipulate that household-collected rainwater, stored in a rainwater tank, is usually suitable for potable purposes, except for suburbs located adjacent to heavy industrial, agricultural and transport emissions (enHealth Council 2011). There is therefore a nuanced understanding that household collected rainwater is drinkable. And yet the rhetoric of rainwater tanks as being suitable only for outside water use persists in urban areas. Public communications from utilities to consumers during drought on water saving measures that include the use of tanks for gardens, such as in **Figure 3.14,** highlights the limitation of the discursive construction of rainwater tanks as saviour established by governments and utilities during the Millennium Drought. Big Water discourses

[36] By comparison, in NSW 26.8% of dwellings suitable for a rainwater tank within the state had one installed and 36.4% of dwellings within rural, remote and arid areas have a rainwater tank installed (ABS 2013).

position rainwater collected in suburban backyards as non-potable, limiting its use to gardening practices or washing cars.


**Figure 3.14:** Sydney Water water conservation promotional leaflet. In early-2019, amidst one of the worst droughts on record, this leaflet from Sydney Water, appeared in my mailbox at my rented apartment in Wollongong. As shown by the mark up (in red) the rhetoric that rainwater tanks are for outdoor water use is reinforced. Source: Author.

The discursive framing of Big Water is best and rainwater tanks should only be for outdoor use persists, despite legislative and policy changes encouraging tank water installation in urban areas. The ongoing concerns around bringing household-collected rainwater indoors for consumption is materialised in building construction reports that point to fewer households in NSW using rainwater tanks beyond garden settings. Delaney and Fam (2015) point to the importance of indoor plumbing of rainwater tanks as an encouraging move towards normalising rainwater tank use in suburban households. However, outdoor non-potable (garden and firefighting) use remains the primary purpose of rainwater tanks in single dwellings in NSW (**Table 3.2**).

**Table 3.2: Rainwater connection types in 'single dwellings' issued a BASIX certificate 2011 – 2020 (BASIX data sourced from NSW Planning Portal [2020])**

| | **NSW** | **Metro** | **Regional** | **Eurobodalla Shire LGA** |
|---|---|---|---|---|
| **Total no. dwellings issued BASIX certificate** | **298,012** | **156,883** | **141,129** | **2,576** |
| **Garden connection** | 87.09% (259,529) | 86.38% (135,513) | 87.87% (124,016) | 97.55% (2513) |
| **Toilet connection*** | 76.68% (228,511) | 75.07% (117,783) | 78.46% (110,728) | 90.68% (2336) |
| **Laundry connection** | 65.54% (195,316) | 60.07% (94,235) | 71.62% (101,081) | 88.78% (2287) |
| **Hot water connection** | 6.23% (18,556) | 1.47% (2,300) | 11.52% (16,256) | 22.05% (568) |
| **All house water source** | 5.79% (17,259) | 1.05% (1,654) | 11.06% (15,605) | 20.88% (538) |

Figures in brackets are numbers of responses
*Additional houses with waterless toilets (n): NSW = 490; Metro = 71; Regional = 419; Eurobodalla = 11.

Political discourses of 'Big Water is best' continue to constrain, if not silence, the possibility of rainwater tanks. While legislative changes and changes in public sentiment towards rainwater tanks during the Millennium Drought served to make them visible again in the suburban backyard, the contents of rainwater tanks in urban contexts continue to be constituted by Big Water utilities as suitable primarily for outdoor practices. Hence, the full potential of rainwater tanks to supplement indoor mains water use is unrealised.

## 3.6 Conclusion

In Australia, from the time of the invasion of the First Fleet in 1788 and the establishment of British colonies, to the present day, the struggle to secure freshwater has underlain the struggle for European colonisation and capitalist society. This chapter examines the discourses produced and circulated by different institutions about rainwater tanks and household-collected rainwater and the role they play in the historical geography of domestic water provision.

This chapter has examined four shifts in discourses about rainwater tanks in the provision of domestic water in Australia. First, rainwater tanks were positioned in discourses of 'promise' of survival in the context of European colonisation of the continent, in the face of chronic fresh water shortages during the late 1700s and early 1800s. Second, rainwater tanks were repositioned as 'villain' in the context of political ideas that aligned dam building with notions of modernity and the nation-state. Rainwater tanks could not keep reliably supply the volume of water needed to meet new standards of comfort, cleanliness and convenience in the 20$^{th}$ century. Third, rainwater tanks were reconfigured in policy documents and by consumers as 'saviour' in the context of the Millennium Drought. Household-collected rainwater allowed continuation of water intensive outdoor practices in the context of mains water restrictions. Finally, rainwater tanks are most recently configured in scientific discourses as offering 'possibilities' of water security in the context of ageing mains-infrastructure, population growth and increasing climate variability.

Big Water remains the dominant socio-technical system for domestic water provision and management in nations such as Australia, the USA and the UK. Public and corporate suppliers of water in these countries favour large-scale engineering projects and assume responsibility for the supply of drinking water and removal of wastewater. Although centralised water supplies began as economically tenuous ventures they have grown into wealthy, comfortable and powerful monopolies that operate to maximise profit for shareholders, arguably at the expense of environmentally and culturally sustainable alternatives (Coombes 2002). The intertwined narrative of modern water and settler-colonial states provide cause to question the ability of the state to 'see' beyond modern water (Meehan et al. 2020). Utilities want to maintain status quo as their economic model relies on people consuming their water. Rainwater tanks threaten the stability of this model. Sofoulis (2015, p.533) argues that:

> Tanks are trouble for Big Water organisations because their small-scale, site-specific and user-controlled character is the exact opposite of the system and management approach Big Water embodies. Yet they also evoke the vision that many water professionals now share of a city maintained as a liveable environment through a diversity of practices and technological solutions dotted around the place.

In asking how we might respond and better adapt to the socio-ecological effects of climate change, Head (2015, p.314) observes:

> We have enormous vernacular capacities, not always where we think they are. The past also provides some imaginative resources to deal with what we currently think of as catastrophe, if we can free ourselves of teleological and progressivist framings of history.

There is little recognition in policy of the importance of exploring the adaptive capacities and experiments with alternate water systems already in existence in the Minority World (Gibson et al. 2015; Waitt 2018; Browne et al. 2019), particularly outside of urban contexts. Experiences with rainwater tanks beyond the metropolis remain largely invisible due to political concerns of water supply for cities. Yet, the lessons that regional and rural households are learning today about independently managing, monitoring, and maintaining water supply, consumption, and infrastructure, are the lessons we may need to learn tomorrow to better adapt to the challenges of increasingly variable rainfall, and the local, national, and global effects of climate change. It is therefore important to shift the focus from macro-scale solutions and mains water contexts, to consider instead the existing capacities of households in regional areas to accept, use, and manage alternate water sources in their everyday lives.

In the next three chapters, I turn to the everyday practices, experiences and perceptions of households that live with rainwater tanks in regional and rural contexts. These households are intimately connected to their water by virtue of physical proximity to the source and responsibility for managing water infrastructure at home. Their narratives provide insight to an alternative way of living well with 'small water', which challenges the aspirations of modernity embedded in water management in Australia.

# *Ripple—Dishes and 'death stacks'*

*June 2016 and November 2021*

Robynne and Robert's seldom used dishwashing machine, with hand-washed dishes stacked for drying on top.

It's an overcast drizzly afternoon when I pull up at Robynne and Robert's[37] house for our interview. They welcome me in through the kitchen where I am stopped in my tracks by their dishes. Balanced with what appears to be precarious order on top of their dishwashing machine are their washed and drying cups, glasses, pots, pans and

[37] Robynne and Robert, both 60–69, 2-person household, primary address, length of residence 12 months, interviewed 12 June 2016.

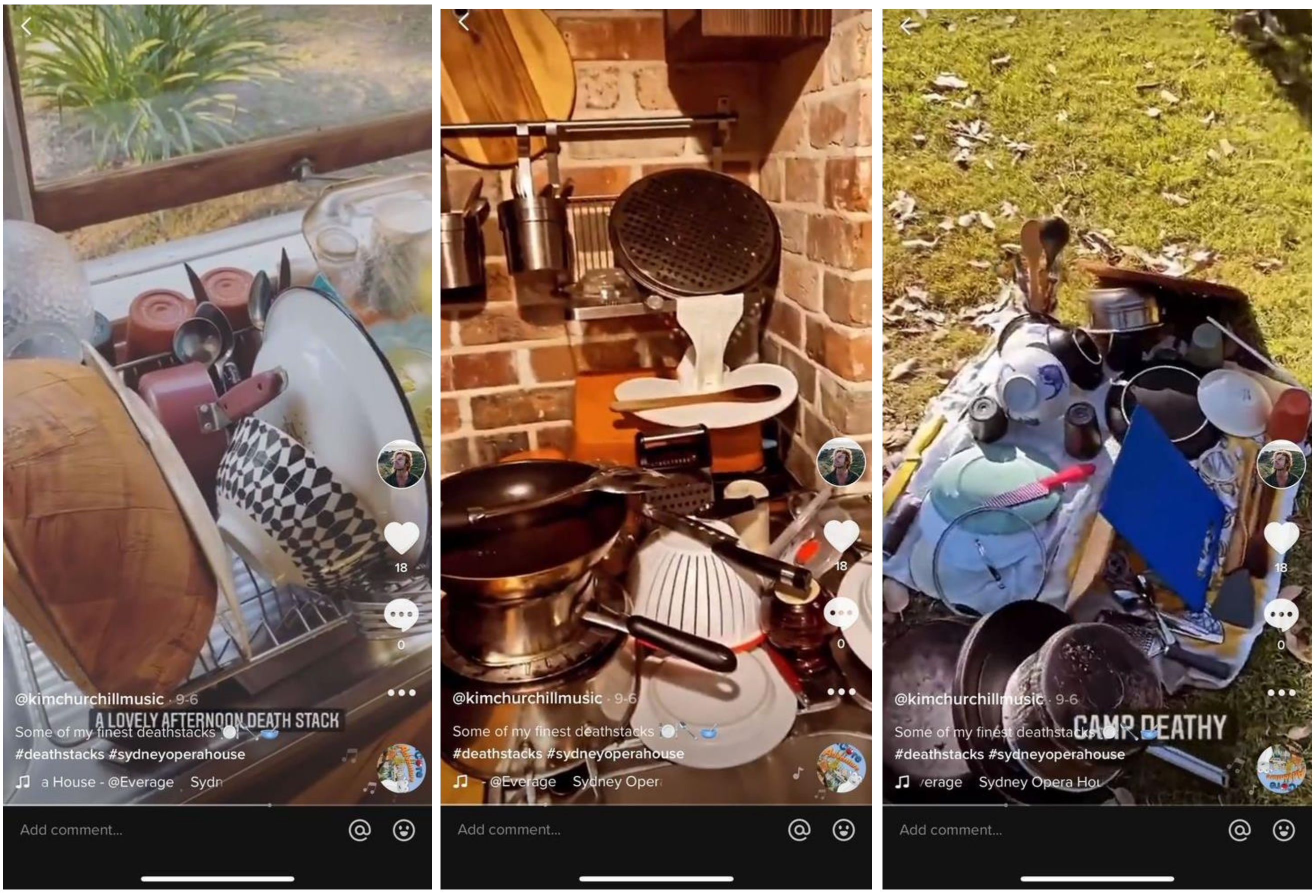
cutlery from, they tell me, last night's and today's meals and snacks. Beside it, in the sink, is a bucket with the, now dirty, dishwater.

I'm accustomed to living in a house without a dishwashing machine, so I'm struck by the juxtaposition of hand-washed dishes, on what appears to be a very expensive Miele dishwasher. 'Why don't you use the dishwasher?' I ask. Robynne responds, 'We only wash up once a day. We stack the dishes, we can soak them, we can do whatever, and if we know there's people coming, sure we'll use the dishwasher. But it's only one wash-up a day'. The conversation continues:

> Robert: Yeah. Our water use has almost halved.
>
> Robyn: Yeah. It went down to– yeah, it was two-thirds less, just not using the dishwasher and just putting a little grey water system in place. So that to me proves that you can wash—and you don't need a lot of water to wash things in. I had arguments with our best friend! "Look, I went and I got a Miele dishwasher, and it's supposed to only be—blah, blah, blah—"
>
> Robert: "Uses less than hand-washing!"
>
> Robyn: Less than hand-washing?! Fucking bullshit! *(Laughs)*

I grew up in a house without a dishwashing machine and hand-washing dishes is second nature. After breakfast every day, before being dropped off at school, all the dirty cutlery and crockery from the last 24 hours would be washed and left to dry in the dishrack by the sink. By the time mum or dad returned from the school drop off, the dishes would be dry and ready to put away and the process would start all over again, with a new dirty pile of dishes amassing next to the sink over the day. I recall that there was a dishwashing machine when we moved in, but it never worked. It just sat there, idle for years, until dad finally pulled it out and took it to the tip. The space where it was is a cupboard now. I've never asked why we didn't replace it. Does washing dishes by hand save water? Does it save energy? Or were we just so accustomed to washing by hand we didn't bother replacing it?

It seems that old-habits die hard. For the last 12 months I have lived in an apartment with a dishwasher but still I'll hand-wash and stack dishes to dry. My husband looks on in horror as I continue to add glasses, plates and knives to the growing pile drying in the dishrack by the sink in what can only be described as a real-life game of domestic Tetris. I can hear his audible intake of breath whenever I reach in to the pile to pull out a spoon or cup to use, rather than pulling one from the drawer or, more sensibly in his mind, putting the cutlery and crockery away! One day, sitting in the park, he hands me his phone to show me a video posted on social media by Kim Churchill, a local musician we follow. 'This is you', my husband says.




A series of 'death stacks', photos of hand-washed and drying dishes. Source: Kim Churchill, with permission.

Kim Churchill has been posting photos and videos showing his dishwashing with the tongue-in-cheek description ‘death stack’, alluding the possibility for a precariously placed plate or glass, or the whole pile, to come crashing down. I’m impressed. Even more so when I see that others have been posting and sharing their own hand-washed dish ‘death stacks’. At least we’ve now got a word for it, I think. I message Kim and ask if he’d consent to my including this story and snapshots of his posts in this ripple. I ask him why he washes dishes by hand. He responds, 'For me it's that hand washing allows an outlet for creativity and has the beautiful mental benefits of giving you a sense of autonomy over your own life whilst making fun of what one could consider a chore'.

# Chapter 4
# Rethinking waste/ing water: family life and everyday water practices off-grid

## 4.1 Introduction

> Then the other thing we do is we don't always flush the toilet when it's just wees, so not flushing the toilet—although with two teenage girls that's changing. But anyway, we try and do little things like that and not have long showers. Again, the girls can go in there for ages, but we're trying to be a bit more conscious that every drop you're putting down the drain is just going into the septic and going into the trenches. It's probably more of a concern, the water use is—is we don't want to overload the septic, rather than use up the fresh water. Do you know what I mean? It becomes more of an issue of managing the wastewater versus the fresh water. It sort of depends on what sort of system people have.
> (Trevor, 50–59, 4-person household, primary address, length of residence 15 years, interviewed 13 June 2016)

The secure supply of potable water is frequently described as a 'crisis' for southeast Australian cities (Waitt 2018). This challenge is often presented by governments and utilities as a problem to be solved by encouraging households to save, or conserve, freshwater. As previously outlined in **Chapter 1**, households that are off-grid for water are constrained by the finite capacity of rainwater tanks to capture and store fresh water. Restricted freshwater use is taken for granted. Furthermore, non-mains households are generally off-grid in terms of managing wastewater also. They are, as Trevor alludes, constrained by the finite capacity of septic systems, as conduits for the disposal and storage of domestic wastewater generated on-site.

This chapter reimagines water conservation through practices that minimise wastewater. Institutional definitions of *wastewater* describe it as 'the used water that goes down sinks, toilets and drains' (Sydney Water 2021c, online). The origin of household wastewater provides two further official categories: 1) *black water*, from toilets and kitchen sinks, and 2) *grey water*, from baths, hand basins, washing machines and other kitchen appliances (WaterNSW 2019). Conventional framings of wastewater management position wastewater as an endpoint of water consumption. However, as Trevor illustrates, managing wastewater is the starting point to consumption for his household. Thinking about where water goes as it exits his home is central to decisions about water conservation and use.

The chapter aim is to better understand how households that are off-grid for water perceive and practice waste/ing water. I am interested in how the shift in technologies for accommodating the storage of wastewater—from distant centralised wastewater treatment works to septic tanks in backyards of private homes—brings new demands and responsibilities on subjects and subjectivities associated with domestic water use in everyday life. To achieve this aim, this chapter moves away from understandings of wastewater and wasting water as technocratic problems involving behaviours of people (as rational individual consumers) and infrastructure, to one that instead involves families.

Water use is a quintessential part of family life and family life is embedded in patterns of water consumption. For families living off-grid, homes are not only where families happen, but homes are where wastewater is made and stored. Sustaining and challenging everyday familial relations are decisions on how to save water, when to use water, the burden of responsibility for monitoring water use, alongside anticipating water shortages and costs. The chapter thereby offers insights to how wastewater is understood in the process of making families through practices of water consumption and saving when living off-grid. I ask: How does water become waste in the context of emplaced family relations?

The conceptual framing of this chapter brings together insights from family studies literature, that thinks about family as a process or doing (Morgan 2011; Holdsworth 2013; Waitt and Harada 2016), and household sustainability literature, that emphasises the importance of social practices, materials, ethics and the spatial in everyday consumption (Hobson 2006; Lane and Gorman-Murray 2011; Gibson et al. 2013; Waitt and Phillips 2016). What brings this work together is that it moves away from static categories and binaries—of water savers and water users, of conserving and wasting water—to think instead about relations, processes, subjectivities and affects that make up everyday life. Water use happens amongst—and in concert with—complex assemblages of everyday practices, subjectivities, materials, values and routines that make up families and the familial home. These elements are missed in conventional approaches to water governance, which focus on supply and demand (shortage and surplus) and the management of wastewater as a technical problem. My conceptual approach challenges conventional framings of wastewater management and governance that positions waste and disposal as discrete activities at the end point of water consumption. Instead, I take my cue from the foundational work of divestment and discard studies scholars who understand waste as a process, such as Hetherington (2004), Hawkins (2003; 2006), Evans (2012; 2014), and Gregson and colleagues (Gregson 2007; Gregson et al. 2007).

The remainder of this chapter is structured in four parts. The first part positions the chapter within the broader practical and political problem of wastewater governance and management in mains water contexts. Next, I briefly outline the socio-technical arrangement for managing wastewater in non-mains contexts, describing the technology of the septic tank and insights from existing social sciences scholarship on decentralised, on-site wastewater technologies.

I then present my interpretation of the empirical data. Insights from the narratives of six interviewees are presented in three sections. Short vignettes provide a way of presenting and analysing the rich empirical data that attends to individual experiences, practices, and meanings. The vignette allows an interpretation of the context in which understandings of waste are embedded in familial relations. Attention turns to geographies of family life and how different families' lives are sustained through practices, including water practices. Implications for understandings of waste/ing water arise through embodied family histories, experiences of living alone and living together apart, and having and raising children and teenagers. This chapter produces novel insights to analysing the ways in which disposal practices and meanings of waste/ing water are shaped through the social and material assemblage that sustains familial relations, which are intimately bound with subjectivities, care and place. To conclude, I return to the research question and provide a summary of the key chapter findings and contributions.

## 4.2 Big Shit

### *4.2.1 Water conservation and waste(water) in mains contexts*

In the context of mains water management, the imperative of 'saving' freshwater in dams for future use dominates public policy and political discourse. Investment in the expansion of Big Water infrastructures—namely surface water reservoirs and desalination plants—remains at the forefront of debates about developing so-called climate resilient reticulated water infrastructure (National Water Grid Authority 2020). The focus on fortifying the provision of freshwater is clearly illustrated in times of drought as citizens are implored to reduce their consumption of freshwater resources through mandatory water practice restrictions (targeting outdoor use) and public education campaigns that advocate for sustainable water use.

Less prevalent in public and political debates of sustainable water use, however, are questions about the disposal of water once used (Hawkins 2006; Moran 2008); that is, what happens to water once it becomes wastewater. Dimpfl and Moran (2014, p.733), referencing Tarr (1996), summarise that 'despite increasing concern over freshwater resources, waste production, particularly the management of wastewater flows, is an obscured counterpoint to domestic consumption'.

The dominant socio-technical system for managing domestic wastewater from mains-connected dwellings in the Minority World is typified by what some scholars have called 'flush and forget' technologies (Moran 2008; Steinberg 2013; Ormerod 2016). In the Australian context, mains sewer systems commonly rely on a steady supply of (usually potable) water to transport and deposit bodily wastes. Dirty water is flushed from toilets, shower drains, bathtubs, laundries, hand-basins and sinks through pipes to a centralised wastewater treatment plant that then flows water, as effluent[38], downstream to the nearest river or ocean[39] (Kaika and Swyngedouw 2000; Kaika 2005). Australian sewerage systems are a colonial legacy of public health measures, reflecting the 19th century British model of largescale subterranean waterworks and sewers (Davison 2008; Barlow 2017).

The beneficial role sanitation provides to human health is widely recognised. Yet most users of the dominant model of centralised, waterborne sewerage systems—what Sofoulis (2005, p.454) terms 'Big Shit' systems—rarely stop to consider the broader logistics of wastewater management (Morales et al. 2016; Ormerod 2016). In the Minority World, the flush and forget arrangement is arguably the most successful and taken for granted system for eliminating human waste from our private lives (Gibson et al. 2013). This is, in no small part, because responsibility for its management is pushed out beyond the boundaries that constitute home, towns and cities, to a typically 'unknown elsewhere' with each flush (Vannini and Taggart 2016, p.87). As Hawkins (2006, p.67) argues, the real work and logic of the waterborne sewer system is that it 'transform[s] shit to effluent, from private waste to public problem'. In effect, 'your shit is not your problem' (Morales et al. 2014, p. 2817).

Like Big Water (see **Chapter 3**), Big Shit (Sofoulis 2005) became symbolic of cities as modern, organised, networked, hygienic spaces through which resources flowed (Gandy 2004; Morales 2016). Sewage was hidden from society, flushed into subterranean networks and kept, out of public sight and mind (Kaika and Swyngedouw 2000). As

[38] Effluent is the outflowing of water from a wastewater treatment plant to a natural body of water.

[39] It is claimed that the word 'sewer' is derived from the Old English word 'seaward' (Sedlak 2014, p.114), suggesting that the role of sewers is to move and dilute wastewater to oceans and seas. About 90% of Sydney sewage, after only primary treatment, is still discharged to ocean by 4 km deep ocean outfall pipes at North Head, Malabar and Bondi (Radcliffe and Page 2020; Sydney Water 2021d).

Hawkins (2006, p.67) summarised: ‘Streamlined removal facilitates literal and moral distance from our bodily waste, and most of the time this distance contributes to an ethical blindness about its management’. There is a ‘sanitary amnesia’ (Ormerod 2016, p.544). These infrastructures and networks of bodily waste disposal have an element of invisibility; that is, of course, until a problem emerges.

### *4.2.2 Overlooking disposal and sinks*

Conventional Big Shit infrastructure does not manage water very well. Rockefeller (1998, p.17–18 [quoted in Gibson et al. 2013, pp.67–68]) summarises:

> No society in the world today deals well with human excreta. At all levels of technological sophistication, damage is done to water, soil and human health—whether by the pit latrine, the flush toilet, the septic tank/leach field, or, most insidiously and destructively, by the central sewage collection and treatment plant, which creates an unpredictably toxic, and therefore unrecyclable sludge.

Since Rockefeller was writing in 1998, the environmental impacts of effluent has been reduced  in many parts of the world through both technologies and legislation (e.g. Deloitte 2016). Yet, there is no denying the vulnerability of municipal Big Shit infrastructures to breakdown. In Australia, many sewerage mains have not been upgraded since they were originally laid over 100 years ago (e.g. Sydney Water 2017). The precarity of this longstanding socio-technical arrangement to wastewater management has recently come to the fore, with increasing incidences of *fatbergs* in sewers, for example. A fatberg is a blockage comprised largely of oil, wet-wipes and other waste products discarded down household toilets and sinks (Browne 2015). This phenomenon is largely the product of household drains being perceived and used by residents as an extension of a garbage disposal system (Hawkins 2006)[40].

The role of oceans, rivers and waterways as conduits for the disposal of bodily wastes is evidenced by the concentrated micro-plastic pollution from personal care products and clothing fibres emanating from wastewater released from sewage treatment works (Kay et al. 2018; Rolsky et al. 2020). Further, emergent research revealed the presence of antibiotics and antihistamines in several rivers worldwide (Richmond et al. 2018; University of York 2019). Alongside this are numerous incidences of failure in ageing and poorly managed wastewater infrastructure resulting in so called 'nutrient outflows' of concentrated wastewaters to beaches, rivers and groundwater (ABC News 2004; 2005; Office of the Commissioner for Sustainability and the Environment 2009; The Beagle 2021). Such breaches attest to the limitations of conventional techno-modern attempts to control water.

Gabrys (2009, p.668), in summarising the work of environmental theorists, suggests that: 'The current stay of our natural cultural ecologies can be understood through our inability to attend to sinks'. Quoting Redclift (1996, p.47), Gabrys (2009, p.668) observes: 'We have for so long fixated on the perceived problem of resource shortages, Redclift notes, that we have overlooked "problems which are associated with global sinks"'. The disposal, or placing, of matter into sinks, is integral to the whole process of resource consumption (Hetherington 2004). However, as social scientists point out,

[40] Icon Water (2021), the government-owned water utility that own, manage and operate all water and sewerage services for the ACT, has a current public education campaign titled 'Free the Poo' targeting the increasing incidence of fatbergs in their sewerage system.

disposal practices are often overlooked (Hawkins 2006; Waitt and Phillips 2016; Stanes and Gibson 2017).

## 4.3 Little Shit

### *4.3.1 Wastewater and disposal in non-mains contexts*

Households that are off-grid for water are typically off-grid in terms of both fresh water and wastewater management. These households are not only constrained by the finite capacity of rainwater tanks to capture and store fresh water, but by the finite capacity of septic systems as conduits for the disposal and storage of wastewater generated by everyday water consumption activities. There is no connection to municipal sewer networks, where wastewater conventionally flows away from both properties and mindfulness.

A septic system, for the purposes of this thesis, is defined as any kind of decentralised wastewater management system that stores, treats and/or discharges wastewater at the premises on which it was generated. Domestic septic systems—also described as On-site Wastewater Treatment Systems (OWTS)—typically comprise of at least one storage tank (septic tank) below ground. There are several different types of on-site sewage management system in Australia[41]. The two most common types encountered in this study were 'pump-out systems' and 'absorption trench systems'. I take my definitions of these infrastructures from my participants' descriptions (**Figure 4.1**).

[41] For a detailed summary of the types and functions of on-site waste management systems most commonly used in Australia, including pump-out, absorption trench and aerated septic systems, refer to *The Easy Septic Guide*, published by the NSW Department of Local Government (DLG) (now Office of Local Government) (NSW DLG 2003).

**Figure 4.1:** Above ground view of household septic systems encountered during the study. Source: Author, March–August 2016.

*Pump-out septic systems* typically involve the preliminary on-site treatment of wastewater in a below ground holding tank, followed by collection and transport of the waste matter to an off-site management facility (being, in the case of the Eurobodalla Shire, the municipal sewerage treatment works). Pump-out septics have a finite capacity for storing waste, and generally need to be emptied every six weeks depending on the volume of water directed to it by the household.

*Absorption trench septic systems*, on the other hand, work by retaining solid scum and sludge (that is, faeces, toilet paper, kitchen grease and oils) in a holding tank while slowly releasing liquid effluent via pipes and trenches into the soil in a designated area (an absorption or 'transpiration' field). The cleansing action performed by absorption trench septic systems occurs mainly in the soil around the absorption field, as a result of absorption of pollutants by soil particles and general dilution in the soils and subsurface (Moran 2008). Given the dilution of wastewaters through the absorption trenches, the holding tank of an absorption septic system needs less frequent pumping out; a healthy absorption septic system can go for years without intervention.

In addition, several households in this study used 'aerated (aerobic) septic' systems (NSW DLG 2000). These systems enable people living in unsewered areas to treat and utilise both grey and black wastewater on-site; these systems typically consist of a series of treatment chambers to process solid wastes combined with an irrigation system through which recycled wastewater is distributed through garden drippers, sprinklers or through a subsurface irrigation system (BioCycle 2021).

It is important to note that all septic tanks are living ecosystems. Bacteria digest fats and solids retained in the tank. These decentralised, small-scale 'little shit' systems can malfunction and become flooded or blocked if inundated with or starved of water, or through the addition of harsh chemicals, such as bleach, or non-biodegradable items, such as sanitary pads and wet-wipes.

### *4.3.2 Understanding everyday life with decentralised wastewater infrastructures*

Studies of decentralised wastewater infrastructures in the Australian context are largely informed by public health, engineering and environmental science disciplines. Such research focuses on evaluating the performance and pollution potential of decentralised wastewater systems and assessing household compliance with regulatory controls (e.g. Sarac et al. 2001; Ahmed et al. 2005; Beal et al. 2005; Nunn and Ross 2006; Levett et al. 2010; Gunady et al. 2015). With the exception of Alexander et al. (2008) few Australian studies critically engage with the experiences and practices of individual households that live with decentralised wastewater management infrastructures. Alexander et al. (2008) held two workshops with residents of communities to understand the issues and concerns held by residents associated with their on-site wastewater systems (e.g. safe and unsafe systems, maintenance and governance issues). The focus was on eliciting and assessing residents' knowledge of their wastewater system, maintenance practices and regulatory compliance. The objective was to better protect groundwater from the impact of systems failures by generating management, regulatory and education strategies.

In the Australian context, at least two reasons account for the omission of research on households' everyday practices of wastewater management. The first reason is, the marginality of septic tank systems as a technology of domestic wastewater management. Recent figures are hard to source. However, in 2000 the NSW Department of Local Government (DLG) reported that up to 20% of regional households in NSW (approximately 290,000 households) used some type of on-site septic system for managing wastewater (NSW DLG 2000, p.7)[42]. The second reason is, the city-centric focus on domestic water issues, as discussed previously in **Chapters 1** and **3**.

The lack of scholarly attention to septic systems, Moran (2008) argues, reinforces the general obliviousness of this essential component of the built environment. Notwithstanding this, several studies from the international social sciences literature highlight the significant opportunity for learning from householders managing wastewater on-site. Empirically, these studies examine the practices and experiences of off-grid households and eco-communities managing wastewaters through decentralised technologies such as septic systems and composting toilets in the UK (Pickerill 2015), the USA (Moran 2008; Pickering 2010; Dimpfl and Moran 2014) and Canada (Vannini and Taggart 2016).

Collectively, what these studies show is that households that are responsible for the management of their wastewater do not treat this by-product of their everyday consumption activities as dirt out of place, to follow Douglas (1966), but rather as matter in and of place and thus subject to their direct accountability (Vannini and Taggart 2015). For example, the function and processing capacities of composting toilet technologies puts clear limitations on water consumption. These domestic limits encourage users to examine not only their everyday practices but the metabolism of their bodies (Dimpfl and Moran 2014). Through disconnection from the state and reconnection with local environments householders reframe their relations to others,

[42] O'Keefe (2001) reported at the *On-Site '01* Conference (University of New England, Armidale) that approximately 20% of Australian households use on-site systems to treat and dispose of household wastewater. In a 2006 paper, Beal et al. (2006, p.2327) reported that, in Australia, soil absorption septic systems represent at least 75% of the >1.5 million on-site sewerage systems.

both human and non-human (Moran 2008; Pickering 2010). They become, to quote Vannini and Taggart (2015, p.87), 'reflexive consumers' of water.

The conceptual entry points of these studies are the structural, material and cultural factors that underpin habitual wastewater practices and competencies. However, less is said in these empirical studies about the emplaced dimensions of water (re)use and disposal in the context of family life. That is, for families living off-grid, the house-as-home is not only where families happen but where wastewater is made and stored. Water is a component and water consumption is a by-product of the practical carrying out of everyday family life (Strengers 2011; Roberts and Henwood 2019). Decisions and trade-offs on how to save water, when to use water, the burden of responsibility for monitoring water use, anticipating water shortages and costs, sustain and challenge everyday familial relations (Gibson et al. 2013). This chapter thereby aligns with research that has rethought family as an emplaced process, not a category, and comprised of relationships between human and non-human bodies, ideas and things that co-constitute familial subjectivities and the house-as-home (e.g. Morgan 2011; Holdsworth 2013; Waitt and Harada 2016;).

In the next part I present my interpretation of the empirical data. The narratives of six interviewees are presented as vignettes coupled in three sections. Each vignette provides illustration of the different way in which embodied understandings of water practices as waste/ful co-constitute families. Implications for water (re)use, conservation and waste arise from embodied family histories, living alone and together apart, and having and raising children and teenagers. I focus on how understanding of family and home are made and unmade through the sensations of showering, bathing, flushing the toilet, watering gardens, doing laundry and washing the dishes. These are practices and routines that make family at the same time that family life is comprised of these practices and routines. However, practices are never constant or fixed. Practices are constantly being reworked and renegotiated (Mela et al. 2018), and, more importantly, they are sites of decision making where, regardless of whether we are conscious of it or not, we ascribe to and perform particular moral codes—we perform tasks in certain ways rather than others (Browne 2015; Shove et al. 2012; Lindsay and Supski 2017).

In choosing to frame this chapter through the lens of family, I understand than not all households are families, nor are all families households. The focus on families is in part a response to the interview study sample, where only one household consisted of housemates with no familial connections. However, families are not static entities. In narrating their domestic waste/water practices, participants—including those who currently lived alone—drew and reflected on their experiences with family across both time and space. Extended and immediate family members may not be part of their household now, but they continue to form part of their everyday relations with water at home. In thinking about families dynamically, this chapter takes seriously not only the immediate intimate connections between people, but the people, animals, elements and infrastructure that make up and extend from a familial home.

## 4.4 Results and Discussion

### *4.4.1 Embodied family past and present*

My first two examples are illustrative of how people gained their understanding of wastewater and wasteful water practices through embodied histories and experiential learning. Many participants who exercised frugality and restraint in water use shared childhood memories of water scarcity, restriction and reuse in largely rural contexts. Discourses of wasting water become embodied through childhood experiences of sharing water and continue to manifest in the present. These examples are about the importance of upbringing with families, water tanks, baths and septic tanks, and of habits and values from childhood. Together, these help make sense of the sensibilities of everyday water practices that configure the frugal and wasteful subject in the context of the off-grid home.

### Kerryn

Kerryn is a single mother in her 40s who, at the time of the interview, was living with her three teenage children, a dog and a horse, on a suburban lot by the beach, where she has been living for the past ten years[43]. I'm interested in Kerryn's experiences heading up a household of teenagers and young adults reliant on rainwater tanks and the septic tank technologies for managing water—my survey and interview sample largely comprised of elderly couples or single-person households, which reflects the wider demographic of the Eurobodalla Shire. As we talk, it becomes clear that Kerryn's own childhood experiences of living off-grid greatly influenced how she takes responsibility for water use in her household today.

Kerryn describes growing up on tank water on a farm during drought in the 1980s. Her family relied on rainwater and water pumped from a creek to the household tanks. Kerryn describes the bath time routine of her childhood and how the experience of

[43] Following our interview, Kerryn and her family moved onto a larger property, which is also off-grid for water, where there is a dam that can provide a more consistent supply of water for keeping horses.

sharing bathwater with family cemented in her a life-long ethos of reusing and not wasting water:

> So we had this big cast iron bath tub for four kids in the family and two adults and the dilemma was, do you want to have a shallow but clean bath, if you were first you got about that much water *[indicating an inch]* but it'd be clean, or—we just kept topping it up with water—do you want to have a deep bath, which three or four other people had used? *[Laughs]* That was a dilemma. I always opted for bath number two or three. But by the time I can remember my dad would get in the bath, and he had been out working on machinery so often he had diesel or oil on him, he'd get in the nice big deep bath and in the morning—the bath water would be left in because my step-mum would dish it out onto plants—you'd go in in the morning as a kid and I can remember this oil slick on top of the water! *[Laughs]* Yeah, it was funny. But yeah, water was really precious then and that pretty much conditioned me to not ever waste water.

Kerryn's narrative demonstrates how 'bathing histories become lodged under the skin' (Waitt and Welland 2019, p.35). As a child, Kerryn learnt that water was 'precious' and should be used conservatively. A bath was a place to get clean, rather than to linger and relax. The routine and pattern of bath time, and ways water is (re)used, are integral to sustaining family. This embodied history manifests in Kerryn's present relationship with water as she describes practices of water restriction and reuse at home. The practice of 'topping up' and reusing water for cleaning is one that Kerryn continues in the present day. She tells me how, in dealing with an onslaught of dirty dishes from her growing teenagers, her household adopts practices of washing by hand at the kitchen sink and topping up and reusing this water for multiple washes during the day:

> My attitude to dishwashing is, well there's a constant stream of dishwashing here and so generally that sink will have just a small amount of water in it, mostly during the day, it gets replaced whatever, but it's just an ongoing process. And I don't—you know, it's not a significant water user at all, because again I don't want copious amounts of water going down the sink and into the septic. Because that disrupts the septic.

The drainage and storage of dirty water in the septic tank is a key factor underpinning Kerry's practices of water conservation, restriction, and reuse. Maintaining family life calls for a small amount of water in the sink all day to wash-up dishes to prevent the septic tank from over filling. Kerryn tells me that the household used to rely solely on rainwater captured and stored in the two tanks on their property but recently they have been invited by their neighbour (a secondary homeowner who is rarely in residence) to top up their tanks using his tank water when they run low. While the home now has access to more freshwater for everyday use, Kerryn continues to implement a longstanding regime of reusing dishwater and taking 'short' showers. As she sketches the flows of water through her home (**Figure 4.2**), Kerryn tells me that she aims to minimise household practices that produce water that requires disposal in the absorption trench septic located at the rear of their backyard:

> And the other thing I guess is- and this is an aim too- *[writes on sketch map]* "minimise water use" to, obviously, save water, and also, and this is a big one, and also to *[writes on sketch map]* "decrease water to the septic". Like the two are inextricably linked. And that's what I say to the kids. Even if the tanks are full they say, "Oh great, the tanks are overflowing, we'll have nice long showers!" And I'm like, "No you won't because we don't want the septic tank filling up

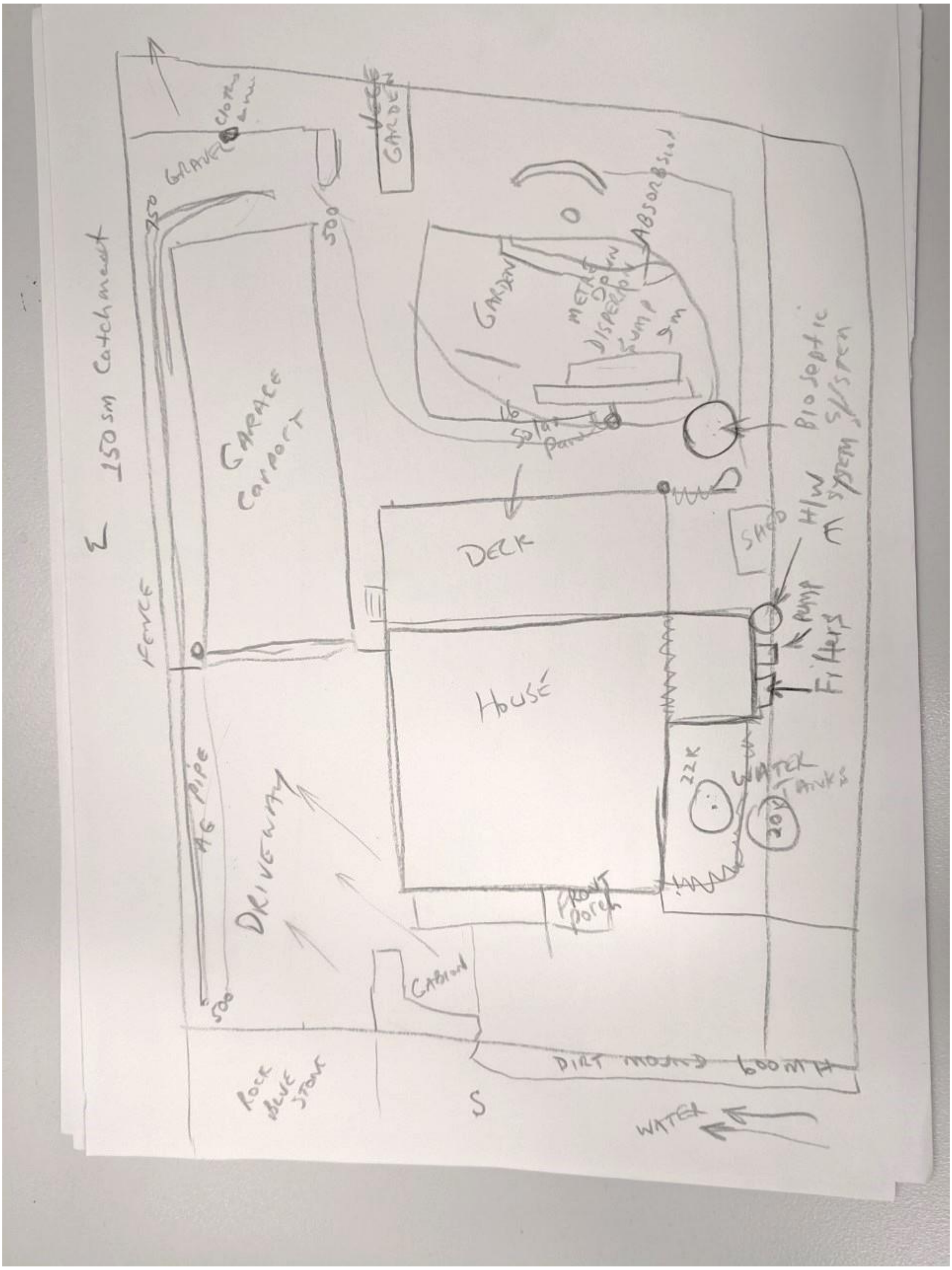



**Figure 4.2:** Kerryn's sketch map. Source: Author, 8 May 2016.

> unnecessarily". So yeah, both things go hand-in-hand. The more water you push into that septic, the more overloaded the absorption trench becomes. […] So, it's not only: "Let's not use all of our good water unnecessarily", but it's also like: "Let's not fill up the septic tank unnecessarily", as well.

In rebuffing her kids' request for longer showers, Kerryn highlights the importance of knowing where the water goes; that is, where it is disposed of once used. The practice of maintaining short showers, even when freshwater is plentiful, was reinforced by her concern of overworking the absorption trenches by flooding the septic tank with shower water. The finite capacity of the septic tank system thereby frames family domestic life through restricting showering practices.

In this next example from Kerryn's narrative, I turn to her households' practices of toilet flushing. Flushing toilets after urination is a cultural imperative in the Minority World, even under a regime of water restriction (Gibson et al. 2013). Here, Kerryn describes how she calls on her children and guests to refrain from flushing after urination; her family follows the saying 'if it's yellow, let it mellow'. In doing so, Kerryn and her kids actively challenge dominant practices around flushing toilets for people living on mains water. The latter are tied up with cultural taboos where not always flushing bodily fluids contravenes social norms of morality and cleanliness (Hawkins 2003; Davison 2008):

> With the kids, they know but I still have to remind them all of the time. And with friends visiting, that's when, you know, tactfully or not so I just say to the kids now, "Don't flush the toilet every time". Because you get—I've had sleepover birthday parties with ten 10-year-old girls, and ten flushes, constantly, they just kept flushing the toilet because they don't know any different or culturally it's

> just seen as inappropriate if you don't flush the loo every time. It's how they've grown up and I'm like, "No, no. It's okay". […] You just have to get conditioned to it and then you're fine. Because it's funny, I know with the younger girls I need to actually make a point of saying it so that they then can all be relaxed with the fact that it's okay to not flush the toilet, otherwise they think they've got to flush it because everybody else is— "They'll know I didn't flush it", blah, blah, blah. So, I just say, "Girls. Don't flush the toilet. Unless you need to", *[laughs].*

Cultural taboos prevent honest conversation about excrement, which hampers wide-ranging understanding of the environmental issues related to modern sanitary systems (Ormerod 2016). There are few audiences more critical than a room full of adolescent girls. Kerryn's call to refrain from flushing the toilet after every use forces her guests to confront their relationship with bodily waste. Her guests must become aware of the conduit and resources that facilitate its disposal (Hawkins 2006). Flush toilets are arguably the biggest consumer of water in the home, representing up to a quarter (20–25%) of the average Australian household's annual water use (Schlunke et al. 2008). As Dimpfl and Moran (2014, p.732) observe, 'flush toilets homogenize waste without exception or clear limit, telling users little about the very real resource demands of the dominant sociotechnical systems designed to manage that waste'. Kerryn and all, but one, of the households interviewed in this study utilised a flush toilet[44]. However, rather than a distant sewage treatment plant, the flush toilet relied on the technology of the septic tank to accommodate and process bodily wastes. The proximity of families to septic tanks shines the spotlight firmly, and perhaps uncomfortably, on the body as

[44] One household currently utilised a compost toilet. Another had utilised a compost toilet in the past.

waste-making. In doing so, off-grid householders and their guests are called upon to relax while challenging dominant social norms around proximity to bodily fluids.

## Kerry

Kerry and her husband Brian are in their 70s and own a secondary residence that is disconnected from mains water. They have owned the property for twenty-five years. They use this house as a 'weekender'[45] (holiday home) throughout the year, and sometimes host their extended family over the holiday and summer seasons. Kerry and Brian have vastly different embodied water histories. Brian has only distant memories of relying on tank water as a young child in the 1950s, having spent most of his life in town on mains water. Kerry, on the other hand, can vividly recall her childhood and young adulthood on a farm reliant on tank water. There is a gendered dimension to Kerry and Brian's narrative of water consuming, wasting and saving practices. Kerry as wife, mother and grandmother takes the burden of responsibility for saving water and anxiety around wasting and living without water. The kitchen sink is a key site around which her subjectivities and moral identities are practiced. There is no automated dishwasher at their non-mains water house and, despite the protests of her family, Kerry prefers to follow a regime of washing up dishes by hand:

> The family says things like, "You should get a dishwasher!" Well, I think it's good for the grandchildren to see how things are done by hand. I don't want anything like that. Well, whether I would get a dishwasher if we decided to move down

[45] Kerry and Brian tell me that the house is generally occupied for about 3 months of the year, cumulatively.

here, permanently? *[pauses, thinks]* But I'm not wasteful with water anyway. I can't bear a tap running and long showers.

Here, Kerry highlights the importance of '*see[ing]* how things are done', as a counterpoint to the automated dishwashing machine that cleans (i.e. removes dirt) behind a closed door. She aligns the dishwasher with wasteful water practices, including leaving taps running and having long showers. Washing dishes by hand stabilises Kerry's subjectivity as someone who is frugal with and responsible for water, as someone who doesn't take long showers or leave taps running.

The sensation of washing-up by hand at the kitchen sink feels 'good' and becomes a site for doing family as Kerry performs care for both water and her grandchildren. Hand washing (re)connects them to the water that is used to remove dirt and educates them about water use. The decision to maintain a regime of washing dishes by hand is, in part, a legacy of Kerry's own childhood experiences; Kerry grew up on a farm that was off-grid for water in rural Western Australia in a town where, she describes, 'It doesn't rain there for eight months of the year'. Like Kerryn, Kerry can vividly recall childhood memories of sharing bathwater with family:

> Well we grew up on a farm and I can still remember bath time. Well, we were beautifully looked after but the children would get in the bath and then mum would get in the children's bathwater and then dad, who was covered in grime from the farm, would get in. [...] So we were taught it was a crime, it was a dreadful sin—we were also brought up Catholics so it was full of sins—it was a dreadful sin to waste water. And that stuck with me really.

Growing up with water scarcity in rural Australia had an ongoing impact on many participants' approaches to water (re)use and understandings of waste/ing water (Allon and Sofoulis 2006; Maller and Strengers 2013; Stanes et al. 2015). Like Kerryn, Kerry's individual experiences of water use that emphasise frugality are understood as part of a collective family experience and establish frugal use over a lifetime. Kerry's embodied history of water scarcity and reuse, told through the narrative of washing up and washing bodies through sharing bathwater in childhood, makes for a commitment to care for water, in this case through the manual labour of dishwashing by hand. The significance of handwashing dishes for Kerry is therefore not only linked to ideas around cleanliness, but also to symbolic and moral conventions around what she considers 'right' and 'proper' (Wong and Brown 2009) from her rural childhood and Catholic upbringing. The persistence of dishwashing by hand is connected to a sense of obligation to a particular moral code, in which doing 'the right thing' for the environment may not necessarily involve a reduction in water, energy use and labour but, more important is the sense and sensibilities of water, particularly a mindfulness of its role in the removal of dirt.

In summary, Kerryn and Kerry's narratives underscore the importance of embodied childhood and family experiences of frugality and water reuse in shaping everyday practices. These everyday water practices were taken-for-granted in relations that comprise their family home growing up rurally, and counter wider social norms found in contexts with mains water. Household water (re)use and disposal practices are embedded in everyday household routines and rhythms that co-produce family. The maintenance of practices of sharing and reusing water, through hand-washing dishes, for example, may be interpreted as a way for Kerryn and Kerry to connect their children and grandchildren with past places, practices, ideas and family members. The sense and sensibilities of frugality, reuse and restraint may become embodied by the next generation of water users, as they were for Kerryn, Kerry, and many other participants in this study.

### *4.4.2 Living alone and living together apart*

My second two vignettes are from single men who lived alone in their non-mains water home. Their narratives of travelling, visiting families and being a guest and a host are illustrative of how living alone—and living together with and apart from family and friends—offer moments for transforming, reaffirming or challenging existing practices and understandings of waste/ing water. Many interviewees spoke about the transformative capacities of travel experiences on their water use practices returning home. For these participants, their embodied relationship with water changed through being a guest in places with different water infrastructures and water availability. Equally, many spoke about challenges of maintaining water conservation practices of reuse when hosting friends and family in their homes. Their narratives offer insight to the social and material relationships in which environmental and familial identities and understandings of waste/ing water are spatially embedded and emergent through experiences of travelling, living alone and living together apart.

John

> I might be able to help you with some info about water use. I have lived with town water all my life until the last 5 years.[…] I have developed a different habit of water use over the last 5 years. About the same time, I started work in Japan for 3 months a year. In Japan, the Japanese have a culture of communal bathing. These bathing places are call *onsen*. While living in Japan I use the *onsen* daily for ablution and relaxing. It was here where I Iearnt how to save water[…]. Since I started bathing at home using this method, my tank has never got under 1500 litres.

*Email from John, 13 March 2016.*

Before moving five years ago, John, who is in his 50s, had lived his entire life in town on mains water. Now he lives for most of the year in a rented, small one-bedroom cottage, directly opposite a creek, with a single 3,000 litre rainwater tank to provide for his domestic water use. In recent years, John has made several extended overseas trips to visit his partner in Japan. In an email to me prior to our interview, he described the profound impact of Japanese communal bathing cultures on his own practices and views on water use. He now uses the hand-held showerhead in his bathroom (**Figure 4.3**) for *onsen*- and *sento*-style bathing[46]. John tells me, 'I've always had it, that apparatus, [I] just didn't utilise it until I went to Japan'.

[46] Broadly speaking, onsen- and sento-style bathing (terms which John used interchangeably) consists of a public, communal bathing practice. The bathing experience in Japan that John described involved being seated on a stool at one of a number of washing stations located in a large room, which consisted of a hot and cold tap, hand held shower head and bucket. Washing involved intermittently running the water between soaping up and rinsing, as opposed to washing under a continuous stream of water in a shower, as was previously the norm for John when living in Australia.

**Figure 4.3:** John's hand-held showerhead. Source: Author, 25 March 2016.

John's respect for Japanese culture extends to adopting Shinto, the Indigenous Japanese faith. The ethics of Shinto seek to cultivate harmony between kami (deities), humans and nature. 'There's a kami for everything', John tells me, 'If we have dry times it's for a reason, there's a reason why kami has done that. We've got to thank kami; even if it's not good for me it might be good for someone else, so there's a purpose to it'. However, there are elements of his partner's culture that do not sit well with John. Despite his admiration and adoption of *onsen* bathing practices, John concludes that 'Japan is the biggest users of water ever':

| | |
|---|---|
| Carrie: | How so? |
| John: | When they do their washing. They just let the tap run all the time. And there's no plug in the sink. |

Here, John is referring to dishwashing practices. I ask him what his dishwashing practices are. John tells me that, to minimise the amount of water he uses washing dishes, he generally washes up once a day, rinsing dishes in water captured from his shower:

> You know how you turn the shower on and it runs cold, I put my showerhead in a bucket and do a couple of things, you know, weigh myself, stuff like that. I've got a regime and that regime fills in that time before it [the water] starts to get warm and then I turn it off, pull the bucket out and then I use the bucket [water] for stuff like rinsing these plates.

Like Kerryn and Kerry, John does not own a dishwasher. His approach to washing up involves letting 'dirty' dishes and cooking utensils stack up on the kitchen bench beside the sink throughout the day. He will then wash a 'full load' of dishes by hand in the sink using bucketed water, rather than doing a stream of little washes during the day. John senses this practice as an efficient use of water because the same water in the sink can be used to wash multiple dishes. However, there is a trade-off:

> Carrie: So, what are your washing up practices here?
>
> John: I try and let it build up *[laughs].*
>
> Carrie: *[Laughs]* We're the same.
>
> John: But I don't like it building up! I'm always on top of things. I like to wash up during cooking, you know, I like to sit back and relax after dinner *[laughs].*

John's home comprises a combined living-dining-kitchen area. John feels uncomfortable allowing unclean dishes to build up on the kitchen bench. However, this is a discomfort he is willing to live with. John is conscious not only of his limited capacity to capture and store rainwater in his water tank, but of his role as consumer in 'filthing' or 'dirtying' water through its use as a conduit for the disposal of food (and body) wastes. John discusses washing-up in the morally loaded language of *abuse*:

> I don't want to use 3,000 litres. There's not much abuse you can do with the water. You know. Because that's what we do to it, I reckon, we abuse the water. Because it doesn't reproduce. What we've got here is a certain amount and that's it. It doesn't get added to, it doesn't get taken away, we don't 'lose it' in any aspect, it just gets filthed, you know, it just gets dirtied.

John confirms Hawkins's (2006, p.ix) observation that waste is implicated in the formation of new 'circuits of guilt' and 'practices of self-regulation'. John's commitment to care for water by not filthing or abusing it sets terms for his dishwashing routine that relies on letting dirty dishes build up until enough are collected to merit washing up. Stacking dishes in the sink hints at John's intimate relationship with water; he suffers discomfort at the sense of who he could become—a vilifier, an 'abuser' of water. Therefore, he learns to live with the discomfort of contravening social norms around maintaining a clean and tidy kitchen.

John's commitment to minimising the production of wastewater extends to the extreme case of telling family and friends to refrain from visiting him in his one-bedroom home. The relationships that comprise his commitment to sustainability are stronger than those that comprise hosting family and friends:

> Carrie: So when, or if, you have friends staying over or visiting or family visiting, do you find that you have to tell them 'Hey I've only got this one tank of water?'
>
> John: Yeah, that's why I say stay away.
>
> Carrie: *[Laughs]* Stay away?
>
> John: Yeah, "Fuck off, you're not staying at my place". "Why?" "Because there's only one toilet". You know, three people staying here for two weeks means I'll have to end up getting the pump-out done.
>
> Carrie: Oh! For the septic!
>
> John: Yeah, because this is only a one person place. You get a family living here this tank will fill up. Then you'll start getting more run-off because it's not a pump-out, it's a drain away one. You know, a

> gravel pit one. So you'll get a lot of green and grey [grass] on that leeside hill there because that's where it runs out. But one person here, there's no change in the colour of the grass at all. It's good for the grass.

John illustrates the familial limits of living with one water tank and a closed septic system. John conveys a sense of obligation to a particular moral code of not wasting water by not using a dishwashing machine or repeated washing up and telling family members to stay away. In this case, his sense and sensibility of responsibility for water manifest through his experiences of traveling and living together with and apart from his Japanese partner, and his observance of the philosophies of Shinto. Furthermore, exposure to Japanese culture and grounding in Shinto philosophy instils in him an awareness of the cyclical and finite nature of water and his placement within the broader ecology of life.

### Mike

Mike, who is in his 70s, lives alone in a home that is located directly opposite a river, and draws on water stored in two large rainwater tanks. Mike is a keen outdoorsman and makes his own sea kayaks and canoes, which he paddles out, almost daily, on the river. Given his proximity to the river—which supports a large oyster industry—and a small natural pond, Mike's septic tank is, by necessity, a closed pump-out system. He is acutely aware of the potential for the septic system, if mismanaged, to overflow and pollute the river. As he sketches the flows of water through his home (**Figure 4.4**), Mike tells me, 'I've got to monitor the levels in that tank down there, the effluent tank, to make sure it doesn't get full up and overflow, because if it does it's basically running

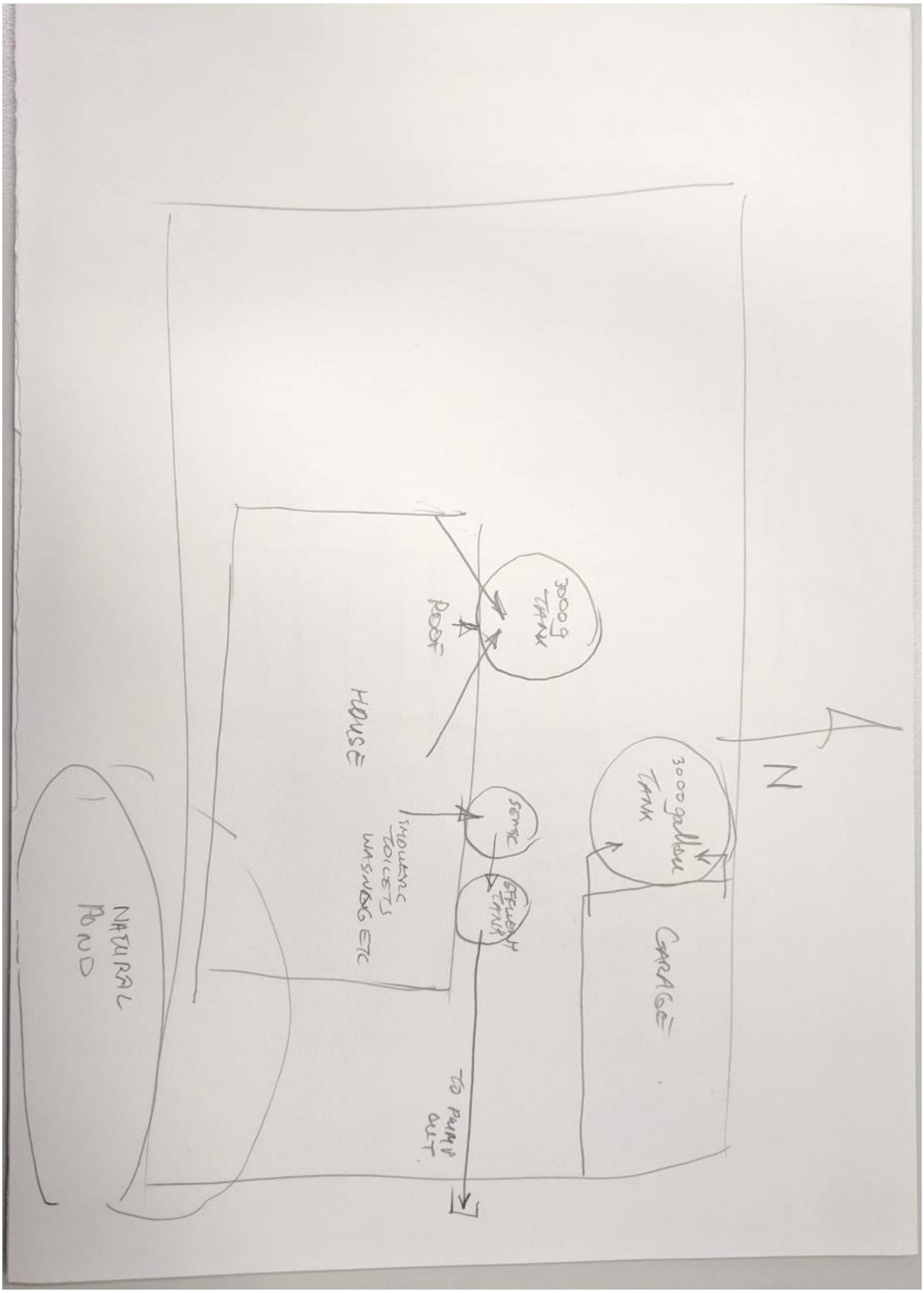



**Figure 4.4:** Mike's sketch map. Source: Author, 14 April 2016.

down the grass into that pond and eventually into the river'. I ask how often the septic tank needs to be pumped out:

> For me it's two to three times a year, but for most people it's more often than that. But for me because I'm by myself and I'm pretty well—well, I think I'm probably a lot more conservative in my water use and flushing than most people. You'll probably get a picture of that as we talk.

Mike goes on to tell me, 'I've got some interesting—well, some people find interesting—ways of doing dishes'. Like Kerryn and her family, Mike washes dishes by hand (**Figure 4.5**); he lets dirty dishwater build up in the sink as he only washes the dishes every couple of days using water captured in a bucket from the shower:

> The water that gets used in the kitchen sink, which is still there from this morning, will stay there all day and I'll use that for rinsing. Even though it's cold, it's soapy so I'll rinse the dishes I use today so they've not got food on them, and then I'll wash them tomorrow morning. So I only wash dishes every second day while I live by myself, and that water in the sink doesn't go down the plug hole, I'll dipper it out [scoop it into a bucket] and I'll chuck it on the garden.

Some houses had mechanised and automated infrastructures in place to reuse grey water from kitchen sinks, showers and washing machines on gardens. These systems varied in complexity, from an aerobic wastewater treatment and biocycle systems, to a hose running water from a washing machine out to the back lawn. Many others, like Mike, adopted more ad hoc, hands-on practices of using buckets and scoops to capture and transport water between different locations, within and outside of the home, for different use.

**Figure 4.5:** A bucket for dishwashing in the kitchen sink at a participant's house. Source: Author, 12 June 2016.

Mike, like John, puts in effort to capture water from showers and sinks. Through handling this grey water between places and uses, he recognises it not as waste or a system by-product without value (Ormerod 2016), but a residual resource. Hawkins (2006, p.103) argues that: 'These different frames of recognition transact new values between the person and the discarded thing'. Furthermore, Hawkins (2006, p.103) writes, 'It is not just the discarded material that is transformed but also the subject who handles it so carefully'. As Mike captures, transports and (re)uses water, what was once suitable for showering, then becomes suitable for washing dishes, which then becomes suitable for gardening. This shows that water use is not a discrete activity—activities are connected, as water flows and is (re)captured it becomes involved in enabling other practices. Consumption is not linear (Hetherington 2004) and water does not have a single use before it is disposed of. Mike's dishwashing and other water use practices nearly always involved what he described as 'second-hand water, pre-used water, pre-loved water'. This rubs against how wastewater is conceptualised and disposed of in mains water contexts. Once sullied by showering or bathing bodies in mains water contexts, water become waste to be quickly piped out far away from the dwelling.

Mike is aware that his practice of letting cold soapy dishwater linger in the kitchen sink, to allow ongoing (re)use in dishwashing through the day, contravenes social norms. A tension between ideas of cleanliness and water frugality becomes apparent when he reflects on the cessation of his dishwashing regime when hosting family who live on mains water:

> My dishwashing water doesn't go down the sink and I don't use the sink taps or rinse anything in them in my kitchen. But when I have family here that's, you know, sometimes I try to keep that going but then usually I just end up going, "Forget it, they'll do their own thing".

Mike lets his regular dishwashing regime, along with the dishwater, 'go down the sink' to become a 'good' host by avoiding potential conflict with visiting family members, whose water (re)use practices are different to his own. This example of the family visit gives insight to how Mike negotiates the tensions between becoming a host and water waster within the material and moral parameters he has set for himself as someone reliant on rainwater tanks and a septic system.

In summary, Mike and John's narratives highlight the importance of familial relations and responsibility for both human and non-human bodies in water relations. Wastewater is understood in the process of making families through experiences of travelling, living alone and living together with and apart from family and friends. Mike and John had set house rules and water use principles for themselves. For John, exposure to other cultures and infrastructures of water use through international travel was integral to changing his sense of how everyday water practices make sense of self and house-as-home. For Mike, his proximity to the river and everyday practice of kayaking along its flow heightens his awareness of the potential for excessive water use to cause the septic tank to overflow and pollute the river.

Mike and John take responsibility for the flows of water through their homes. However, the presence of family and guests in homes brings to the fore the anxiety of house rules and principles being broken and water being wasted, offering moments in which existing practices of waste/ing water are transformed, reaffirmed or challenged. On the one hand, it feels right to reuse shower water and dishwater, to not fill up the septic tank and pollute nearby rivers and creeks. At the same time, it feels right to avoid conflict with family members over different water use practices, even if that means compromising personal philosophies and practices of sustainable water use by letting family 'do their own thing' in Mike's case, or telling family to 'stay away' in the more extreme case of John. Mike and John's narratives offer insight into the social and material relationships in which environmental and familial identities and understandings of waste/ing water are negotiated.

### *4.4.3 Having and raising children and teenagers*

My last two examples explore the sense and sensibilities of water becoming waste/d through narratives of raising children and teenagers. In the first example, I explore the implications of toilet training. In the second example, I examine the implications of puberty and the importance of bathing more frequently. These examples highlight the material and temporal elements of waste/ing water and the importance of thinking about water use and waste in family narratives over a life course.

## Linda

For the last 12 years Linda and her husband, who are in their 40s, have lived on a 1-hectare property with their two young children. The construction of their house is a work in progress, with Linda and her husband having taken on a large part of the design and build themselves. Part of this build involved the installation of a dry compost toilet, which, unlike flush toilets, does not require water or a connection to a septic tank or sewer system[47]:

> I think there was a year where we actually had no toilet, and we had to do a sawdust toilet. So that period of time we had done a lot of reading on sustainable living—magazines and things like that—and that sort of made me think a lot more about our water usage, because it's things like toilets use 30,000 litres per person per year. If you're flushing all the time. All of those things. So that started getting me to think a lot about it. And also freaking out a little about because we just had two [rainwater] tanks so I was trying to be uber conscious about the whole process.

In the context of discussing sustainable household practice, Linda draws on the emotionally loaded language of fear, of 'freaking out' to describe the flushing toilet. Here, the knowledge that the flush toilet relies on large quantities of water to expel wastes heightens Linda's awareness of the limited capacity of the household to capture and store freshwater in their two rainwater tanks. However, despite this knowledge and

[47] Each time a compost toilet is used, sawdust or wood shavings are tossed into the bowl to absorb odour. This material becomes the bulk of the resulting, humus-like compost, which can then be used to enrich soil (local government regulations permitting) (NSW DLG 2000).

anxiety about running out of water, ultimately they removed the compost toilet from the house (**Figure 4.6**). Instead, they installed and now use a dual-flush toilet:

Carrie: I know building a house is always a process in motion, in a way, so what prompted the decision around shifting from a compost toilet to the flushing toilets, which use more water?

Linda: Children. Children, yeah. The compost toilet that we had purchased wasn't working properly. It was a design fault, so when we purchased it, it was one of the few—so when did we purchase it, about 12 years ago or something—it was one of the few that had been approved by NSW Department of Health. It was designed for South Africa. The situation did not work here. So the theory was great, it had all this approval but the reality of it didn't work here. So not as effectively as we wanted. So we had that but then we went to toilet training and it didn't work, she [my daughter] was terrified. So it was a very confronting situation. So we couldn't. And that was also at the time when we were moving into the house and we had allowed an outlet just in case we needed it and so we put that [flush] toilet in and that just made toilet training a lot easier because it wasn't as confronting.

**Figure 4.6:** The discarded composting toilet at Linda's house. Source: Author, 7 August 2016.

Following Ahmed (2004), fear involves relationships of proximity to something previously positioned as threatening. For Linda's daughter the compost toilet was *too* confronting, she was 'terrified'. Linda does not go into detail on how exactly the compost toilet 'wasn't working properly' or what aspects her daughter found confronting. That said, it could be assumed that there was an unpleasant smell and/or humidity in the toilet environment. Both are signs that a compost toilet is not working properly (NSW DLG 2000). For Linda, the bonds of parenting are troubled by her daughter's fear of the composting toilet. Linda must reconcile her sense of self as a 'good' environmental citizen with her sense of self as a 'good' mother.

In the context of household sustainability ideals, Linda and her family refrain from flushing the toilet after every use.

> Well so in terms of household water usage; still very conscious. So things like toilet flushing doesn't always happen. You know. We like to save it up, kind of

> thing until you get to the point when it smells and you think 'Okay'. Or if you have someone coming over to visit *[laughs]*. So being very, very conscious about usage. And it kind of freaks me out when I see city people and their water usage. So I find that, like, going to visit—Oh! No, I went to a house last weekend in Mollymook that didn't have a dual flush toilet. Freaked me out. Big time. So yeah I get thoughtful about the process in other people's areas. I guess that's the main kind of thing.

Like Kerryn and Mike, Linda is conscious of the implications of her household's non-flushing practices as troubling social norms. Exceptions are made around flushing the toilet for house guests. That said, for Linda, the idea of frequently flushing the toilet provokes a strong emotional response through which her sense of self is lost. In her words it 'freaks' her out. Ahmed (2014, p.66) reminds us that: 'The affect of fear is sustained, or even intensified, through the displacement between objects'. Here, the displacement is between bodies and the resources they use ('you're using all this water, do you have any idea where it comes from?'). Her awareness of the water needed to facilitate the disposal of body wastes is a result of her embodied involvement in capturing, storing and distributing rainwater for domestic consumption (Hetherington 2004). However, unlike Kerryn and John, Linda's practices are motivated by an awareness of water use rather than an awareness of the finite capacity of septic tanks.

Linda goes on to tell me that, as a family, values and practices around water use have changed over time. Linda's daughter and son are now in early primary school. Linda has relaxed the home rules she's created around water use (especially toilet practices). For the family to operate, they now have two flush toilets rather than making do with the compost toilet. In her words:

> We’ve kind of been a little more liberal. Also, now we’ve got two flushing toilets. We did at one point have a compost toilet. Now we’ve got two flushing toilets and a nice shower *[laughs].* We’re just sort of seeing how we’re going to go with that water usage. […] So overall, as a family compared to non-tank families, we are very good. We’ve just got a little bit more luxurious with our water use lately. So it’s more of a learning curve for us. How much we can shower versus how much water. But we’ve never had to buy water, which is awesome.

Linda evokes the importance of experimentation with flushing and showering in balancing sustainability ideas with a liveable family life on tank water. Two flushing toilets is understood as a ‘luxury’ rather than a taken-for-granted norm. Linda continued by pointing out the heighted responsibility her children have learnt from living with tank water:

> I do do very quick showers compared to most people. My daughter, who has grown up on water tank water, she has the quickest showers ever. So much so I actually have to go, “Did you wash? Go and wash. Put the tap on”. “No! I’m going to waste the water!” She’s super conscious about it. She’s very, very conscious. They’ve also done stuff at school about it too. So she’s very aware.

In the context of living with water tanks, Linda illustrates how the heightened awareness of wasting water is embedded in the process of family making through taking showers. Her daughter embodies sustainability values she has learnt from her mother and at school by showering quickly.

Like Mike and John, Linda reflected upon hosting guests as times when the frugal use of water for flushing toilets and cleaning bodies in her home was brought into stark contrast with the practices of others. For example, Linda said:

> So for example, my brother who lives in Singapore came to stay over Christmas and we had to make them aware that we are on tank. Still didn't quite sink in on some aspects. Like he'd run very big baths for their children, like double the size we would have. But then we, you know, made our kids share the water *[laughs].*

Children's bathing routines bring to the fore the reciprocal relations between water consumption, social norms and family. Linda felt her brother's bath-time practices as excessive. To compensate for deep baths, Linda insisted that children shared the bathwater. In doing so, she is able to accommodate her brother's family and their water practices, whilst maintaining her sense of frugality by circulating more bodies through the bathwater. Different norms around parenting are brought to the fore through reliance on rainwater tanks.

For Linda's family, having 'big baths' is not an everyday event. Instead, Linda spoke of big baths as a treat made possible only when it rains.

> Carrie: Is it possible to have too much water? Water abundance?
>
> Linda: Um… it's… well I don't know if it's too much water but when we've had those flooding weeks and we have—quite often our tanks overflow. That's quite a fun period because we're like, "Yay! Let's all have big baths! Really big baths!" *[Laughs]* And then just the thought of, "Dammit, I should have washed more clothes or more

sheets" or more whatever, but that's it. No, you can't have too much *[laughs].*

Linda illustrates that it makes sense to have big baths during a flood week. The weather is an important consideration in whether bathing (and laundering) practices are sensed as a wasteful use of water or not. The sense and sensibilities of waste/ing water shifts when the focus is not centred on the materiality or quantity of the water being used itself, but the timing of its use. For example, in anticipating rainfall, many participants in this study spoke of adopting practices that would, in any other situation, be considered by them to be a wasteful use of water. Several participants described adopting water intensive practices such as washing the car or filling an outdoor spa[48] whenever rainfall appeared immanent according to their understanding of a short-term weather forecast or their own observation of prevailing weather conditions.

The intersection of the weather, climate and understandings of waste resonates with mains water contexts during drought. As discussed in **Chapter 3**, governments impose water restrictions on mains water users. However, unlike mains contexts, householders in this study relied on embodied knowledge of their water use (see also **Chapter 5**) and skills of observation, to deduce when prevailing weather conditions—clouds, wind, temperature, humidity—and weather forecasts herald rainfall (or not). In Linda's case, sensible uses of water while it rains and rainwater tanks are overflowing include having a deep bath, a longer shower, or putting on extra loads of laundry. Having space in the water tank to capture rainfall for future use was part of Linda's understanding of not being a waster of water.

[48] Note that these same participants described washing cars on lawns and bucketing spa water onto gardens so as not to 'waste' the water by letting it flow down drains.

### Penny

Penny is in her 50s and lives with her husband and teenage son in a home of their own design. Their home is totally off-grid, on a densely forested 15 acres of land. The opportunity to be off-grid for water, sewage *and* energy was not a drawcard or determining factor in their decision to buy the land and build 14 years ago. Instead, the more important factors were the affordability of housing and cost of living, amenity value and the idea that the area would be a good place to raise a young family. Indeed, being off-grid has presented a number of challenges. The first four years the family lived in a shed on-site with limited water and power. Here, they weathered drought and flooding rains. For the past ten years, they have lived in the finished house. Penny feels more secure in terms of their capacity to capture and store water, and to manage their wastewater and electricity use. That said, a recent change in her teenage son's showering and bathing regimes has prompted Penny to revaluate her understanding of waste/ing water. In Penny's words:

> You see the thing is really, in the last year, suddenly he wants to wash. And so now a shower is much more important to him, and he likes baths but he can only really have baths if we have the generator on, you know, so it's really nice if we've got the generator on he'll say "Can I have a bath?". But when he's in the shower now, we just yell at him all the time to get out. […] [In the past][y]ou had to kind of go, "You really, really need a shower". I could get him interested in a bath, but he wasn't interested in a shower, but now he really wants showers and he wants long showers or baths.

Research demonstrates how Generation Y has an intense preoccupation with cleanliness (Low 2006; Waitt 2014a). Penny's son is no exception. At first, Penny was able to reconcile her son's increased demand for baths by using the bathwater for watering the garden. In her words:

> I find it hard not to [bucket the bath water]. So if it's just been raining, no. But otherwise I will use it as a way of watering the pot plants. I find it really hard to just let it out.

Letting the water out to the septic tank feels wrong. By repurposing bathwater for gardening Penny can resolve caring for her son's comfort through increased water consumption without compromising the valued identity she has built for herself as a saver of water.

That said, squaring these concerns is gradually becoming more difficult. Most recently, Penny's son not only wants to bathe more frequently and for longer but now wants to have a *bubble* bath, in which soap is added to make a foam:

> I mean this is totally a minor thing, but for some reason, I don't know where it came from but he wanted a bubble bath. And he kept pushing and pushing and pushing and we finally bought bubble bath but I then couldn't bucket the water because I didn't want to put it on the plants and I thought "Well isn't that interesting, suddenly the bath now seems like a waste!".

For her son, the addition of chemicals to foam the bathwater transforms the bath from purely utilitarian (getting clean) to something that is for luxuriating, relaxation and fun. But for Penny it has transformed the materiality of the water and the practice of bathing into something that is sensed as waste. No longer can the water be reused on plants. Instead, the bathwater is disposed of in the septic tank. To follow Douglas (1966), in being 'dirtied' by soap chemicals the bathwater becomes 'matter out of place' in the garden. Here, Penny's reflection highlights tensions between different subjectivities and different expressions of care: caring for her son, caring for plants and caring for water. Penny finds it hard to reconcile her subjectivity as someone who is responsible and frugal with water and someone who is a mother and shows care for her son, who wants to bathe more.

In summary, Penny and Linda's vignettes enable us to understand water (re)use and waste as an emplaced and embodied relational process. This process involves improvising and responding to environmental and social cues as individuals seek to balance different purposes, meanings and subjectivities amongst family members. Moreover, current water (re)use practices are often shaped by past experiences as well as anticipated futures, and so, are not only relational but also constantly in flux. Timing is central to narratives and understandings of waste/ing water and operates at different scales. There is timing in the context of the minutiae of everyday life (of changing seasonal rainfall regimes, storms, of hosting visitors and being a guest) and timing in the context of a life course. Implications for sustainability principles arise from having and raising children and teenagers and may result in changes to the patterns of water (re)use, as will other events of family life, such as leaving home, moving in with a partner, or retiring (Klocker et al. 2012).

## 4.5 Conclusion

In the context of living off-grid, this chapter offers insights into how wastewater is understood in the process of making families through practices of water saving, (re)use and disposal. Conventional framings of wastewater management position wastewater as an endpoint of water consumption. However, as this chapter illustrates, values and meanings of wasteful and frugal water use are not fixed. Instead, how water becomes sensed and understood as waste must be situated with the practices that maintain family life. Thus, the notion of waste becomes aligned to ideas and experiences that work for and against sustaining family life and subjects, as opposed to the technical definitions of wastewater set out at the beginning of the chapter.

The chapter highlights two important implications for understandings of waste/ing water through embodied family histories, experiences of living alone and living together apart, and having and raising children and teenagers. First, practices that are considered wasteful in one context may not be sensed and understood as so in another time and place (Gregson and Crang 2010). A deep bath, long shower, flushing the toilet or putting on an extra load of laundry one day does not hold the same meaning as on another day, for example, when soap is added, guests are present or rainfall is forecast. Likewise, water practices that are accepted by a child may not be accepted by a teenager or adult. There can be a breakdown of familial relations and/or water relations depending on how the tensions of what and how to care for family and water are resolved.

Second, the chapter underscores the importance of bringing to the fore the question of responsibility for managing water that flows down the drains of showers, baths, sinks and toilets. The mythology of an endless supply of freshwater has been debunked through increasing incidences of drought and restrictions on mains water consumption. That said, we are only beginning to recognise the perverse notion that there is an endless drain to accommodate the wastewaters of everyday life (Hawkins 2006). The septic tank, as a conduit for storing the waters used in everyday family life, *isn't* bottomless—there is a finite capacity to the septic tank before it overflows or malfunctions. Households that are off-grid for water take responsibility for the 'sinks' (Gabrys 2009) where their grey water and solid wastes are disposed of, unlike mains water contexts where responsibility lies with government and the capacities of oceans, rivers and waterways to accommodate and process wastewater. In off-grid homes, sinks are co-located with the places where households do family, where family lives play out.

## *Ripple—A family rain record*

*February 2016*

My household's rain gauge, gathering spider webs in drier times. Source: Author, February 2016.

I'm home at mum and dad's for the summer holidays. It's just after breakfast and I am standing barefoot, outside, staring intently at a rain gauge affixed to a post.

This scene is not as strange as it may sound. This rain gauge has been a fixture in our household for as long I can remember. It is nothing special to look at—just an upside down pyramid-like chute of plastic with an opening on top for capturing falling rain, with increments etched on the side to show how much rain has been captured in millimetres or inches. It's my dad's project. He has kept a rain gauge and a rain record for as long as I can remember—a legacy of his childhood on a dairy farm perhaps. He disappears outside first thing in the morning—rain, hail or shine and sometimes in pyjamas wearing a raincoat if it is still pouring down rain—to inspect the volume of rain (if any) in the gauge. Returning inside, he records his daily observations in an exercise book, alongside recordings of the previous day's maximum and minimum temperatures, taken from readings of a thermometer strapped to a post on the back veranda.

Even though I am now well into my twenties, I still get a bit of a thrill when I can correctly guess how much rain the gauge has captured in the last 24 hours. When we were younger, as we sat around the breakfast table, my brother, mum and I would guess how many millimetres of rain had fallen as dad prompted us to guess 'higher' or 'lower' until we stumbled on the right amount. In making our guesses, we'd take our cues from puddles and soggy grass, or memory of the sound of rain falling on the tin roof of our house during the night. Even now, we are rarely correct in our guesses first try. Although it has always been my dad's project, occasionally my brother or I would be tasked with checking the rain gauge and reporting back; we would trot outside, usually barefoot, over grass squelching damp underfoot, to read the gauge and tip out its contents in anticipation of the next drop of rain, sometimes dislodging a frog or snail that had taken up residence in the process. Following especially large rainfall events we'd eagerly tune in to the local ABC radio channel on the drive to school, as people in the community often phoned in to share their own measurements of rainfall at their homes. On very rare occasions, we'd go to school feeling a smug satisfaction that we'd had more rain than 'Beth in Batehaven', who lived some seven kilometres, as the crow flies, down the hill in the next suburb. However, much to our disappointment, Beth always seemed to have more rain than us.

# Chapter 5
## (En)Gauging: Getting the measure of tank water

### 5.1 Introduction

This chapter offers the concept of 'embodied water metric' to explore participants' practices of measuring water in their rainwater tanks that regulate and restrict domestic water consumption. As described in previous chapters, households that are off-grid for water live with proximate and visible vessels and infrastructure of water capture, storage and disposal (i.e. rainwater tanks and septic tanks), and take responsibility for monitoring and regulating domestic water supply and use. They are essentially, as one interviewee described, 'the CEO of your own water company'. This socio-technical arrangement is in contrast to mains water contexts, where Big Water sources of domestic water provision (usually surface water supplied dams in the context of NSW) are distantly located, and often not well known by consumers. In Big Water arrangements, consumption is mediated through the directives and governance regimes of water utilities alongside the technologies and metrics of standardised water meters and water bills.

The implications arising from the separation of domestic water consumption from water storage is extensively criticised for facilitating notions of water as an infinite resource (Shove 2003; Strang 2004; Sofoulis 2005). The delegation of water provision to external authorities and automation of resource provision is described as a challenge of sustainability (Wallenborn and Wilhite 2014). This is because bodily interactions with water are both disembodied and decontextualised from the places where it is captured, stored and managed. For example, research on water saving practices in Sydney during the Millennium Drought found that, contrary to expectations, per capita water consumption showed little difference between occupants of detached dwellings with gardens and occupants of apartments or units, despite restrictions on outdoor water use (Troy et al. 2005). Head et al. (2013, p.358) hypothesise that, 'Apartment dwellers with less exposure to the material provision of their water, and often with no clear connection to their usage patterns due to centralised metering, had little incentive to reduce consumption'. There is thus a material and conceptual disconnection between domestic water use and the environmental, social and economic consequences of its supply (Strang 2004).

Building on scholarship that attends to the politics of measurement (Blue and Brierley 2016; Bouleau 2016; Jackson and Head 2020; Blue and Tadaki 2020), and volumetric measurement, more specifically (Elden 2013; Lehman 2013b; Steinberg and Peters 2015), this chapter offers the concept of embodied water metric to answer two research questions. First, how do people who are off-grid for water measure and monitor their water supply without a conventional water meter? Second, how do households reliant upon rainwater tanks regulate water consumption when not subject to the governance regimes of external authorities?

An embodied water metric is underpinned by my concept of *(en)gauge*, a narrative device that brings together the terms *gauge* and *engage* to draw attention to the role of materials and technology, embodied and situated knowledge, practices and meanings. This narrative device foregrounds the materiality of homes and focuses on the embodied ways of measuring and knowing that inform domestic water use.

The remainder of this chapter is divided into four parts to address the research questions. Part one outlines how water is accounted for in the Australian policy context. I explore the implications of two seminal reforms in water governance for measurement. First, the 2007 National Plan for Water Security (Howard 2007a), which legislated the quantification of Australia's water sources and use through preparation and delivery of an annual National Water Account. Second, the 1994 Council of Australian Governments (COAG) Water Reform Framework (COAG 1994), which established national standards for measuring and metering domestic water consumption. In reviewing and critiquing these policy reforms, I draw on STS and social sciences scholarship informed by theories of social practice (Strengers 2011; Mela et al. 2018). This work highlights the limitations of conventional water accounting and metering approaches and methodologies, which focus on a narrow understanding of what water volume *is* rather than what water volume enables or *does*.

In part two, I advocate for an embodied water metric. To do so, I bring into conversation critical social sciences literature, which attends to the politics of measurement (Lehman 2013b; Steinberg and Peters 2015; Bouleau 2016; Blue and Tadaki 2020), with research that highlights the importance of everyday embodied practices and knowledge in household resource consumption (Waitt 2014b; Wallenborn and Wilhite 2014; Waitt and Welland 2019). This literature asks us to consider what things are missed when water bodies and flows are conceptualised and measured through standardised metrics of litres and dollars. This literature advocates for thinking relationally about measurement, volume and consumption through bodies, materials and place.

Part three presents the interpretation of my empirical data through the lens of embodied water metric in two sections, corresponding with the two research questions. First, I look to people's practices of measuring rainwater in domestic water tanks. That is, the embodied methods that people employ to (en)gauge water. Second, I explore how people learn to measure and make sense of the water in their tanks, and what practices this water enables. That is, how measuring tank water availability and use becomes an embodied practice that manifests in regulating and restricting domestic water consumption.

To conclude, the chapter discusses the benefits of an embodied water metric for more sustainable water consumption and invites further research to engage with diverse, place-based methods of measuring, monitoring and managing water use. From a policy perspective, these insights are important as they may offer more creative ways to reconnect embodied selves with everyday environments to rethink, and reduce, water consumption. Following Blue and Brierley (2016, p.194), such insights may help us to move beyond ‘mindless metrics’ towards metrics that are ‘more flexible, more place-sensitive and more reflexive’.

## 5.2 Background

### *5.2.1 Accounting for water*

> You can’t manage what you don’t measure.
>
> - John Howard (2007b), then Prime Minister of Australia

In 2007, at the height of the Millennium Drought, then Prime Minister John Howard addressed the National Press Club and made the above declaration in his announcement of a $10 billion National Plan for Water Security. As part of this Plan, the Commonwealth *Water Act 2007* was enacted. The Act tasked the Australian Bureau of Meteorology[49] with responsibility for compiling and delivering detailed information

[49] The Bureau of Meteorology is Australia's national weather, climate and water agency. It is an Executive Agency of the Australian Government and operates under the authority of the *Meteorology Act 1955* and the *Water Act 2007*, which provide the legal basis for its activities.

about water across Australia, including the duty for publishing an annual *National Water Account* (the first being published in 2009 following a pilot study). The *National Water Account* (NWA) provides detailed information for eleven 'nationally significant' water management regions including geographic and temporal variations in surface and groundwater availability; existing water rights, water use and trading; and water extracted for economic, social, cultural and environmental use. These eleven regions represent approximately 80 percent of Australia's total water use and more than 75 percent of its population (Green et al. 2018). The annual NWAs are used to assess and inform decisions on water use and management under different climatic conditions and models in different parts of Australia. Since 2015, the BOM has also published an annual *Water in Australia* report, which summarises climatic conditions and physical hydrology at a national level, as well as how much water is available, and how it is accessed and used, for the previous financial year. The NWAs and *Water in Australia* reports complement the Australian Bureau of Statistics'[50] *Water Account, Australia*, which provides information on the physical and monetary supply and use of water within the Australian economy (ABS 2021).

In its inception, the objective of the NWA was to standardise enumeration methodologies across different agencies, regions, states and territories to provide ostensibly rigorous and nationally consistent water usage measurements. The NWA applies 'the rigour and principles of financial accounting to water resources' (Green et al. 2018, p.1)[51]. The purpose of the NWA is to close gaps in knowledge at the federal

[50] The Australian Bureau of Statistics is Australia's national statistical agency. It is an independent statutory agency of the Australian Government and responsible for statistical collection and analysis.

[51] It is thereby unsurprising that the National Water Account is produced for a 'water year' spanning 1 July to 30 June, annually, mirroring the Australian financial year.

level about water availability, allocation, trading and use between regions and states. At the crux of the proposed reforms was an attempt to rectify the mismanagement of the Murray Darling Basin, which had resulted in the over-allocation of water between uses, agencies and states and resulted in near collapse of the ecosystem. ‘Australia’s water scarcity problem also requires that we measure our water resources and our usage of them far more accurately’, John Howard (2007b) avowed, repeating the refrain, ‘You cannot manage what you cannot measure’.

### *5.2.2 Measuring and metering domestic mains water*

In 2019–20, 14,270 gigalitres (GL)[52] of water was extracted from rivers, storages, aquifers and desalination plants across Australia for consumptive use, according to the annual Water in Australia report (BOM 2021d). Of this total water volume, 22%, or 3125 GL, was extracted for urban (mains) water supply (c.f. 67% for agriculture and 11% for industry). Mediating consumers’ everyday relations with water in mains contexts is the water meter. Water meters are tools for measuring and monitoring water use. Water metering is a relatively new practice in Australia. Water reforms agreed upon by COAG in 1994 (initiated in 1995) heralded the requirement for metering household water consumption nationally (Koech et al. 2018)[53]. The reforms were intended to ensure equity in water usage charges, better demand management and leakage detection. In short, the water meter is configured by water corporations as both a billing tool[54] and a household management tool.

[52] Gigalitre = one billion litres

[53] The framework also sought to reform water pricing and water institutions—including the corporatisation of government-owned utilities—allocate water to the environment and develop water trading.

[54] Households in NSW are generally charged for water use quarterly, at a dollar per kilolitre rate (a kilolitre being a thousand litres, which is roughly the equivalent of three standard bathtubs).

Today there are many different types of water meters installed at homes in Australia[55]. For most mains water connected residences, particularly those of older housing stock, analogue water meters are located outside the home and record the amount of water supplied to a property in kilolitres. Readings are typically undertaken in-person by a representative of the water utility for billing purposes on a quarterly basis (although more frequent readings can be taken for an additional service cost. While this may be adequate for billing purposes, conventional analogue water meters are critiqued for providing both utilities and residents with limited information about water use (Lovell et al. 2017; Koech et al. 2018).

Conventional water meters count litres of water as it passes through the meter into the house, but do not record when (time of day) or where the water consumption occurs (e.g. shower, toilet flush, washing machine, garden, leakage) (Stewart et al. 2013). Sofoulis (2005, p.455) observes the following about conventional water meters:

> Designed to a template from the steam age, with dials and numbers housed in a casing affixed to the main water inlet somewhere outside of the house, it reports on water usage through an interface, using units most householders find incomprehensible. Indeed, the device was never intended to provide householders meaningful information about their everyday water consumption, but rather, to be read periodically by a technician who records the information for the utility's billing and statistics departments.

Critiques of conventional water meters have led to calls to re-engineer urban water management infrastructures through more widespread use of digital—or 'smart'—

[55] Sydney Water (2021e) provides a succinct summary of domestic water meter types on their website.

water meters and informatics (Nguyen et al. 2018). A smart water meter essentially performs the same function as a conventional analogue meter, however, to make it 'smart' the meter is equipped to allow for automatic and remote reading of water use by utilities. Some smart meters include in-home data display of water consumption in litres to consumers in near real time (Stewart et al. 2013). The reporting of water consumption data to both utilities and consumers in real-time was not possible under so-called 'dumb' analogue systems of quarterly reading and feedback via bills (Wilson et al. 2015).

### *5.2.3 A 'smart' water utopia?*

Governments and water utilities are increasingly focused on the rollout of smart meters and creation of 'smart grids' (Beal and Flynn 2014; Sønderlund et al. 2016; Lovell et al. 2017). The assumption is that consumption habits will change through in-home displays (IHDs) conveying real-time information and feedback on resource use. Consumers will become conscious of otherwise taken-for-granted practices and alter the wastefulness of their behaviours (Vannini and Taggart 2015). This assumption relies heavily on concepts such as the Theory of Planned Behaviour: smart water feedback is assumed to make rational consumers alter their wasteful behaviour where the rational response to information about their consumption (and the related financial cost) is to use less (Mela et al. 2018). However, as I expand in the ensuing paragraphs, a large body of STS and geographical research informed by theories of social practice challenges this assumption. People do not often respond to theories of rational action or consumer choice in their use of water (e.g. Hargreaves 2011; Browne 2015; Watson 2017; Mela et al. 2018).

The academic literature on smart metering is substantial (Hargreaves et al. 2010; Wilson et al. 2015; Sønderlund et al. 2016; Lovell et al. 2017; Sovacool et al. 2017). Empirically, there are numerous studies that suggest that when consumers are provided with real-time water consumption data they are more likely to adopt water conservation measures (e.g. Doolan 2011; Davies et al. 2014; Liu et al. 2017). However, other studies have found that the impact of smart metering interventions may be short-lived, with a lapse in water savings to pre-intervention levels over time (e.g. Fielding et al. 2013). For example, visual alarming display monitors detailing shower water consumption in southeast Queensland households were discarded by residents several months after installation, with mean showering times reverting back to pre-intervention levels after four months (Stewart et al. 2013).

Empirical analyses of smart metering projects identify many possible reasons for the 'failures' of smart meter interventions in their objective to create sustained reductions in household water use. In the remainder of this section, I outline three critiques of smart metering technologies and approaches to monitoring resource use identified in the literature.

The first critique of smart water metering projects is that such interventions frequently ignore people's existing practices of water use and the meaning underpinning these. Numerous studies show that timers and IHDs are quickly discarded alongside water saving competencies in favour of sustaining commitment to water use for personal presentation and self-care (Stewart et al. 2013; Browne 2015). Building on the work of Shove and colleagues (Shove 1997; Hand et al. 2003), Strengers (2011, p.331) concludes that:

> While an IHD can show someone how much water they use in the shower, and possibly encourage them to spend less time in there, it doesn't address the perceived 'need' to maintain certain standards of hygiene, body odour and presentability, nor does it counteract the pleasure, convenience and ritual associated with showering.

Knowing about the volume of resource consumed does not necessarily change how the resource is used or the value or meaning of those practices. Smart water feedback concentrates solely on water, or energy, as commodities, measured in litres or kWh. Ignored is the role of practices in which resources are consumed (Strengers 2013). This speaks to the importance of attending to what water does, the practices water enables, rather than the commodity of water itself, as highlighted in geographical scholarship discussed further in **section 5.3** and **Chapter 6** of this thesis.

A second critique of smart metering projects highlights how the technology and consumption data gathered by meters are still largely tools of the state; meters are objects of power and governance (Loftus 2006; 2007; Loftus et al. 2016). Corporate and state power in the 'natural' resource sector is commonly constituted through volumetric practices. For example, Bridge (2013, p.56) observes, 'the exercise of power involves technologies of calculation, visualization and manipulation around volume'. Utilities are key proponents of smart meter rollouts and smart grid development. However, as Wilson et al. (2015) argue, utilities are less motivated by household resource savings and more so by data collection for market analysis and in managing supply and demand throughout distribution networks. There is little doubt that digital water meters are big data gathering exercises for utilities. Concerns around data security and the potential for utilities to monitor and restrict household resource use have led to consumer backlashes against mandatory smart metering, particularly in the energy sector (Wilson et al. 2015; Lovell 2019).

A third criticism of smart metering initiatives is that they can, contrary to expectation, further decontextualise bodily interactions with water sources. The need to give greater visibility to water use arises from longstanding critiques of the invisibility of mains water infrastructures of supply (Strang 2004), and yet critics of smart metering projects, which ostensibly claim to give greater visibility to resource use, note how the technology of smart meters perpetuate separation and abstraction through automation (Wilson et al. 2015; Sovacool et al. 2017; Stagnaro and Benedettini 2020). Human agency has been, to a large degree, designed out of a range of socio-technical systems through automation. Groves et al. (2017, p.76) argue:

> A desire for greater efficiency and ease in how domestic services are provided has shifted to become an end-in-itself. […] Socio-technical arrangements have therefore emerged that 'obviate the human sources of friction' (Ellul 1964: 414) within them. These 'human sources of friction' are the ways in which human agency can subvert the intended mode of operation of technologies. A key design goal must therefore be frictionlessness, often achieved by reducing engagement in the system to the making of simple choices between predetermined options.

Wallenborn's (2013) theory of the 'extended body'[56], for instance, proposes that, in modern households, bodily interactions with resources often involve delegation from fleshy bodies to technologies. The extension of bodies through different 'prostheses' or 'artefacts' (in the case of water, for example, meters and water bills, but also

[56] Wallenborn (2013) conceptualises the 'extended body' as being the human body, plus everything else that is implied in the performance of a practice.

technologies such as clothes washing machines and dishwashers) is a challenge of sustainability—through consumption, bodies are extended into networks of provision and production. However, people's awareness of these extensions and their contributions to consumption are minimal (Strang 2004).

The 'failure' of smart metering projects in their aim to prompt and sustain reductions in household water consumption, as highlighted in these three critiques, stresses the fallibility of an approach to volumetric measurement that encapsulates just one hydrological model of water. This model codifies water into litres and dollars and focuses on just one understanding of what water is—a commodity managed by the state—instead of the practices that water enables and the bodies involved in those practices. So how, then, do people who are off-grid for water monitor their water supply when they do not have a conventional analogue or 'smart' water meter? How do people manage and practice water use and restriction when their water use is not subject to the governance regimes of external authorities?

In the next section I outline my analytical approach, which builds on literature that thinks relationally about water and critiques the abstraction of water through reductionist approaches to volumetric measurement. This scholarship attends to the politics of measurement and thinks in different ways about how water is measured and quantified. This scholarship asks what things are missed when water is conceptualised through metrics of litres and dollars. I first discuss the scientific ontology of measurement, specifically the metric of volume. Next, I draw on relational approaches that have helped rethink the metric of volume that is alive to the notion of embodiment. This literature underpins and advances the concept of an embodied water metric.

## 5.3 Rethinking measurement

Measurements are central to contemporary environmental debates and decision-making (Blue and Tadaki 2020). Around the world, governments turn to measurements and monitoring data to inform and justify actions, on the assumption that 'measuring something makes it 'known' providing a sense of surety, of accuracy and of scientific credibility' (Blue and Brierley 2016, p.191). However, it is understood that measurements do not simply exist but are instead a social achievement (Jackson and Head 2020). Measures selectively portray and represent what an environment is, and what we choose to monitor and assess makes possible particular management outcomes and environmental trajectories (Blue and Brierley 2016). Literature on the politics of measurement urges scholars to interrogate the framings and assumptions underpinning environmental measures and to explore possibilities for knowing worlds differently (Blue et al. 2012; Brierley et al. 2013; Tadaki et al. 2015; Blue and Brierley 2016).

The metric of *volume* has received growing interest in recent years, particularly in geopolitical geography. Work by Elden (2013) and Adey (2013) is particularly influential in this emerging field. For Elden (2013), the term *volumetric* is important given its two aspects: 'volume' implying dimensionality, and 'metric' implying calculability. Taken together, volumetric hints at the 'determination of political space, as calculable' (Elden 2013, p.35). This in turn, Elden (2013, p.49) argues, offers the potential to open to interrogation some of the political technologies of territory such as 'weighing, calculating, measuring, surveying, managing, controlling and ordering'.

Efforts to standardise water and secure volume through accounting reflect the desire to colonise, enclose and control water across spaces (Grundy-Warr et al. 2015). 'Modern water may be considered much like absolute space', Linton (2010, p.30) observes, 'in the sense of its abstract, metric identity'. Massey (2005) describes the Euclidean concept of space as a stable surface separate from the matter and meanings that occur within. The National Water Account and household metering reforms brought into being a single commensurable metric through which water supply and use is 'known' by agencies, politicians and consumers—a supposedly objective, nationally-consistent and comparable numeric metric of volume expressed in giga-, mega- and kilo-litres, dollars and cents (see **section 5.2.1**). Quantification is long associated with forms of explanation that emphasise universal principles over nuanced accounts of particular places (Blue and Tadaki 2020). In the literature that examines water governance it is often pointed out that the commodification of water bodies and flows through mathematical formulae reduces water to an abstract price tag (Strang 2004; Heynen and Robbins 2005). This form of conceptual abstraction of water bodies and flows, Jackson and Head (2020, p.50) argue, leaves no place for local, place-based knowledge, 'whether held by Indigenous people or settlers', and obscures the nuances of context in human-environment interactions (see also Gibbs 2006; 2010).

Attending to the politics of measurement can reveal how measurements pre-select which biophysical and social phenomena are observed, valued and understood, and which are not (Bouleau 2014; Blue and Tadaki 2020; Jackson and Head 2020). The validity of hydrological measures is determined by the ontology, social norms, communities and institutions of politicians, engineers and scientists. The National Water Account and household metering models rely heavily on engineering and scientific ontology to identify, secure and control water through volumetric measurement and accounting, with its checks and balances. Particular voices (like water engineers and scientists) and arguments of what water is (volume, dollars, megalitres) and how it should be accounted for are assigned weight. Such measures support particular visions of how those relationships should look in the future while overlooking others (Blue and Tadaki 2020).

By contrast, relational approaches to measurement draw attention to the various things and circumstances that, in effect, make water and measurement what it is. By this way of thinking water is not an object but, rather, 'a process of engagement, made identifiable by water's emergent properties but always taking form in relation to the entities with which it engages' (Linton 2010, p.30). The call to think more critically and relationally about the metric of volume is being taken up by those concerned with more-than-human geographies. Scholars such as Lehman (2013b), Squire (2017), Steinberg and Peters (2015) and Grundy-Warr et al. (2015), urge us to think about the vibrant materiality of voluminous space and the complex ways in which human and non-human bodies are entangled. These scholars trouble the metric of volume—which is enshrined in the management of mains water supply and use—and encourage scholarship to instead think more critically about what water does.

Lehman (2013b, p.52) for example, in her research on oceans, advocates for understanding the materiality of volume 'as doing more than contributing to different metrics'. She argues that 'volumes are irreducible to and in excess of the apparatuses of their capture' (p.52) and points to recent literature on non-human agency and new materialisms, which make clear that we must look at more than numeric and linguistic representations of matter (e.g. Coole and Frost 2010). Following Steinberg (2018, online), volume is ‘more than simply the summation of horizontal, vertical and diagonal vectors. Volume is tactile, affective, embodied and immanent.’

Appeals to the materiality of volume beyond volumetrics are provocative because they require us to go beyond considering water as a static substance or object, measurable and categorisable through legal-political apportioning, and leads us to consider the importance of what water volume does, or enables. As Blue and Brierley (2016, p.192) observe, ‘The precision of measurement and the confident language of classification, with its clear categories, belie a “messy” world’.

In this chapter, I build on scholarship on the politics of measurement and bring these insights into conversation with research that highlights the importance of everyday embodied practices and knowledge in domestic resource consumption (Strengers and Maller 2012; Gibson et al. 2013; Maller and Strengers 2013; Waitt 2018). There is growing interest in understanding how everyday embodied domestic practices have repercussions for environmental sustainability (see Lane and Gorman-Murray 2011; Waitt 2014b; Stanes and Gibson 2017; Ames 2018; Waitt and Welland 2019). It is through the body that consumers sense the world and develop an understanding of consumption phenomena (Wallenborn and Wilhite 2014).

Households that are off-grid for water, who take responsibility for monitoring the supply and use of water volumes at home, year-round, present a space for thinking about how bodies are engaged in practices of measurement. ‘A methodological focus on measurement’, Blue and Tadaki (2020, p.25) argue, ‘provides unique insight into how arguments regarding what the environment is, and what people’s relationship with it should be, are made, maintained and potentially challenged’.

In the remainder of this chapter, I draw on the notion of an embodied water metric to offer an interpretation of participants' practices of measuring and regulating water use at home. First, I look to people's practices of measuring rainwater in water tanks at home. That is, the embodied methods that people employ to measure water. Second, I explore how people learn to measure and make sense of the water in their tanks, and what practices this water enables. That is, how measuring and managing water through regulating and restricting use becomes an embodied practice.

An embodied water metric is underpinned by my concept of (en)gauge, a narrative device that brings together the terms *gauge* and *engage* to draw attention to the role of materials and technology, embodied and situated knowledge, practices and meanings. According to the *Macquarie Dictionary* (2020, online), *gauge*, as a noun, is defined as 'a means of estimating or judging; criterion; test; any instrument for measuring pressure, volume, or dimensions'. This draws attention to the role of materials and technology. As a verb, *gauge* means 'to appraise, estimate or judge; to make conformable to a standard'. This highlights the importance of knowledge and meaning. *Engage* (verb) means 'to occupy the attentions or efforts of; to attract and hold fast; to reserve or secure; to occupy oneself; become involved'. This underscores the significance of embodied practices and knowledge in measuring tank water. An understanding of volume, and what it enables, grows through embodied relations with the materiality of rainwater tanks. Methods for (en)gauging water are highly contextual, drawing on situated and embodied knowledge, and a haptic engagement with things, practices and place. An embodied water metric calls for a different understanding of the politics of numbers based on emplacement not abstraction. This narrative device foregrounds the materiality of homes and focuses on the embodied ways of measuring and knowing that inform water use.

## 5.4 Results and Discussion

### *5.4.1 Measuring and monitoring water*

Helen has lived in her non-mains water home for 18 months. Previously she lived on mains water in various towns and cities for over 60 years. It comes up in conversation that Helen has no idea how much water is in the single rainwater tank that supplies her home:

> I don't usually ever worry about it because we have had high rainfall, but you know, last night I started to worry because we haven't had rain for a while now. And I went down and just hit the thing [the tank] with a broom and it's empty for as far down as I can get the broom, so it means I don't know in fact how full it is. (Helen, 60–69, 1-person household, primary address, length of residence 18 months, interviewed 13 April 2016)

The tank, which is corrugated poly-plastic, is situated underneath the back veranda and partially submerged below ground. To reach it you need to crawl under the house. Helen has a chronic knee injury that prevents her from doing so unassisted. With the help of Helen's friend Max[57], who was visiting during the interview, we took the opportunity to get under the house to investigate (**Figure 5.1**).

[57] Pseudonym.

**Figure 5.1:** (En)Gauging tank water volume at Helen’s house. Source: Author, 13 April 2016.

The following extract captures our conversation as we looked into the tank through the open filter screen:

Helen: Oh yeah, there’s quite a bit [of water] in there still. Could we—would we put a stick in there or something? How would be best to know [how much water is in the tank]? *[Looks more closely with a torch]* Oh! It’s actually very low!

Max: Can you see the bottom of the tank?

Helen: Yeah, it’s full of sand. It looks to be about that much in there *[indicates depth with hands].* It’s quite low. I would say it’s almost down to the top of the first ring. Oh, that's great though, being able to see in. I can do that again. But I can see from the outside its maybe four rungs. Perhaps it's just the perception from up here?

Carrie: I think it's deeper than the bottom ring.

Helen: I think you're right. Yeah, definitely.

Max: The best guide then is to count the number of rings, and I can only count two full inner rings below the water level.

Helen: Yeah, but if you look in the distance it looks more like four.

The way in which Helen (en)gauges tank water, by lifting the lid and looking in, encapsulates the geometric definition of volume, that being the combination of height width and depth. And yet the currency is different. Rather than a metric output—say, 'I must have 400 litres left'—Helen understands water volume relationally through her 'reading' of the rungs on the water tank that are visible above or below the water line. Helen estimates that there are fifteen rungs on the tank in total, two to four of which appear to be below the water line. She concludes, 'So that, mathematically, is how we'll have to work out how much water there is'. While Helen is relatively inexperienced in being off-grid for water compared to most of the participants interviewed in this study, the practice of (en)gauging water volume in relation to the rungs on the outside of the tank was widely practiced among participants.

Mike—who we met in the previous chapter—has been off-grid for water for 11 years. When I asked him how he kept track of water in his two corrugated poly-plastic rainwater tanks, he explained:

> Just knock on the side. Yeah, and count the number—they've got these broad rungs, similar in a sense to the corrugated [steel] tanks and you can work out percentages, well I do anyway, it's a third-full, half-full sort of thing by counting the rungs. That's close enough.
> (Mike, 70–79, 1-person household, primary address, length of residence 11 years, 14 April 2016)

When asked if and how they monitored how much water was in their rainwater tanks by far the most common answer from interviewees was 'knocking' on the tank's side to gauge the depth of water within. Interviewees described and showed me how they knocked, tapped, banged or slapped the side of rainwater tanks in a vertical motion and listened to the echo for change in resonance to indicate the presence or absence of water within. During my interview with Fraser, for example, he gave me a demonstration of how he measures the volume of water in his poly-plastic rainwater tank by tapping the side:

> Yeah *[sound of Fraser tapping on the side of tank]*, so that's about where it's at now *[continues tapping on the tank]*. It's definitely full there. So that's all I do. Because I can do that. [My wife] has a bit of difficulty with her ear on that one [that rainwater tank]. I have considered putting a tank level indicator on but, you know, our life is just so busy there's always other priorities and it's not a priority, really. We're pretty on top of it.
> (Fraser 40–49, 4 person household, primary address, length of residence 10 years, interviewed 12 May 2016)

Having 'hands on' the rainwater tank allowed participants to understand the amount of water available, not only through sound but through touch and thermoception[58] as Paul explains:

> When the sun shines you just feel the tank. It's warm at the top and cold at the bottom. You know where the water is and that's on most of the tanks, even the plastic tanks you can feel it. There's not much of a temperature difference on them but there's a big temperature difference on the galvanised tanks. Not so good today [it's cloudy] but you can feel it, you can feel the water in the plastic tanks.
> (Paul, 70–79, 1-person household, primary address, length of residence 5 years, interviewed 18 April 2016)

In assessing water levels in a water tank through touch and hearing, people become 'flesh barometers' or 'bell boards', to follow Thomas Hardy (1886, p.209). In these examples, the rainwater tank, as the vessel for supplying domestic water in-situ, emerges as a vital actor in these relations in shaping how householders engage with water volumes and monitor water supply.

For other households—particularly those with concrete tanks or tanks below or partially sunken into the ground—(en)gauging water volume involved opening the inspection hatch or filter screen on top of the tank and submerging a 'dipstick' into the tank. Far from being a standard tool of measurement, akin to a ruler, dipsticks were ad hoc in construction, fashioned from a myriad of materials from around the home. I was shown dipsticks made from a length of bamboo, a broken rake handle, a long tree

[58] Thermoception is the sensation and perception of temperature of the external environment or, more accurately, temperature differences sensed relative to skin temperature.

branch, bent copper piping leftover from repairing a hot-water boiler, and two tomato stakes wired together (**Figure 5.2**). Reading the saturation point on the dipstick helped households to understand the volume of water available relative to the height of the tank. As Frank explained:

> I have a dipstick and I take a reading of the water tank and septic tanks every week. And that way I know exactly where we're going. I can monitor available water and use accordingly.
> (Frank, 80–89, 2–8-person household, secondary residence, length of ownership 12 years, interviewed 12 March 2016)

**Figure 5.2:** Participants demonstrate how they (en)gauge water volume within concrete and poly-plastic rainwater tanks by reading the saturation point on a dipstick. Source: Author, March–April 2016.

For others, practices of (en)gauging domestic water volumes start not with rainwater tanks, but with the weather. Twenty-eight (28) of the fifty households interviewed in this study had a rain gauge for measuring rainfall at home and twelve (12) kept a written record of rainfall[59] (as previously described in **Chapter 2**). For several interviewees, the rain gauge (**Figure 5.3**) was the means through which they (en)gauged water volume in their rainwater tanks, as Vicki and Fraser explained in separate interviews:

> I have a rain gauge and I keep a note of how much rain we've had, so that I can—there's no way to tell how much is in the tank unless you physically look into it, so we just check with the rain gauge how much water we've got, we know how much that'll fill—I mean, after a while you sort of know how much it takes to fill that tank.
> (Vicki, 60–69, 2-person household, primary address, length of residence 3 years, interviewed 11 May 2016)

> I still do the rain gauge and I'll still mentally note, you know. I know in January we had two hundred-and-something millimetres and I know we haven't had anything since until a couple of weeks ago, and that was 40 millimetres and then we had 15 or 13 the other day, so I keep a mental record like that. But it's definitely something—I don't record it and look and compare. I just know after a certain amount of rain the tanks should be full.
> (Fraser 40–49, 4 person household, primary address, length of residence 10 years, interviewed 12 May 2016)

[59] In addition to their own rain gauges and rainfall records, two households were reporting sites for Bureau of Meteorology rainfall data and hosted official Bureau-managed automated rainfall stations (BOM 2021c).

**Figure 5.3:** A rain gauge at a participant's home. Source: Author, 18 April 2016.

Critical social sciences research on homemaking highlights the importance of materials in contributing to both the acquisition and performance of environmental knowledge and skill (Carr 2017; Carr et al. 2017; Hunt 2018; Holloway 2019). Materials influence how we learn our immediate environment, and how we operate our houses accordingly (Hitchings and Lee 2008; Carr and Gibson 2015; Roberts and Henwood 2019). Instead of measuring water through an abstract number on a meter far removed from the water source, methods for (en)gauging water are highly contextual and embodied. These methods draw on both optical and a haptic engagement with materials and things in ways that are close range and hands-on. These relations may be conceived of as a form of engagement of a 'mindful body at work with materials […] "sewing itself in" to the textures of the world', to follow Ingold (2011, p.133) (see also Hunt 2018). For participants in my research, water volumes are (en)gauged through bodies and the materiality of rainwater tanks, dipsticks, the sun's warmth, rain gauges, and rainclouds in place. As Henk and his partner Kate explain, they don't need sophisticated 'gadgetry' to measure water tank volumes and monitor their household's water use:

Carrie: You mentioned before that your tanks were about halfway [full], so how do you keep track of how much water is in your tanks? *[Henk imitates door knocking with fist]* Just knocking?

Henk: On the concrete tank you can actually feel it. On a warm day the empty tank is warm, and then 'oh, there's the water'. That one [the poly-plastic tank] is just 'knock, knock, knock'. It's the same with a metal tank, just 'knock, knock, knock'. But now I've actually bought—Bunnings sells these measurement things. You put a small hole in the tank, you put it in there and there's this floaty down the bottom or the top, and as the water goes down it floats down with it and it tells you how much there is in it.

Kate: Boys' toys.

Carrie: Yeah, I was going to ask, what prompted you to purchase that after years of knocking?

Henk: Gadgets. Yeah, a gadget for a male is a gadget *[laughs].* Other things I used to do with that [poly-plastic tank] was to put the rake handle in. And that gives me a fair idea. I don't really need a gadget. I'm not going to get one for the concrete tank.

(Henk and Kate, 70–79 and 60–69, 2-person household, primary address, length of residence 18 months, interviewed 10 May 2016)

As discussed previously in **section 5.2**, human bodies have been 'designed out' of systems of water provision to a large extent, first through conventional meters—which are located outside houses and convey metrics that are largely incomprehensible to anyone but water utilities (Sofoulis 2005)—and later, through automation of meter readings and feedback through digital meters. Henk's assertion that he doesn't really need a 'gadget' to measure water infers that 'smart meters' are not just a technological phenomenon; humans bodies can be 'smart meters'. People who live in off-grid homes and rely on rainwater tanks, measure and monitor domestic water volumes by feeling the side of tanks, fashioning dipsticks and being attentive to local rainfall (see also Shirani et al. 2020, 'I'm the smart meter').

### *5.4.2 Embodied regulations and informal restrictions of tank water use*

As the previous section has illustrated, (en)gauging water volume through the intersection of materials, bodies and place hinges on skilful haptic embodied practice. However, it is not simply a case of knowing how much water is in a tank. Rather, an embodied understanding of what practices water volume enables points to the importance of the relations between rainwater, tanks, bodies, materials, climate, weather, place and people. This embodied knowledge allows those living with water tanks to regulate and restrict household water consumption in order to maintain a sense of self and home as sustainable and responsible.

#### Place-based connections and weather observation practices

Embodied knowledge is learnt through place-based connections necessitated by a rainwater tank, including weather observations. Take Carolyn, for example, who has lived in a non-mains water home for 12 years with her husband and two, now teenage, sons. When I ask how she monitors the amount of water in her rainwater tanks, she reflects:

> Some people keep a rainfall record and they'll say "Oh we had 5 millimetres [of rain] last night!" That's great *[rolls eyes]*. We just go "ding, ding, ding" *[imitates knocking]* on the tank and that's it. You know, we know if we're getting a bit low and if we're sort of "ding, ding" down there *[indicates knee height]* it's like, "Guys, get out of the shower! Let's hope we get some rain soon".
> (Carolyn, 40–49, 4-person household, primary address, length of residence 12 years, interviewed 9 May 2016)

Through an embodied knowledge of what water 'down there' means when measured against the side of the tank, Carolyn is able to reflect on and adjust or maintain everyday water use practices. In this case, she calls on her family to shorten the showers they take in anticipation that rainfall isn't imminent. The immediacy of actioning consumption feedback elicited through (en)gauging rainwater tank volume by knocking and by restricting water consumption is reflected also in Robynne's experience of monitoring tank water volumes:

> I'm really starting to become a lot more conscious about trying to measure [tank water] because you know what you can do when you measure. You can't judge anything without measuring anyway, or you can't make critical decisions without measuring. The way we measure is a bit of stick and we go and tap the tank. We had visitors the other week—'Look! We went that far down! Bloody Hell!'—Should've screamed at them when they were in the shower.
> (Robynne, 60–69, 2-person household, primary address, length of residence 12 months, interviewed 12 June 2016)

Robynne and Carolyn have years of experiential knowledge and practical experience in measuring and managing water at home. They conveyed a sense of confidence in managing the volume of water in their tanks through an embodied water metric underpinned by practices of knocking on rainwater tanks and this led them to make decisions about how and when to restrict water use. Although Robynne draws on the same language as politicians in proclaiming 'you can't judge anything without measuring', the universal metric—litres—is not being used. Instead, she suggests a completely different metric and way of measuring tank water—a method and metric that is place-based and responsive to context.

The availability of rainwater is temporally contingent. Understanding how much water one has available for consumption and making anticipations about the future availability and demand for water are crucial to living well with rainwater tanks. Decisions need to be made. Too little water in the tank and you might run out if it doesn't rain soon. Jan and Martyn, for example, have been keeping a record of the rainfall at their property for the last 30 years. Through attentiveness to weather in keeping this rain record, they have developed an embodied understanding of the seasonal variation in the rainfall regime in their local area. Spring and summer is generally wet, whereas autumn and winter are generally dry. The intersection of the rainfall record and their understanding of local rainfall regimes with their measurement of their rainwater tank levels has been important when making decisions about whether or not to purchase mains water when their rainwater tanks were low:

Jan: During the drought years it [our rain record] was really important.

Martyn: Were we going to get another tank? What were the odds? We knew that March historically was—the past thirty years here—has been

> our wettest month. Doesn't look like it's going to be terribly wet [this year], but the last thirty years this is when we get all of the rain. And so we'd think, well, February was dry, do we need to get a truckload of water? We went through that discussion and never did, maybe based on experience and the rainfall charts; it helped us make that decision.

(Jan and Martyn, both 60–69, 2-person household, primary address, length of residence 30 years, interviewed 3 March 2016)

A key point of difference between the supply of water to households in mains and non-mains water contexts is the *cost* attached to water use. In metered mains water contexts, the cost of mains water use is monetary; utilities calculate domestic water use at a dollar per kilolitre rate as water passes through domestic water meters and charge householders through water bills issued on a quarterly basis[60]. For non-mains water households, rainwater essentially falls free from the sky. That is not to say that there are no monetary costs associated with being off-grid for water. Installing water tanks and pumps, maintaining decentralised water infrastructure, paying for pump-out of septic tanks and electricity used to power electric pressure pumps were described by interview and survey participants[61] as costs of non-mains water use. Rather, the ongoing monetary costs of using household collected rainwater can be negligible compared to using mains water.

[60] There is also diversity in this arrangement in mains water contexts, particularly between detached residences and owner-occupied dwellings (which are typically individually metered), strata titled apartments (where dwellings are not individually metered and water use is part of strata fees) and rental properties (where tenant's water use may be absorbed into the set rent).

[61] See summary of survey results in **Appendix K**.

## Responsibilities and understanding of self as sustainable: practices around the water carrier

Households that are reliant on rainwater tanks in the Eurobodalla Shire can purchase mains water from the local water utility to fill or top up a rainwater tank when water volumes are low and rain is scarce. For a flat fee, water carriers can truck mains water to non-mains water residences. According to interviewees, the cost of purchasing 'town water' was not financially prohibitive. That said, of the fifty households interviewed in this study, just fifteen described purchasing mains water to fill up their rainwater tanks at least once, at either their current address or a previous non-mains water home. However, even for these households, buying mains water was far from a recurrent practice. Interviewees had purchased mains water in response to prolonged drought or following repair to a leak in a water tank or pipe. Most had purchased water on a maximum of two occasions during years of water self-sufficiency, with one interviewee describing purchasing town water on three occasions in twenty-five years of living off-grid. There was great resistance to buying mains water. As Kerryn, who we met previously in **Chapter 4**, described:

> Kerryn: You'll see here after six to eight weeks of no rain, like around this time [autumn], except now we've got this [referring to the drizzling rain], the water tanker comes down the street. And it's sort of a competition to see who can be not the first to buy water *[laughs].*
>
> Carrie: *[Laughs]* It's like "Oh the shame, the shame!"

Kerryn: *[Laughs]* It's like "Haha! Neighbours on the corner have got water!" Well, they've got two little babies and they do a lot of washing, yeah, but everyone else, we just hold off, hold off, hold off.

(Kerryn, 40–49, 4-person household, primary address, length of residence 10 years, interviewed 8 May 2016)

The participants in my study always had the option of purchasing truckloads of water from a mains water utility to fill or top-up their rainwater tanks when running low. Yet all refrained from doing so. It is not a financial imperative that drives practices of measuring, monitoring and restricting tank water use (for, as noted above, purchasing town water was not prohibitively expensive, according to interviewees) rather (en)gauging water is motivated by a sense of pride and joy in being responsible for one's own water supply. Participants were ashamed by the prospect of running out of water and having to buy town water. Water is not just '$H_2O$'. For Kerryn, there is a sense of shame and guilt in being seen to mobilise connections with entities external to the socio-spatial bounds of home by having to purchase mains water.

For Kerryn, the memory of having to buy town water in the past motivates her to (en)gauge the amount of water she uses on a regular basis, to enrol her children in (en)gauging water through the rainwater tank, and to adopt frugal water practices:

> The very first time I almost ran out of water I had to buy water to top the tank up up. So I bought a load of water and there was mutiny. The kids were up in arms. They were like "Oh the water is disgusting! It smells like a swimming pool." Yeah, they could really notice the difference [...]. In my head I was totally conscious of

> the fact that it was town water; it had chemicals in it; and I couldn't wait until we had enough rain or until we used it and then our rainwater flushed it through.

Carolyn similarly recounted her disgust at having to drink 'town water' in lieu of rainwater tank water in the past:

> Yeah, they would've been drought periods when we haven't had rain for an extended period of time and you know, we'll be hanging on hanging on hanging on because I don't like to buy town water. I don't like the fact that it's got chlorine or fluoride. Well, it probably doesn't have fluoride but I don't like the fact that it's been treated. I like fresh rainwater. So what we try to do is just to economise as much as we can when we're getting a bit low.

There are anxieties attached to the inability to capture water tied up with the possibility of not being able to have the water security to care for gardens, to care for self, for human and non-human others and, ultimately, to live in place comfortably. Most participants described regimes of monitoring and restricting tank water consumption in order to avoid an anticipated future of having to buy, and consume, what they described as 'disgusting' town water (a theme I explore further in the **Chapter 6**). Scrutinising and regulating water use at home in response to lower than expected tank water volumes was thereby motivated by the desire to maintain their understanding of themselves as self-sufficient for water, rather than financial savings.

### Novices: embodied knowledge and repetition of routine water practices

Carolyn, Robynne, Jan and Martyn, and Kerryn have the embodied knowledge and history to know when and how to reduce their household's water use to avoid a future of water scarcity—a future where more draconian water restriction practices may be needed or they must buy and consume town water. Other interviewees told me how they struggled to monitor their tank water volumes. Those who verbalised anxiety about being off-grid were either new to their property or new to taking responsibility for measuring water and monitoring use within their household. When I interviewed Dave and Kim, they had been off-grid for water for just under a year. They moved to a non-mains water home for the first time after living on mains water in various cities in Australia and in the UK. Dave and Kim reveal their learner status through anxiety about their ability to measure, monitor and manage rainwater available in their tanks:

Dave: So these tanks don't have gauges at the moment. I bought a gauge because these go up and down at the same time, because they're linked at the bottom. I've got a new gauge [**Figure 5.4**]. I've just got to put a new manhole cover on it, the existing one is concrete so I can't put the gauge on that so I've just got this metal sheet I can put on so at least we've got visibility as to where these [tanks] sit. At the moment, we haven't got a clue unless we tap it *[knocks on side of tank].* That's low.

Kim: Is it? So are we running off both [tanks] at the moment or one?

Dave: Both. It should be both *[taps the other tank to confirm]*. Yep *[bangs on other tank]*. Yeah, so unless we get some rain shortly I'm going to be feeding water [from another tank] down into these because at the moment I haven't got a clue. So unless I get up on the ladder and look down I can't really verify it.

Kim: Which I find really weird. I think as a—sort of as a city person *[laughs]*—I find it really strange that you would have a system—I guess maybe it's just the age of when it [the tank infrastructure] went in, but I guess I find it hard because when basic gauges have been around for a long time, to me it's odd to not know, when you rely on something so heavily to not know where you're at.

(Dave and Kim, both 40–49, 2-person household, primary address, length of residence 18 months, interviewed 22 March 2016)

**Figure 5.4:** Dave demonstrating the new 'floaty' gauge he's installing on a rainwater tank. Source: Author, 22 March 2016.

For Dave and Kim, coming to grips with (en)gauging rainwater tank volume is a work in progress. They have long ascribed to a numeric understanding of water volume—as reported to consumers through the metrics of water meters and utility issued water bills—and this helped define their sense of their consumption practices and habits at their previous, mains water connected home. But water bills don't indicate how much water is left or how much they can use—a volume is presented to consumers on water bills which shows how much they have used and what it costs, financially. Further, bills do not signal a limitation, or a need to change consumption practices, for example, to reduce or increase use or to use different water. Responsibility for monitoring water use and making decisions about regulating consumption in mains-contexts is the prerogative of utilities and authorities external to the home. But now, living in a non-mains water home, Dave and Kim are independent of government directives on water use and must take responsibility themselves, not only for monitoring water availability and water use but for making decisions about *when* and *how* to regulate or restrict their water consumption. They need to know, as Kim alludes 'where they're at' in terms of their water use, measured against falling tank water volumes, and they need to understand their own water use needs, priorities and practices.

Dave and Kim's difficulties in (en)gauging water volume through the materiality of their rainwater tanks highlights how (en)gauging is reliant on embodied knowledge. First, practices of (en)gauging water involve a combination of haptic and optical interaction with materials. Second, (en)gauging water relies upon experiential place-based learning about climate and rainfall regimes. Third, the embodied process requires understanding the water volumes needed to satisfy a household's water-based practices. People must learn to (en)gauge water and to render this information into action in contextually and personally meaningful ways. This embodied knowledge can take time to develop and is learnt through repetition of routines, including routines of (en)gauging introduced in childhood. Don and Liz, for example, have encouraged their grandchildren to understand the finite nature of fresh water supply by showing them how the rainwater tank—in combination with rain, roofs, gutters and pipes—supplies water to their home:

> Liz: When we had the grandchildren here, they were here for nearly four weeks at the beginning of last year, we said to them ‘We don't waste water, because when it is gone, it's gone and we won't have anymore’. They were quite mystified with this. ‘But how will you get it?’ I said, ‘We will have to buy it from somewhere else, because it doesn't just come out of the tap like it does in town’.
>
> Don: I also walked them around and showed them how the water gets there [into the tank] and where it goes and what happens to it and so on. I said ‘It all comes off the roof and if there's nothing coming off the roof and there's nothing in the tanks, where are we going to get water from?’
>
> Liz: They were 10, 8, and 5, so they were at an age—well, perhaps not the five year old—but the two girls were at an age where they could understand. That reinforces it for you too. That, yeah, we're very lucky to have this resource and it isn't infinite.
>
> (Liz and Don, both 70–79, 2-person household, primary address, length of residence 3 years, interviewed 23 March 2016)

Participants with grandchildren, children and teenagers spoke of this learning process. (En)gauging with water is one way in which familial relations and responsibilities are learnt. Kerryn, for example, has actively encouraged her teenage children to monitor the fluctuating rainwater tank levels at their home:

> I also get these guys to go down and check the water. I'll get them to go and check it for me. I'll get them to tap on the side of the tank and work out where it's up to, so that way they'll get 'Oh, this has gone down. Gee we haven't had rain! We've only got this much water left'. Yeah, I don't have any other fancy kind of floatation devices; I think it's just tap on the side. *[Laughs]*

This practice allows Kerryn to counteract disconnection with water use and further affirm to her kids the falsehood of the 'fantasy of endless supply' 'baked in' to existing domestic mains water infrastructures (Sofoulis 2005, p.452). The importance of teaching and instilling in her children an awareness of where their water comes from, and how its volume fluctuates with rainfall and with use, is highlighted when it comes time to regulate shower-durations for her teenage daughters:

> They'll be in the shower and I always say, you know, '5 minutes is enough', and I'll keep an eye on it. I'm really aware if I can hear the tap running and the shower is on, I'll say 'Hurry up, get out of the shower, get out of the shower'. And there has been a few instances of, nah, they haven't got out of the shower. So I just go down and turn the pressure pump off. 'But I haven't washed the conditioner out!' 'Well I'm going to turn it on for one more minute and that's it'. And they learn.

Furthermore, many participants spoke about their attempts to dissuade other household members and guests from having long showers, which they understood to be a big user of water. In the previous chapter, we met Linda, who lives with her husband and two young children in a home of their own design and build. Linda recounted how the presence of guests in her home made her aware of the frugality of her water use and described how her brother, who lives in urbanised Singapore on mains water, would run very large baths for his children when he visited Linda. When it came to regulating the water use of her brother, 'to make them aware that we are on tanks' she reflected:

> You know, we really had to spell it out because city people don't have that relationship with water. They don't really see where it's coming from. (Linda, 40–49, 4-person household, primary address, length of residence 12 years, interviewed 7 August 2016)

Central to Linda's narrative is the importance of having a 'relationship with water', of 'seeing' where water is sourced. In this case, Linda explicates her brother's prolific use of water as being the result of his lack of relationship with water where he lives in Singapore far removed from the reservoirs, rivers, and water treatment plants that supply water to his home. Here, Linda highlights the importance of proximity to domestic water sources in defining her and her brother's relationships with water use. Linda *sees* where the water that supplies her home comes from, she knows how much is left to use, and adopts more frugal water use practices. Linda infers that her brother doesn't know where the water comes from and adopts what she considers to be more excessive water use practices[62].

### Proximity, connectedness and responsiveness

Several interviewees described their responsiveness to water because of their reliance on rainwater tanks (and, for some, also solar power), physical proximity to resources,

[62] To contextualise Linda's comments, Singapore's approach to water resources management has received international acclaim (IWA 2021; PUB 2021a). A city-state with limited land for rainwater collection, Singapore's water supply is comprised of four key sources: local catchment water, imported water from Malaysia, recycled wastewater and desalinated water. The Public Utilities Board's (PUB's) holistic approach to sustainable water supply does not rely only on physical infrastructure, but also emphasises legislation and enforcement, research and development, and public education, and has won numerous international awards (PUB 2021b).

and embodied practices of (en)gauging resource availability. Picking up on Penny's narrative from the previous chapter, she has an embodied water metric developed through years of being off-grid for water (and energy). She tells me that she has a rain gauge and will occasionally knock on the side of the rainwater tanks to (en)gauge water availability and use. I asked Penny to reflect on what life with water tanks meant to her. She replied:

> It's really hard to explain, but there are some days where I'll have a shower in the middle of the day when it's sunny and so I'm not worried about the power and I think, you know, it feels good because the water is renewable. And it gave me- you know, the funny thing is, is it actually gave me an understanding of what renewable meant. You know, we talk about renewable resources but you don't realise that you don't really know what it means until you *see* your tanks almost empty and then full, or the dam almost empty and then full, and the same with the power. And you suddenly go 'Now I understand what renewable means'. It's not limited in the sense- well, it feels limited at times but it comes back.
> (Penny, 50–59, 3 person household, primary address, length of residence 14 years, interviewed 11 May 2016)

This quotation illustrates how Penny's relationship with her tanks and tank water, have agency to inform her about the resources she is using; 'seeing' the rainwater tanks and dams 'almost empty and then full' helps Penny to understand what renewable means. Reflection on waters' renewability is prompted by the collocation of the water source (the rainwater tank) within the space of consumption (home). Penny highlights the importance of proximity and place in shaping how people engage with and come to assess and value water resources and consumption.

Kate, and her husband Henk, who I introduced earlier in **section 5.4.1**, expressed a similar sentiment when reflecting on the changing qualities of their relationship with water between their previous non-mains water home in Tasmania and their current non-mains water home in the Eurobodalla Shire. In addition to their practice of knocking on the side of the tanks and using a rake handle as dipstick to measure tank water volumes, Kate and Henk (en)gauge water through rain collected in a rain gauge:

> Kate: When we moved to Tasmania we just stopped looking [at the rain gauge] after a while, it was ridiculous, the thing would overflow, the rain collector would over flow, we'd think 'Oh, this is crazy!' But now we're back to 'Hey! We've got 5mm! Woo-hoo!' So as Henk says, you do live closer to nature with tank water. You are very conscious of the fact that you don't just turn on the tap and there is a reservoir up on the top of the hill that feeds you your water.

When one lives in proximity to their water source, and takes on the responsibility for its management, other relations emerge. Kate's story of (en)gauging water through rainfall and rain-gauges highlights how a dependence on rainwater tanks may sustain an attentiveness to relations between climate and rainfall regimes, weather, water infrastructures and place. My interviewees' stories resonate with research that has shown that sustainable practices of resource consumption are strongest where people actively understand and participate in networks of supply and distribution (Head and Muir 2007; Woelfle-Erskine 2015a; 2015b). As Penny goes on to summarise, being off-grid for water:

> [M]akes you more aware of the source of things and also what you use and I think that's something that's important really, for everyone, because I think

> we're not often given the language or the tools or the context to really think about those things so we're quite divorced from the—and I think being divorced from things that are so fundamental it isn't actually good for the way we live in an individual way and at a broader level.

## 5.5 Conclusion

This chapter sought to address two research questions. First, how do people who are off-grid for water measure and monitor their water supply without a conventional water meter? Second, how do households reliant upon rainwater tanks regulate water consumption when not subject to the governance regimes of external authorities? To address these questions, I offered the concept of *embodied water metric*, underpinned by the narrative device of *(en)gauge*, to explore participants' practices of measuring water in their rainwater tanks that regulate and restrict domestic water consumption.

For participants in my research, water volumes are measured and monitored relationally through embodied and experiential engagement with materials, things and the environment. Methods of (en)gauging water are highly contextual and draw on repetitive haptic engagements with the materiality of rainwater tanks, dipsticks, the sun's warmth, rain gauges, and rainclouds in place. Sensing tank water volumes through touch and hearing are embodied skills that take time to develop, relying on situated knowledge of climate, weather and the water needs of household members. In terms of regulating consumption, this chapter shows how proximity and place impact the meanings people attribute to water use. Participants spoke about frugality and sufficiency with respect to regulating their water use. They wanted to make their sensed limited resources last as long as possible and were highly resistant to the idea of purchasing mains water to fill up their water tanks because it undermined their sense of self as frugal, responsible and self-sufficient. In focusing on the embodied dimensions of measuring water volume, water is no longer simply a resource measurable in litres. Rather it is embodied and involves sensations that help people make sense of their past and current water practices against anticipated rainfall regimes, and make decisions to adjust their water use to satisfy current and future anticipations of supply and demand.

The concept of an embodied water metric makes a novel contribution to the water metering literature. Strengers (2011) concludes that smart meters with IHDs can work well to engage consumers with their resource use and reduce consumption. However, the enduring success of the intervention 'will necessitate a shift in the type of information IHD's provide—namely from kilowatts, litres and dollars to the meanings and competencies associated with the practices these resources are implicated in'. Recent studies of the effects of smart meter feedback on residential water consumption have begun to acknowledge these embodied dimensions (Schultz et al. 2016; Sønderlund et al. 2016; Otaki et al. 2017; Cominola et al. 2021).

From a policy perspective, the insights presented in this chapter are important as they underscore the importance of the senses and experience to help rethink, and reduce, water consumption. The politics of modern water are organised on metrics that flatten the complexity of water relations. Responsibility for monitoring water use and making decisions about regulating (restricting) consumption in mains-contexts is the responsibility of agencies external to the home, that is, a water utility or local council who issues water bills and mandates a regime of water restrictions.

An embodied water metric argues for emplacement not abstraction. That is not to say that knowing the quantity of water used and in storage through numeric units of measurement is not important. Rather, raw numbers were not very meaningful to the households in my study when it came to making sense of and regulating daily water use practices. The universal liquid metric—the litre—was not used to make sense of water volumes and consumption practices. Instead, participants were (en)gauged in measuring and regulating water use in ways that were relational, place-based and responsive to context.

## *Ripple—A multiplicity of freshness*

*March and April 2016*

Martyn, Jan and rainwater tank. Source: Author, 3 March 2016.

The cicadas are humming when I pull up the driveway to Jan and Martyn's[63] place. It's a warm autumn morning in early-March 2016 and I've just arrived for the first interview of my PhD research. The postal survey hasn't even gone out yet; Jan and Martyn heard me speak on local ABC radio about my project last week and got in touch. I'm a bit nervous and quite sweaty and dishevelled, having driven the 25 minutes from town along unsealed roads with the windows down, my ancient car having long given up on air-conditioning. It's approaching 10am and already the temperature is creeping up towards 30 degrees. I take a sip from my water bottle—I drove the 200 kilometres down from Wollongong last night and my bottle contains the remnants of the city water. It's too lukewarm for my liking and tastes stale. The road I take winds through State Forest, with trees pressing densely against both sides. I creep past a wallaby standing

[63] Jan and Martyn, both 60–69, 2-person household, primary address, length of residence 30 years, interviewed 3 March 2016.

erect by the road, hoping it doesn't decide to leap out in front of my car. Eventually the road widens out as I come alongside the Deua River, one of the rivers upon which the Eurobodalla Shire relies for the supply of mains water. I park beside a single storey timber house in a clearing.

I'm not really sure what to expect. The first thing I notice is an enormous water tank, easily the largest domestic water tank I have ever seen, cut into the slope (**Figure 6.0**). Beside the house is a large solar panel raised up on a pole. Martyn and Jan meet me at the car and usher me inside: 'We'd usually sit out on the lawn but it's a bit warm today. Come in, it's much cooler inside'. We make introductions as Martyn, a retired water engineer, and Jan, a semi-retired teacher, brew tea in the kitchen (a chai spice blend of their own making). I set out my note pad and recorder on the dining table. I'm rummaging around my backpack for a pencil when something Martyn says brings me back to attention. 'Hang on,' I say, 'You did what?'. 'Yeah', Martyn shrugs his shoulders. 'We hosted a water tasting event for local councillors and water managers. We'd bottle up water from around the catchment and serve it in champagne glasses as a kind of blind taste-test. Who has the nicest tasting water, you know, that sort of thing'. I'm speechless; they laugh at my stunned face. It all sounds a bit eccentric to me and I think little more of it, other than as a funny anecdote, until a few weeks later when driving back from another interview I tune into the radio:

Radio Presenter 1: We've been talking about water and the water around Australia; some of it is very good, some of it, very rubbish.

Radio Presenter 2: We're talking about the best and worst in Australia, we're trying to find it and so we're getting water sent in from all different parts of Australia, from Triple J listeners and we thought what's the best way that we are possibly going to organise ourselves to test this?

Radio Presenter 1: Yeah, cos [sic] a lot of people said 'You've got to get a scientist in, and test all of the things' and 'Taste isn't about science goddammit! It's about humans and mouths!' And so the best human we could think of was the best mouth around; it is a sommelier, a wine taster…

I'm pulled over by the side of the road listening enraptured. After weeks of deliberation and input from listeners, on 15 April 2016, the hosts of Triple J's afternoon show Veronica and Lewis, with the assistance of master sommelier Franc Moroe, declared Launceston, Tasmania, as having the best tasting drinking water in Australia (Triple J 2016). Adelaide, South Australia, was crowned the worst. I'm intrigued by the conversation that plays out over the airwaves. Having received bottles of tap water sent in by listeners from around Australia, Moroe samples and comments on water from five urban locations, assessing the quality on taste, texture, odour and appearance. While I am a bit put out that a sample from a rainwater tank was not included in the deliberation, I am absorbed by the conversation as listeners call in to add to the lively debate, illuminating the sheer diversity not only in terms of the aesthetic qualities of drinking water in Australia but in terms of the language and meanings through which people make sense of their drinking water, as 'disgusting', as 'beautiful', as 'funky', as 'soft'. It gets me thinking, what do households that are off-grid for water have to say about the water that they consume?

# Chapter 6
## Immersion: how tank water matters

### 6.1 Introduction

This chapter aims to unsettle current ways of thinking about domestic water quality in Australia. Specifically, it takes aim at the reduction of the notion of water quality to something configured solely through health and aesthetic values, as enshrined in the Australian Drinking Water Guidelines (ADWG) (NHMRC 2011)—the authoritative resource for water regulators and suppliers on monitoring and managing drinking water[64]. It builds on the preceding chapter, **(En)Gauging**, which was concerned with how water is quantified and measured, and similarly engages with scholarship that critiques existing frameworks of domestic water management. The chapter draws on insights from research that asks what is missed when we ascribe to conventional, reductionist values of water quality that hinge on standardised, typically euro-centric (and human-centric) measurement. In this value system water is reduced to a purely physical resource that can be measured, quantified, and chemically analysed, commodified or economised, and traded. In this chapter, I consider what can be gained by instead thinking relationally about values by exploring the ways in which water *matters* to people who are off-grid in managing its provision and use.

Taking my cue from literature that advocates for a relational understanding of water values (e.g. Strang 2004; Gibbs 2006; Tadaki and Sinner 2014), this chapter pursues two research questions. First, how does water *matter* to households that are off-grid for

[64] The ADWG define drinking water as that intended primarily for human consumption. Their definition also recognises that drinking water is also used for other domestic purposes such as bathing and showering.

water? That is, what do they value about water. Second, how might these 'ways of mattering' (or values) inform calls for a more diverse spectrum of domestic uses of household-collected rainwater? To answer these questions I look to insights from participants' narratives of *immersion*. In using the narrative device of immersion to explore participants' practices of water use, this chapter includes bodily encounters with water other than through drinking water.

In this chapter, I explore participants' narratives of *immersion* in two parts. First, I look to participants' stories and reflections on their bodily immersion in the *materiality* of water, through drinking and bathing. I pay attention to touch, taste and smell, and embodied emotions and affect. Second, I look to narratives of their immersion in the *processes* of domestic water provision, through practices of maintaining, repairing and caring for the infrastructures and places of rainwater capture, storage, distribution and disposal. I pay attention to the discourses and ideas participants draw upon when reflecting on the labours of being off-grid for water.

Participants' narratives of immersion imply something more than human perception of water quality. Quality is visceral, moral and aesthetic. Quality is shaped by the agency of water and its associated socio-material infrastructures of supply. It is not only what water *is* (its material composition) or what water *does* (what practices water enables) that matters to people, rather it is also how water *comes to be* (drinking water, showering water, water for cooking, laundering and gardening) through the relations of materials, processes and places that is important and valued. This chapter shows that the ways in which water matters to households that are off-grid for water challenge, reinforce and go beyond dominant discourses of what comprises 'good' water[65] or 'good' water qualities (Tadaki and Sinner 2014).

The remainder of this chapter is divided into four parts. The first part briefly sets out the policy context for managing domestic drinking water quality in Australia, focusing on the ADWG. Examples are offered of public debates about the governance and use of household collected rainwater for drinking water.

Next I turn to insights from two strands of academic scholarship. The first concerns studies that explore public perceptions of and attitudes towards using household-collected rainwater for potable[66] purposes. The research contexts and results of these studies reflect a stigma around domestic use of water from a rainwater tank, specifically practices that bring the water into close bodily contact, such as drinking, cooking and bathing. However, I note that scholarly research on perceptions of non-mains water predominantly focuses on metropolitan households. In these urban contexts, the rainwater tanks supplement mains water connection and residents have little direct experience of subsisting on non-mains water sources. I then turn to a second body of scholarship from the social sciences that contests 'the value of water values' in water management (Gibbs 2006; Jackson 2006; Linton 2008; Ioris 2013; Tadaki and Sinner 2014). This scholarship challenges reductionist measures of water and advocates for a relational understanding of water values. Taking my cue from this work, this chapter foregrounds a conceptual approach that thinks relationally about water and is alive to

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[65] Kaika (2005, p.54) provides an oft cited delineation of 'good' and 'bad' water; 'good' water is defined as water that has been 'processed, controlled, commodified', and 'bad' water is framed as 'untreated metabolised water, to be found in city rivers, lakes, rainwater, sewerage'. This dualism has been widely used in cultural studies of everyday water to understand people's perceptions of the use of alternative to surface mains water, including rainwater (e.g. Moy, 2012; Head and Muir, 2007; Delaney and Fam, 2015).
[66] 'Potable water' is generally understood to be water that is intended for use as drinking water, cooking or personal bathing.

the emotions and affects that arise through interactions between watery and fleshy bodies, materials, ideas, processes and place. The analysis is underpinned by a relational approach to understanding how water *matters*.

I then present and discuss results from my empirical research. Results are presented in two parts. First, I draw on insights from interviewees' narratives of drinking and bathing in water. Water matters to participants due to relationships configured by their immersion in water through the sensations of drinking, bathing and otherwise tasting, smelling and touching water. Second, I look to interviewees' narratives of managing rainwater tank infrastructure. Water matters to participants through their immersion in the work of securing water from sky, rivers, and bores through processes of designing, creating, and developing knowledge about materials and infrastructure

To conclude, I discuss key insights from the analysis. The empirical data shows that the material qualities of water are tied up with the technologies, places and processes of its capture, storage, (re)use and disposal. Understanding the notion of 'immersion', as always an embodied achievement through consumption and labour, this chapter reveals qualities that matter that are not captured by the ADWG and other related institutions of water governance in Australia.

## 6.2 Background: A values-based framework of drinking water quality in Australia

### *6.2.1 The Australian Drinking Water Guidelines (ADWG)*

The ADWG provides a framework for the management and assessment of drinking water supplies in Australia. The ADWG are produced by the National Health and Medical

Research Council[67] (NHMRC 2011). Although not mandatory or legally enforceable standards, the ADWG are designed to provide an authoritative reference for Australian water regulators and suppliers on what constitutes 'safe, good quality water, how it can be achieved and how it can be assured' (NHMRC 2011, p.2). With the exception of bottled water, the ADWG can apply to any water intended for drinking (as well as cooking, bathing and showering) irrespective of the source, thereby encompassing rainwater tanks in addition to reticulated supplies.

In providing a rubric for the assessment of water quality, the ADWG provide two guiding values: 1) a health-related guideline value, and 2) an aesthetic guideline value. Specifically, water 'should contain no harmful concentrations of chemicals or pathogenic microorganisms, and ideally it should be aesthetically pleasing in regard to appearance, taste and odour' (NHMRC 2011, p.6). According to the NHMRC (2011, p.6) 'appearance, taste and odour are useful indicators of quality because they are generally the characteristics by which the public judges water quality'. The ADWG define both what water is, and what makes water potable, in very specific ways. The project of domestic water governance can therefore be read as fundamentally understanding and enacting a particular set of values about what comprises 'good' quality water (Tadaki and Sinner 2014, p.140).

### *6.2.2 Governing potable water*

As previously discussed in **Chapter 3**, the politics of domestic water provision and management have problematised the use of rainwater tanks and tank water in private homes (Moy 2012; Sofoulis 2015). Many water technicians and policy makers frame

[67] The NHMRC is an independent statutory agency and Australia's peak funding body for medical research (NHMRC 2018).

rainwater tanks as threats to public health because of the lack of centralised control over the usage and maintenance of this water—in contrast to mains water which is produced, managed and distributed in the public domain. The stigma against household collected rainwater as potable water has historical antecedents in the rise of scientific theories of disease transmission in the late 1850s. As Bakker (2012, pp.617–618) explains:

> Microscopes and bacteriology began to change both our water assessment techniques—its properties, quality, risk to the human body—and water control techniques. As new discourses of 'safe' water emerged (associations with new water practices incumbent upon 'modern' citizens), local, place-based practices and perceptions of qualities of different waters were deemed 'backward', or 'uncivilised', and replaced by more unified understandings of water defined by 'scientific' analysis of its biophysical properties.

Despite the heavy promotion by governments and enthusiastic adoption of rainwater tanks by householders during and following the Millennium Drought, rainwater is still seen as potentially contaminating or dangerous. Until 1994 Australian plumbing standards forbade rainwater tanks from being connected to pipes used by utilities to supply mains drinking water (Waitt 2018) and regulations[68] on rainwater use in mains-connected suburbs continue to stipulate that backflow devices must be installed to prevent rainwater from entering the mains supply (enHealth Council 2011). However, current best practice guidelines on the use of rainwater tanks concede that household-collected rainwater, stored in a rainwater tank, is usually suitable for potable purposes,

[68] The *Plumbing Code of Australia (PCA)* (Australian Building Codes Board 2019) and *AS/NZS 3500.1:2018* (Standards Australia 2018).

with the exception of suburbs located adjacent to heavy industrial, agricultural and transport emissions.

The Federal Government's Department of Health *Guidance on use of rainwater tanks* (enHealth Council 2011) recognises that in most areas of Australia the risk of illness arising from the consumption of rainwater is low. Similarly, NSW Health (2017) acknowledges that: 'A reasonably low level of management can ensure provision of good quality water that can be used for a wide range of purposes including drinking, food preparation, bathing, laundry, toilet flushing and garden watering'. However, despite this, NSW Health (2017) guidelines continue to stipulate that: 'In urban areas the public water supply remains the most reliable source of drinking water for the community. In these areas NSW Health supports the use of rainwater tanks for non-drinking uses'.

The stigma around the use of rainwater for potable uses further plays out in the public realm. Lively debates around rainwater bacteriology (Heldon [2017] responding to Taylor [2017]) and the potential for poorly maintained tanks to harbour mosquitos (Harvey [2019] responding to Young [2019] and Hyam [2019][69]) have featured in news media. However, the perceptions and experiences of households that rely on non-mains water sources are largely absent from this scholarship and debate. For example, an article published by the national broadcaster ABC News (Taylor 2017) inferred that

[69] An article published by ABC News on May 3rd, 2019 (Hyam 2019), inferred that water tanks were 'bad' for public health; the narrative presented in the article posited that unsealed rainwater tanks posed a threat for the outbreak of vector-borne disease as a habitat for mosquitoes. The article, which draws on a study by the CSIRO (Young 2019) has been critiqued by Rainwater Harvesting Australia (Harvey 2019) for drawing on a narrow commentary that fails to engage with health and rainwater harvesting experts. Specifically, 'the CSIRO has not presented evidence that the current, well established regulatory controls over rainwater tanks have failed or are not well understood and therefore pose a significant risk to public health'.

water tanks and drinking tank water was 'bad' for public health. Notably, the author did not disclose that the article drew only on research from contexts where rainwater tanks supplemented a mains water supply. Rainwater Harvesting Australia (RHA), the national representative body of the Australian rainwater harvesting industry, responded to the article in a statement describing the ABC article as 'poor reporting' (Heldon 2017). Specifically, RHA rebuked the assertion made in the article 'that all rainwater is unsafe for human consumption', and invited an apology from the ABC for the story. This debate is symptomatic of a broader public narrative in which mains water for potable use is positioned as 'good' and desirable, and rainwater from a water tank is positioned as 'bad' and undesirable.

## 6.3 Literature Review

### *6.3.1 Perceptions of non-mains water*

Scholarly research, from a range of disciplines, mirrors the increasing public debate about mains water, tank water and potable water. This research examines public perceptions of and attitudes towards using sources of potable water other than surface (dam) supplied mains water, including recycled wastewater and stormwater, desalinated sea water and household-collected rainwater (e.g. Marks et al. 2008; Dolnicar and Schäfer 2009; Dolnicar et al. 2014; Fielding et al. 2015; Leonard et al. 2015). Research on rainwater for potable use predominantly focuses on urban areas where the rainwater tank supplements mains water connection (Head and Muir 2007; Moy 2012; Delaney and Fam 2015). In this context, few households use rainwater for potable purposes (ABS 2013). There is some variation among perceptions of respondents along lines of age and previous experience of alternative water sources and technologies (Fielding et al. 2015), whether tanks were compulsory or voluntarily installed (Gardiner 2010; Mankad et al. 2012; 2015; Moy 2012), and the characteristics of local reticulated water supplies (Chubaka et al. 2017). However, broadly speaking, this research has found greater acceptance of rainwater for uses that do not involve personal contact, such as gardening, and lower levels of acceptance as the use becomes more personal, such as laundering, bathing and drinking (Ward et al. 2013; Chubaka et al. 2017; 2018). In interviews with households where a rainwater tank supplemented mains water, a number of respondents perceived tank water as 'dirty', or a lesser quality to mains water, and unsuitable for indoor use (Moy 2012, p.214; see also Po et al. 2003; Delaney and Fam 2015).

Collectively, these studies, and the grey literature, indicate that there is a stigma around the use of household collected rainwater as an alternative potable water source in reticulated contexts in Australia. Kaika (2005) argues that resistance to use of non-mains water indoors is underpinned by the notion that the modern home is constructed discursively and materially as a pure space, separate from nature. The denial of nature within the home is reinforced by the invisibility of domestic water supply networks. This resistance to non-mains water for use within the home is frequently expressed as the 'yuck factor' (Schmidt 2008); that is, for some, disgust and fear elicited by the idea of drinking water from alternative sources to surface-water supplied mains water (Po et al. 2003). The 'yuck' factor has been mobilised by opponents to the use of alternative water sources to augment drinking water supplies (such as recycled stormwater and wastewater e.g. Hurlimann and Dolnicar 2010). In short, water tanks storing rainwater for indoor use are understood by opponents to go against Western notions of morality and cleanliness (Shove 2003).

As previously discussed, most Australian households have little direct experience of subsisting on non-mains water sources (ABS 2013). Two key issues are overlooked in privileging the experiences and viewpoints of mains water households in public policy, scholarly research and public debate on domestic potable water quality. First, the expectation that the government will provide an unimpeded supply of potable mains water is not always met. As previously discussed in **Chapter 3**, the fantasy of an endless supply of government supplied and managed water was quashed by widespread water restrictions during the Millennium Drought (Sofoulis 2005). More recently, in NSW in 2019 and early 2020, three years of low rainfall coupled with low streamflow to surface water reservoirs resulted in a number of regional and rural towns running out of potable mains water supplies (Perinotto 2019). Further, in light of the increasing urban sprawl of Australia's major towns and cities, questions have been raised about the feasibility and cost of expanding existing mains water pipelines to supply new residential development with reticulated water. This is particularly the case in western Sydney, for example, where explosive population growth is concentrated and far removed from the dams and desalination plants that supply water to much of the eastern suburbs (Khan, S. quoted in Longbottom 2018).

Second, the emphasis on mains water as 'best' ignores failures in modern water treatment and supply systems. There are increasing examples of mains water contamination from pollutants such as microplastics (World Health Organisation 2019), heavy metals such as lead (e.g. in Flint, Michigan [Pauli 2020], and chemicals such as PFAS[70] (Fitzgerald 2022; Coggan et al. 2019), which can infiltrate surface and ground water reserves and evade conventional water treatment processes. The idea that

[70] PFAS = per- and poly-fluoroalkyl substances. PFAS are commonly used in firefighting foams.

‘healthy’ ‘good’ potable water is provided through mains water systems is increasingly contested. This is particularly the case for rural towns that rely on bore water or river water for mains water supply, where high salinity, turbidity or hardness makes the water aesthetically unpleasing to drink (Chubaka et al. 2017) and creates challenges for use in other ‘immersive’ contexts, such as washing bodies, hair and clothes.

Considering how water *matters* to off-grid households that rely on rainwater and the technologies of water tanks for the provisioning of water for potable use may thereby trouble conventional understandings of mains water as the default source of desirable or ‘good’ domestic water. How does water matter to these households; that is, what do they value about their rainwater? And how might these ways of mattering inform calls for a more diverse spectrum of domestic water use? To explore these questions I mobilise existing social sciences and humanities scholarship on the valuing of water and geographical work on domestic water use practices.

### *6.3.2 (E)valuating waters’ qualities*

The (e)valuation of domestic water quality by governing utilities and policy-makers typically follows the two-pronged approach of health- and aesthetic-guideline values outlined in the ADWG (NHMRC 2011). Emphasis on the health and aesthetic aspects of water embodies the long-standing tradition in public health and water governance of assessing quality by discrete, measurable categories that form the basis of judgement on its fit for human consumption (Bakker 2012).

While pathogenic and aesthetic variability remain the benchmark in both managerial and scholarly interrogations of drinking water quality, this has not completely displaced ‘non-scientific’ views of water (Hamlin 2000; Strang 2004; Gibbs 2006; Waitt 2018; see also public initiatives such as the Museum of Water[71]). Building on the **preceding chapter,** which is concerned with how water is quantified and measured, this chapter takes guidance from social sciences scholarship that works to contest water management values (Gibbs 2006; Jackson 2006; Linton 2008; Ioris 2013; Tadaki and Sinner 2014). Specifically, this chapter draws on insights from work that advocates for thinking relationally about water. This literature reminds us that values 'are not present in things but derivative of relationships and responsibilities to them' (Chan et al. 2016, p.1462; see also Tadaki and Sinner 2014). Emphasis turns to not only what water *is*, but what water *does*; that is, the practices that water enables are important (Strang 2004; Allon and Sofoulis 2006; Gibbs 2006; 2010; Head and Muir 2007; Waitt 2018). In thinking about the shortcomings of conventional approaches to environmental values, Tadaki and Sinner (2014, p.141, *original emphasis*) observe:

> Values can be many things, but to be *reducible, stable* (for modelling across space) and *scalable* (able to be ranked along a single scale), only some concepts of value are admissible. Narrative and place-specific meanings, in particular, are not rendered calculable, and this highlights some of the normative implications of this method that has attempted to mimic biophysical science.

Scholarship on environmental values has highlighted a number of limitations of the reductionist approach to determining values in water management. In considering the intersection of the biophysical and the social in the formation of values in freshwater governance, Tadaki and Sinner (2014, p.148), for example, highlight that categories of

[71] Originally established in London in 2013, the Museum of Water is a collection of publicly donated water and accompanying stories. The project, which has travelled across the UK, the Netherlands and Western Australia, invites people to donate water that is precious or has meaning in their lives. The collection currently holds over 1,000 bottles of water including bottles of tears, a melted snowman, puddle water, sweat, bath water, sprinkler water and river water (Museum of Water 2019; Harmon 2018).

value are fashioned on the presumption that 'geographical location and variability are not constitutive of values themselves' and that the attributes and indicators of value are determined by 'a universal human subject'. Jackson (2006), in her research on the treatment of Indigenous values in contemporary water resource management, argues that setting up categories of values represents a means of exercising power over rights to define what is and is not valuable about water and its environs. Similarly, Linton (2008), writing on the hydrologic cycle as discursive construct, argues that policy documents such as the ADWG, with its focus on health- and aesthetic-guideline values as benchmarks for assessing water quality, embody 'a way of representing water that was constructed in, rather than revealed through, scientific practice' (p.631); a way of 'making water visible [...] for the purpose of accounting for and controlling it' (p.636). The range of values about what comprises (or should be a 'measure' of) quality that is enshrined in the ADWG can thereby be read as determined by one socio-culture and the (e)valuation process is undertaken through one perspective—western, urban, scientific—in which water is reduced to a purely physical resource that can be measured, quantified, and chemically analysed, commodified, or economised, and traded. A traditional reductionist approach to the values that define 'good' quality water as a singular homogenous resource, objectifies water and establishes it as other or separate from the heterogeneous bodies it permeates and sustains (Attala 2017). This perspective sees the relations between materials, bodies, processes and place as secondary.

Health and aesthetic values are central to managing the micro-biological qualities of drinking water. However, thinking only in these terms overlooks the fact that aside from being a vital resource in creating and sustaining life, the ways in which water matters goes far beyond its material properties. Equally important are the sensory experience those properties offer (Strang 2004; 2005; Waitt and Welland 2019), the variability of water (Gibbs 2010), its symbolism (Bakker 2012) and flow (Tadaki and Sinner 2014). Bureaucrats who make decisions on water have been reluctant to accept water as anything but a purely physical resource, a resource that can be chemically analysed, homogenised, measured, commodified and traded financially (Allon and Sofoulis 2006; Tadaki and Sinner 2014; Fam et al. 2015). Such a view of water is inconsistent with the existence of plural and incommensurable values (O'Neill et al. 2008).

Separating and attributing power to specific categories of value limits opportunities for talking across the divides created by these processes (Gibbs 2010). The selection of topics and case studies in research is laden with assumptions about what and whose knowledge is important. This constrains the range of meanings, skills and technologies that could be considered useful, desirable or important now and in future. Tadaki and Sinner (2014), for example, whose work critiques a freshwater-governance methodology in New Zealand, remind us that values have politics: 'it defines the stakeholders involved, legitimise[s] particular "ways of knowing" and empowers certain developmental trajectories over others' (p.140). This is especially important in the context of uncertain water futures where the durability of current value-attribute relationships may be called into question. As Tadaki and Sinner (2014, p.149) argue: 'water-stressed futures may require a shift in the "ways that rivers matter" to people from extractive and utilitarian uses to passive or existence use values'. Concretising the categories and relationships that exist *presently* may make the task of changing or reforming these values more difficult in future (Tadaki and Sinner 2014).

Environmental philosophers O'Neill et al. (2008, p.1) urge a rethink of the ways environmental value is considered, by suggesting, provocatively, rejecting the language of 'values' altogether. Instead, they advocate for a relational approach to environmental governance that is grounded in and emerges through an understanding of the narrative and history of particular places; that is, how things 'matter':

> There are no such things as values. There are rather the various ways in which individuals, processes and place matter, our various modes of relating to them, and the various considerations that enter into our deliberations about action.

Thinking about values as 'ways that matter' is concerned with the meanings themselves, rather than the structures or norms which underlie them (Tadaki and Sinner 2014). For example, Gibbs' (2006; 2010) work with settler pastoralists, Aboriginal people, ecological scientists, tourism operators, and policy-makers living and working in the Lake Eyre Basin, central Australia, reminds us not to treat western values in water management as implicit or as the presumed norm against which others are compared. In adopting a broadly relational approach, informed by ontological pluralism, Gibbs points to cultural specificity of non-indigenous water values, which are contingent on the temporal and geographic mutability of water. Gibbs shows how pastoralists, for example, value the variability in different types of water (river, dam, bore, rain, brackish) and for different uses (drinking, swimming, cooling down, washing, watering stock) and at different times. Meanings associated with water are therefore 'diverse, changing and complex' and tied up, in this case, in the temporary absence, abundance and overflow of water (Gibbs 2006, p.77; see also Tadaki and Sinner [2014] on variable river flows). Gibbs' work highlights the limits of orthodox approaches to values in water governance based on the triple bottom line of economic, environmental and social sustainability, where 'local realities are simplified to fit generic categories, overriding specificity and difference and marginalising interconnections' (2006, p.75) and points to the importance of what water *does* in sustaining lives and livelihoods as mattering.

Turning now to the household scale, work by Waitt and colleagues (Waitt 2018; Waitt and Welland 2019; Waitt and Nowroozipour 2020) has similarly sought to illuminate the active, agential and affective roles of water, which shape meaning. However, Waitt's work takes as its starting point an interest in domestic water use practices and the relations between fleshy, sensuous bodies and the material infrastructure of watery household spaces—what Waitt and Welland (2019, p.26) refer to as 'situated watery skin encounters'. This research—which is located within an emerging scholarship concerned with migration, ethnicity, household sustainability and domestic water use (see also Maller 2011; Maller and Strengers 2013; Yan et al. 2018)— adopts a broadly practice-centred approach. Waitt and colleagues seek to amplify the role of emplaced and enskilled bodies, emotions and affect in everyday, watery household practices: 'Attention turns to the visceral experience of how water ebbs and flows in, on and through us and has the capacity to fix, unmake and remake discursive-based ways of understanding how water comes to matter in our everyday lives' (Waitt and Nowroozipour 2020, p.1272). Like O'Neill et al. (2008), Tadaki and Sinner (2014) and Gibbs (2006; 2010), Waitt and colleagues point to the importance of narrative, place and history, which are often overlooked in conventional (e)valuations of water.

The flattening of water quality to a set suite of health and aesthetic benchmarks in current policy thereby overlooks the plurality of experience with water. Insights from social sciences and humanities scholarship shows that people attribute values and engage in practices that sit in tension with economic rationality (Strengers 2013;

Browne 2015). Taking cue from this work, this chapter foregrounds a conceptual approach that thinks relationally about water and is alive to the emotions and affects that arise through interactions between watery and fleshy bodies, materials, ideas, processes and places. Specifically, this approach draws on insights from social practice theory and more-than-human geographies, which emphasise the importance of relations in stabilising meanings and values. Attention turns to the embodied, affective and emplaced relationships between people, rainwater and the associated infrastructures of rainwater capture, distribution and disposal when living off-grid.

## 6.4 Results

### *6.4.1 Immersion—drinking and bathing*

Rainwater was the sole source of drinking water for all households who participated in this research. Overall, participants spoke of the pleasures of drinking rainwater and most drank rainwater without any filtration beyond leaf guards on tanks. Rainwater was 'heavenly water', to quote Val, who had lived with rainwater for more than 60 years. It was 'fresh' according to Helen, who had only recently moved to her non-mains water home. Rainwater was 'lovely' to quote Alison, whose tank-water-dependent home was her secondary residence; tank water felt 'soft all of the time'. I asked participants to describe the qualities of their tank water. They responded:

> It's sweet. It's really sweet. It's beautiful. (Kerryn, 40–49, 4-person household, primary address, length of residence 10 years, interviewed 8 May 2016)

> This is always really refreshing. It's the nicest water that I drink. (Jayne, 60–69, 1-person household, primary address, length of residence 6 years, interviewed 17 April 2016)

> It tastes of nothing here, which is what you want water to taste of really. Nothing. (Sharon, 40–49, 2-person household, primary address, length of residence 8 years, interviewed 18 April 2016)

> I think, to me, the feeling I get from the water here is that it's fresh, it tastes fresh and pure. Maybe that's a psychological thing. (Helen, 60–69, 1-person household, primary address, length of residence 18 months, interviewed 13 April 2016)

> My tank water always tastes fresh, for want of a better word, tastes like water, nothing else. (Harvey, 40–49, 5-person household, primary address, length of residence 10 years, interviewed 7 August 2016)

> It's softer, it's got a lovely soft feel on your skin and it just feels healthier. (Kate, 60–69, 2-person household, primary address, length of residence 18 months, interviewed 10 May 2016)

> I love it, I think it just tastes so pure, whatever that means, and it's just nice. (Alison, 60–69, 2-10 person household, secondary residence, length of ownership more-than-20 years, interviewed 14 April 2016)

Tank water, according to all participants, felt soft, healthy, fresh and pure. Importantly, their assessment was always a comparative one. For the majority of households interviewed in this study, the pleasure was often the outcome of the *lack* of treatment and chemical purification of their tank water in comparison to mains water. The treatment of mains water in Australia is typified by the use of chlorine to kill bacteria (NHMRC 2011). All interviewees described chlorine as having an unpleasant taste and smell. Interviewees conveyed visceral disgust at mains water, not only through their words but in their tone of voice and facial gestures:

> I just help out at one of the schools and I was there the other day, and I left my drink bottle in the car and I thought, "Oh, I can't chat for another hour without having a drink". I went to the bubbler. True poison! It's just revolting *[pulls face].* The taste of town water is bad. (Bron, 70–79, 2-person household, primary address, length of residence, more-than-20 years, interviewed 21 March 2016)

> If we go back to Canberra to visit our kids it's like "Phoar! Fluoride! Chlorine!" Well I don't know if the fluoride smells but the chlorine does and if I do want to drink water I'll just pour a jug of water and stand it in the sun for half a day to get rid of that smell. (Kate)

> I like fresh rainwater, I think it's—you know, it might have a few bits and pieces from the roof in it but that doesn't bother us, it's just, I would say it's good for our immunity. So that's the way that goes, and I can taste the difference, when we have had town water in, you know, everyone instantly goes 'Bleargh, disgusting!' (Carolyn, 40–49, 4-person household, primary address, length of residence 12 years, 9 May 2016)

> I actually think Eurobodalla [mains] water is pretty good to be honest, really, compared to going—well I spent a lot of time in Brisbane last year, it's just disgusting up there! It's just horrible! It's actually not pleasant to drink at all, and that's when it's hot all the time and you want to drink, it just doesn't taste good at all. You can really taste the—it's not even necessarily the chlorine, it's just… I don't know what it is, it just doesn't taste nice at all. (Harvey)

Here, in comparison to tank water, mains water has a visceral potency that through ingestion prompts Bron, Kate, Carolyn and Harvey to recoil in disgust. Town water tastes and smells 'revolting'. In metropolitan contexts, where mains water is the social norm and water is sourced from dams, resistance to use of alternative domestic water sources is frequently expressed through disgust and fear (Po et al. 2003). My interviewees showed the opposite to be true for those living off-mains water supply.

Many respondents expressed considerable pleasure in drinking rainwater that was untreated and unfiltered. Sensory cues, specifically smell and taste (or the absence thereof), were critical to the categorisation of mains water as disgusting and the categorisation of tank water as clean and pure. The absence of chlorine from tank water was frequently described by interviewees as what made their tank water 'beautiful' to drink. Harvey, reflecting on the qualities of his rainwater tank water, commented: '[It] just tastes like water instead of water with additives'. These responses emphasise the importance of taste and smell in assessing water quality. Interestingly though, many participants were comfortable with the potential for certain other 'additives' in their tank water other than chlorine. For example, many were willing to accept the possibility of sticks and leaves, frogs, silt, bird poo and dirt in their water tank. Henk and Kate—who have decades of experience with rainwater tank water across multiple homes—highlight the 'liveliness' of rainwater tank water:

> Henk: It's nicer to shower in. The tank water is much, much better than town water.
>
> Kate: Definitely.
>
> Henk: It's easier on the skin.
>
> Kate: It doesn't smell. It doesn't have that chemical smell. Plus we know what goes in it. I mean we know there's bird poo and twigs and, you know,

mosquito larvae *[laughs]* and frog spawn *[laughs]*! All of those things are in the water.

Henk: The first time when we were [living] in Bungendore on tank water, in the tanks I noticed a frog sitting in the overflow so I thought "hmmm" *[sounds concerned]*. I asked one of the gurus at work, "There's a bloody frog sitting in my overflow". He said, "Good, you've got healthy water" *[laughs]*.

(Henk and Kate, 70–79 and 60–69, 2-person household, primary address, length of residence 18 months, interviewed 10 May 2016)

Henk alludes to a different set of measures of quality. In the absence of chemical analysis, the reliance is upon the ability of water to sustain life forms, including a frog. The water becomes healthy to drink through the presence of the frog. A willingness to accept twigs and dust, bird poo and leaves in the tank water, over chemical treatment and filtration does not conform to dominant Western, urban-centric discourse of what comprises 'healthy' water. In mains-contexts, water that is healthy to drink must be purified and brought in line with universal public health standards through chemical treatment and filtration. In contrast, interview and survey participants commonly expressed their disgust at drinking chemically treated mains water, which is regulated, homogenised and sterilised of lifeforms to be potable.

Furthermore, participants point to how tank water is not an inert material. Some tank water is 'crisper' than other tank water, particularly after rain, and changes in taste trigger different anxieties, actions and affects. There is a distinctly temporal element to freshness, as the experiences of Fraser, Linda, and Kate and Henk indicate:

The characteristics of the water is, I like it. You now, it's definitely different from the dam water and it's completely different to town water… It's crisper, I would say. Especially after rain. Sometimes in summer it can be a bit, especially if the tank is getting low, it loses its appeal a little bit. Like I can detect differences, which concerns me. I think "Oh shit. I hope something hasn't died in the tank" or something like that. But anyway I come up and check.
(Fraser 40–49, 4 person household, primary address, length of residence 10 years, interviewed 12 May 2016)

I much prefer drinking our water. However after a big rain it does taste earthy, which is alright to a certain point. We had a little period a couple of months ago where [my daughter] wasn't drinking the water because she found it too earthy tasting so we just had to boil it. We were boiling jugs of water and letting it cool and then it was fine. So, whatever the flavour was, it went away *[shrugs][laughs].* We're not quite sure what it was, just too much stuff on the gutters or whatever, but it was sort of an earthy flavour.
(Linda, 40–49, 4-person household, primary address, length of residence 12 years, interviewed 7 August 2016)

Kate: So yes, definitely [I like] the feel of it, the smell of it—well the lack of smell. And even—I mean, even when we haven't had rain here for a while, it doesn't smell swampy. The [tank] water [at our previous house] used to smell swampy every so often didn't it?

Henk: Oh yeah, not enough rain.

Kate: Yeah, because we were in drought for those years.

A reductionist perspective of domestic potable water quality overlooks the physicality of the materials enrolled in its capture and storage. The narratives of Fraser, Linda, Kate and Henk highlight the agency of infrastructure in shaping the qualities of water. In the case of water tanks, when the water is being sourced matters. Whether a water tank is low or has been 'refreshed' by rain impacts on quality. The notion that drinking water is a singular, homogenous entity is challenged when considering place-based relations, water's temporality, flow and stagnation. Instead, as water flow varies, water is imbued with a unique temporally transient materiality (Attala 2017). These insights from participants point to the importance of material and temporal arrangements in shaping how people come to understand and value water as potable, including knowledge of environmental changes and cycles that influence the volume of water in their rainwater tanks.

But water quality is not just about taste, smell and touch. Water and associated infrastructures (and processes) connect people to places, past and present, distant and immediate, and these connections matter. This brings a different set of relations and values about domestic water to the fore. Kerry and Brian, who I introduced in **Chapter 4**, live in Canberra in a dwelling connected to mains water—their off-grid for water home is a secondary residence that they use as a holiday home. Brian is hesitant about drinking the tank water, having only distant memories of relying on tank water as a small child in the 1950s, and will often, as he describes, 'bring down some clean water to drink' from Canberra in plastic containers. Kerry, on the other hand, recalls her childhood and adolescence on a farm reliant on tank water and has no qualms with drinking and bathing in rainwater from the household tanks. Kerry tells me:

> One the things I love, the first night, every time we come down here is to have a rainwater shower. It is one of the last great luxuries. Absolutely beautiful. And I love the taste of rainwater because that was drinking water when I grew up. (Kerry 70–79, 2–8-person household, secondary residence, length of ownership 25 years, interviewed 21 March 2016)

For Kerry, her embodied history of drinking rainwater as a child and young adult has a historical meaning in a physical and emotional sense (Delaney and Fam 2015). While the socio-material arrangement that provisions drinking water has changed for Kerry in the interim (having lived in Canberra on mains for several decades), the historical meaning associated with the practice of drinking and bathing in rainwater has a significant influence on her contemporary understanding of tank water as a 'luxury' and as something that she 'loves' the taste of, that she luxuriates in the feel of. The ingestion of rainwater and its touch reconnects her to memories of the past. That is more than visceral; it is embodied and affective.

When I interviewed Marian, she had recently moved permanently to her non-mains water home, having previously used it for several decades as a holiday home when she lived on mains water in Canberra. Marian had recently returned from travelling overseas and in this extract from our interview she hints at the grounding that drinking rainwater from her tank provides—it tastes, to her, of home:

> Carrie: How would you describe the qualities of your tank water?
>
> Marian: Well I love it. Yeah, I think it tastes really nice. I don't know about its chemical make-up; I used to live in Canberra and sometimes I would take water [from my rainwater tank] home, because it's a

> lot nicer than the Canberra water. I've only once looked in the tanks and it had a lot of roots and things growing in it and I thought 'hmmm' *[sound of concern].* But anyway, I've just recently travelled in America for a month, and Canada, and my water tastes to me like—it's my own bed I suppose, it's the best *[laughs].* So I don't know if it has any special qualities. It's free. That's a big plus, and it doesn't get pumped too far.

(Marian, 60–69, 1-person household, primary address, length of residence 12 months, interviewed 11 March 2016)

The taste and touch of water resonates in ways that are more than odour, appearance and texture. Thinking relationally, the joy felt from drinking water increased the affective capabilities of bodies to connect with past and present places. The taste and touch of water becomes an important mechanism to enhance and affirm participants' connectedness and sense of self. These become important points of differentiation from living on mains water. These qualities and values are difficult to capture and quantify under existing institutional measures of good water quality.

#### *6.4.2 Immersion—water-getting*

In the previous section I explored insights from participants' stories and reflections on their bodily immersion in the *materiality* of water, through practices of drinking and bathing. I focused on interviewees' stories of touching, tasting and smelling water, and the embodied connections, emotions and affects that resonate from these relations. In this section, I look to insights from interviewees' narratives of being immersed in the *processes* of domestic water provision, through practices of maintaining, repairing and caring for the infrastructures and places of rainwater capture, storage, distribution and disposal. I pay attention to the discourses and ideas participants draw upon when talking about the labour of being off-grid for water; that is, the work of ‘water-getting’.

A large part of taking responsibility for the provision and supply of tank water lies in the maintenance of infrastructure of water capture, storage and distribution. Water tanks, pipes, gutters, roofs and pumps can rust and leak, fill up with leaves, crack and stall. Maintaining the flow of water from sky, to tanks to houses, demands that participants physically engage with these objects and develop skills to identify, anticipate and respond to moments of breakdown. As Trevor explained:

> I sort of like how it's “do it yourself”. I like the idea that you're managing water at your own property and you're not relying on some major corporation to supply you a resource, and you just pay their bill, and you're removed from it. It means there's a bit more work involved, like I just said, having to pump water, and keep an eye on the rain gauge, and go up on the roof. There's a little bit more work that you have to do, but it's like you own it, you're owning your resource use. You're not leaving it to someone else to worry about. I like that element of it. I've learnt some skills. I've learnt some plumbing and basic skills out of it. I've had to do a bit of plumbing or work, or do things that if I hadn't have had to maintain things I probably wouldn't have learnt those skills or that knowledge.
> (Trevor, 50–59, 4-person household, primary address, length of residence 15 years, interviewed 13 June 2016)

The acquisition and application of maintenance skills needed to take responsibility for water matters to participants. Here, Trevor points to the importance of maintenance work in sustaining responsibility through strengthening connections with tank water.

His narrative also infers care and responsibility through independence and experimentation. In comparison, he critiques Big Water that distances people as consumers from water, a sentiment shared by Fraser:

> And it's [tank water] natural, it's not been adulterated. There's not a whole lot of energy going into that. You know, it's not supporting this whole other thing. It's just us. Getting a tank and putting it on the roof, it's easy. It's not just mindless, again that mindless consumption of buying stuff, turning stuff on, leaving stuff on, you know, consuming the planet the whole time. As "green eco-warrior" as that sounds it's not my intention, I just like having that awareness. Yeah, that's the positive.

The pleasures of drinking and bathing with tank water help increase participants' capacities to do the work of looking after the systems and helps affirm their difference from people who are reliant on mains water. There is an ethics and politics to being off-grid that is closely tied, for some, to ideas of freedom from capitalist markets, as well as sustainability. But it is fundamentally about how water *comes to be* that matters. For example, when I asked Stuart, who is also off-grid for energy, to describe what being off-grid for water has taught him, he ties together the material qualities of water with the process through which it reaches him:

> I think the water is—how could you say it? It kind of feels more energetic or more right. Just that simple process of falling on a roof and going into a tank and then you use it.
>
> (Stuart, 60–69, 1-person household, primary address, length of residence 17 years, interviewed 18 April 2016)

Reliance on the rainwater tank activates a material-discursive relationship with water that according to Stuart *feels right*. This speaks to rainwater having a particular 'quality' because of the way it is collected and supplied. Water *feels* different when you capture it, care for it, and manage it yourself. Stuart goes on to reflect:

> It's the ultimate in luxury, you know, to be able to have a guilt free shower, and to know that all that hot water is solar heated and the pump energy has come from photo-voltaics and you've collected that water in the first place. It's a fantastic feeling, yes. But being in a city apartment [in the past] and seeing- being really conscious of your input and outputs and how little control you have over it is very disempowering.

Both Stuart and Fraser point to how alternative ways of thinking about and valuing water in non-mains water households emerge not only through the physical proximity to and visibility of the water catchment and infrastructures (i.e. rainwater tanks, roofs, gutters, pipelines), but through independence from broader capitalist systems of production and consumption (Ioris 2013). As Fraser says, 'It's just us'.

Studies of household-collected rainwater use in mains water contexts have troubled the romanticised image of rainwater tanks as a panacea for prompting more sustainable water use—that is, rather than constituting change, rainwater tanks sustain (usually outdoor) water consumption. For interviewees in Moy's (2012) study of mains water households with retrofitted rainwater tanks, tank water was meaningful and valued as 'private water' or 'my water' in how its consumption was immune from government regulation. These households had a desire for water autonomy and independence to continue previously enjoyed water practices that had been restricted. There are certainly elements of desiring autonomy and control over water use in the narratives of my interview participants. For example, when I asked Penny to reflect on what living in a house that is off-grid for water—and electricity—meant to her, she responded:

> I love not having a relationship with, you know, any corporation around my power and water, and I didn't even realise that that would be good until there isn't one and I love having control myself. Like during the drought the suburbs were on odd and even days for watering their gardens. And I thought- imagine if you're having a 45 degree day but you're not on the right day to water; that would drive me absolutely batty! Whereas here, even though you might not have as much water, you can do what you want with that water and when. I can water when I want to, how I want to.
> (Penny, 50–59, 3-person household, primary address, length of residence 14 years, interviewed 11 May 2016)

There is no doubt that Penny values having control over her water supply and use. That said, Penny hints that control is not simply about having mastery over water. Rather control is something that households actively work and labour for, and manifests as *responsibility* for water, infrastructure and place. Penny cleans the roof's gutters of leaves, she checks the pipes for leaks, she seeks advice and engages a mechanic to get the water pump repaired when it breaks, she carries buckets of bathwater to the garden. All interviewees in this study were conscious of the variable limits on the availability of water at home and made efforts to ensure their water tank infrastructure was maintained in good working order. As Linda explains, 'having control' is about *bearing and taking responsibility* for one's water use and being cognisant of the consequences of not doing so; this includes regulating water use:

> I like being master of my own destiny. I like being able to have that control and being responsible for myself. When I'm in a situation when I'm in a town where I can use whatever I want—well I can't really but, you know, I don't like that being responsible, feeling responsible that if I use 'X' amount that will mean someone will have less water overall, the town will have less. But yeah, so I like that I can be responsible for my water here. That if I run out of water, well that's my own fault, really.

Ongoing maintenance and attentiveness to the materials, infrastructures and bodies comprising human-water-tank relations is required to keep the water flowing. This sets up a relationship of labour and responsibility and leads to an embodied sense of pride and empowerment. There is a moral geography here – it terms of people becoming responsible for their water consumption. This is tied to the identity of being self-sufficient. 'I like that I can be responsible for my water here', Linda states. Through place-based relations of connectedness and responsibility, participants became alive to the limited supply of water and engaged in routines of maintenance to ensure ongoing provision. This resonates with research findings that show that in contexts of more visible water system arrangements people value water based on the labour invested in capturing, storing and managing it (Linton 2010; Vaninni and Taggart 2016; Waitt 2018; van Holstein 2020). Participants spoke of actively labouring to learn about and maintain the material quality of water, through taste and sight, of learning about monitoring the quantity of water used (as discussed in **Chapter 5**), and of maintaining and repairing infrastructure. You have to learn to 'take care' of the water in order to live well when off-grid for water, as Val explains:

> I think if you learn to take care of the water you won't have a problem. But if you think you can just turn the tap on… *[shrugs and shakes head].*
>
> (Val, 80–89, 2-person household, primary address, length of residence 50 years, interviewed 11 May 2016)

This resonates with Jan's reflection on what it means to be off-grid for water:

> I also think that every place that has tank water, or saves water, they're all individual so you have to learn for yourself on your own place. No two places have a similar set up so you have to adapt all of this into your setting and that's trial and error, and there are people who have this expertise but you really have to become your own expert in your own place.
>
> (Jan, 60–69, 2-person household, primary address, length of residence 30 years, interviewed 3 March 2016)

For non-mains households, people access their water through systems that they design and know and maintain; they do work, they know the materials, they develop knowledge, they have relationships with the water and the infrastructure in order to access it. Living well with non-mains water sources hinges on an intimate and experiential knowledge of place; namely of limitations in water availability and of the small-scale, sometimes improvised, technical infrastructures and maintenance regimes needed to acquire, store, distribute and dispose of it (Vannini and Taggart 2013; 2016). These people have relationships with all stages of the process of water-getting that transpire through physical engagement with water and infrastructure.

## 6.5 Discussion and Conclusion

This chapter has sought to unsettle current ways of thinking about water quality in Australia. I trouble conventional understandings of water quality, which reduce water to a purely physical resource configured through discrete health and aesthetic values, by considering instead relational water values. That is, how water *matters* to people. Taking cues from literature that advocates for thinking about water values relationally, the chapter pursued two research questions: 1) how does water matter to people who are off-grid for water? That is, what do they value about water? And 2) how might these 'ways of mattering', or values, inform a more diverse spectrum of uses of rainwater in homes?

Drawing on the narrative device of immersion, I found that water matters to participants in ways that relate to their embodied contact and relationships with it—immersion through drinking, bathing and otherwise tasting, smelling and touching water—and through their immersion in the work of water-getting—the processes of designing, creating, developing knowledge about materials and infrastructure, knowing and managing how they get their water from sky, river and bores, into their homes and bodies. Through those two forms of 'immersion', which focus on relations with water and the infrastructures of its provision in place, this chapter reveals qualities of water that matter that are not captured by the ADWG (NHMRC 2011) and other related institutions of water governance in Australia.

Interviewees valued the taste, touch and smell of their tank water. Many described mains water, by comparison, as having an unpleasant taste and smell because of its treatment with chlorine; participants rejected (and recoiled viscerally from) this water, mains water was, in their words 'disgusting'. Sensory cues, specifically smell and taste (or the absence thereof), were critical to the categorisation of mains water as disgusting and tank water as fresh, clean and pure.

For participants, the act of drinking mains water was not only resisted on a visceral level—there was also a moral and ethical level in terms of bodily habits. Interviewees valued the fact that their water system was small scale and local. The water 'felt more natural' or 'right' because it arrived at their taps through a simple process over which they had the capacity to exercise some autonomy and control through taking responsibility for the maintenance of tank water infrastructure. More palatable and fresh was their own living, local water, which they had taken responsibility for capturing and managing. These relations imbued in the water a 'quality' that went beyond the physical—there is a moral imperative to drinking and managing household collected rainwater.

Accepting and enjoying domestic water that goes against the norm challenges conventional ideas of healthy or clean water as water that is treated through chlorination and industrial systems. The material qualities of the water and the process through which tank water *comes to be* domestic water through infrastructural arrangements and processes are important and difficult to separate. The process through which water is obtained matters. What is important to the participants in this study transcends the categories of 'health-related' (being pathogenic related) or 'aesthetic related' (being taste, odour, appearance) by which drinking water is measured according to the ADWG.

As cities begin to rely more on citizen self-sufficiency with respect to water and energy resources, issues relating to infrastructure maintenance and operation become paramount. As such the question arises as to how the interconnectedness, bodily embeddedness and greater ecological awareness encouraged by dependency on household collected rainwater and water tanks can be capitalised on and extended to people with no history or experience in managing their own water supply. Building on Chan et al. (2016), including relational values could help water managers integrate approaches to water management rooted in both Western scientific thinking and local knowledge and practices. In this way, this chapter works to challenge colonial assumptions embedded in modern water that position water as having a singular material existence (Jackson and Head 2020). To reiterate Tadaki and Sinner's (2014) point, this is important in the context of uncertain water futures where the durability of current 'value-attribute relationships' may be questioned. Limiting the categories and relationships that matter in (e)valuating waters' qualities to discrete health and aesthetic benchmarks may make the task of changing or reforming water values more difficult in water stressed futures. Better understanding what is important to people about domestic water may therefore highlight different priorities and opportunities.

# *Ripple—A changing climate*

*December 2019 – January 2020*

Effects of the New Year's Eve fire at home—surviving rainwater tank and melted water piping. Source: Author, 7 January 2020.

It is New Year's Eve 2019 and my husband and I are back at my parents' place for the holidays. At 6am I wake to the telephone ringing. Sirens scream through the receiver as an automated message plays through. 'Emergency Warning. There is a fire in the Mogo area. Leave now to the east towards the beach and shelter'. For weeks now a fire has lingered about 15 kilometres to the north-west in remote bushland, cloaking the coast in a veil of smoke, blocking out the sky and ocean. We're shocked that the fire has travelled so far overnight. Going to bed the night before we'd checked the predictive fire spread maps, satellite thermal imaging and numerous weather forecasts—paying close attention to the wind speed, wind direction and humidity—thinking that we were out of immediate danger for another day. We have been doing this for weeks. We live on the fringe of town, on acreage in dense bushland. We're not prepared to stay and defend. We water down the house and garden and leave. The smoke flows brown and heavy overhead as we drive out. Spot fires ignited by embers ahead of the front are already burning in bushland beside the road. The car is buffeted by flames. We head to the beach and join thousands of others—residents and holiday-makers all along the south-coast—seeking shelter. Hundreds of homes are lost that day, but by some miracle our house is still standing when we return at night. Our neighbours aren't so lucky. We spend the night watching their homes smoulder and collapse, the silence punctuated only by the sound of eucalypt trees, still burning from within, that crack and break and fall in the darkness.[72]

We're lucky. We still have ample tank water but no way to access it. Without power for the pump we can only gravity feed tank water from a garden tap into a bucket for drinking, bathing and pouring down the toilet. The tank water tastes and smells smoky, but we've experienced that before in the years when the state forest across the road would clear and pile burn. Replacing melted pipes to the water tank from the house and shed roofs is one of the first repairs dad makes in the days after the fire—he wants to make sure they can capture any and all rain that might fall; the fire may have passed but there was still a long summer ahead.

It is two days before the roads are clear for my husband and I to leave for Wollongong. Until I am able to source and return with a generator from Wollongong a week later, mum and dad cart water in buckets collected from the gravity fed garden tap. The people in town are no better off—power is not restored at home, in some areas for weeks. Mains water use is restricted, with the Council urging residents to refrain from any non-essential water use, to only water down their property if they were under immediate fire threat as reservoirs plunged and questions were raised about the

[72] My reflection in this paragraph has been published and appears in Wilkinson, C. and Clement, S. 2021. Geographers declare (a climate emergency)? *Australian Geographer* 52(1), 1-18.

availability of water for fire-fighting. 'Boil mains water' notices are issued for fire-impacted towns to the south.

It seems strangely fitting that this thesis should start[73] and end with a reflection on fire and water. For many months over 2019–20 I, like millions of others along Australia's eastern seaboard, lived and worked under a dense veil of smoke as bushfires burnt along the Great Dividing Range. During the course of this PhD project (2015–20), residents of the Eurobodalla Shire experienced periods of flooding rain, drought, bushfire and water restrictions. There is nothing unusual about these events in isolation, but the southeast of NSW was caught in a cascade of intersecting environmental crises, culminating most dramatically with the bushfires of 2019–20, which punctuated the state's historic drought that lasted from mid-2017 to mid-2020.

These events and their increasing frequency of occurrence have implications for how we live with and manage water. Severe bushfires, local drought and water shortages frequently coexist, making water usage planning critical for households, particularly households subsisting on non-mains water supplies. Experiences such as what I've described here bring to the fore issues of climate change, resilience of services, decentralisation of services, and latent skills of ad hoc water provision in an inevitably water stressed future.

[73] Refer to section 1.1.

# Chapter 7
# Conclusion

## 7.1 Introduction

> It's nice to be self-sufficient, the water tastes nice, and it's not a hassle, it just feels normal now. I think the thought of it sounds a bit 'Jesus-sandal-hemp-clothes'. If you'd said to me in Edinburgh—you know what I mean—I would've been, 'Oh. Septic tank *and* you collect your own rainwater...' and you think 'Oh yeaaah *[sounds sceptical]* ... Lovely' *[Rolls eyes].* But now it's just normality I suppose.
>
> (Sharon, 40–49, 2-person household, primary address, length of residence 8 years, interviewed 18 April 2016)

Large-scale, centralised water systems have evolved in Australia as homogenous systems of supply, regardless of how water is used at the household scale (Allon and Sofoulis 2006; Dovers 2008; Fam et al. 2015). This thesis offers a new understanding of everyday life for households living off-grid from municipal water and sewerage systems in regional Australia. Informed by relational ontologies of everyday life the research design combined a household questionnaire survey with semi-structured interviews and home-insight tours. Doing so involved engaging with embodied domestic water histories and the materiality of off-grid water systems, alongside values, attitudes, skills, and behaviours. The thesis advances a relational geographical framework for offering insights to everyday water by bringing into conversation concepts from social practice theory and embodied feminist scholarship, to conceptualise the more-than-human and discursive dimensions that shape everyday life with off-grid water infrastructures.

To adapt, alter or replace the dominant socio-technical system of water provision and management requires an exploration of everyday life. As the quotation from Sharon that opened this chapter illustrates, water and sewerage infrastructure are not just technological artefacts, they are equally entrenched in and shaped by the culture of practices and values of the people who use them (Teh 2015). The intimacy of small-scale systems—particularly decentralised systems installed and managed by households—requires embracing heterogeneity and understanding how people interact with and think about these systems in practice (Fam and Lopes 2015). In this thesis, I have offered insights into the everyday life of households that rely on technologies of rainwater tanks and onsite septic systems for subsistence.

Three research questions have framed this thesis:

1) How are rainwater tanks understood as a source of domestic water in Australia in relation to the wider socio-material contexts in which these infrastructures are situated, such as institutions, regulations, and homes, over both time and space?

2) How do water practices take shape in relation to the human and non-human bodies, materials, technologies, subjectivities and places that make up everyday life in households that are off-grid for water?

3) How does understanding human-water relations in off-grid contexts contribute to unsettling dominant understandings of water provision, use and disposal in mains water contexts?

This concluding chapter summarises the contributions advanced by the thesis. I discuss my methodological contribution made through the research design and approach. I then turn to the discussion chapters, which were oriented around three inter-related everyday water practices: provision, (re)use and disposal. Each chapter illustrates the importance of geographical relational thinking to conceive of domestic water self-sufficiency. To conclude I outline a future research agenda.

## 7.2 Research contributions

**Chapter 2** provides the methodological contribution of the thesis. The chapter engages with calls for geographers to be attuned to the sensuous and material dimensions of conducting research. I present my everyday water sensory ethnography, which combines survey (postal and online),semi-structured interview and home-insight methods. This combination of methodologies deliberately responds to the conceptual approach adopted in this thesis, which is underpinned by a relational ontology that while attentive to more-than-human agency does not jettison the importance of the social. My methodological approach sits at the intersection of post-structuralist feminist research methods and more-than-human research praxis, which endeavour to amplify and learn from sensory and affective registers in fieldwork.

The chapter makes a methodological contribution to social sciences research by advocating for what can be learnt when the 'doing' of the research method is thought of as an embodied and reflexive practice. I extend conversations about more-than-human agency shaping research methods and response rates, emotions in research-researcher relations, and the importance of relational positionality. I argue that becoming alive to the more-than-human dimensions of field sites helps draw attention to the role of materiality, emotions, and affects in the wider process of mobilising research and becoming researchers. Furthermore, the methodological approach underscores the importance of capturing those moments of ephemeral experience.

**Chapter 3** addresses research question 1. Chapter 3 maps the changing discourses that fashion rainwater tanks as a source of domestic water supply in Australia. Rainwater tanks are aligned with four broad discursive shifts in the historical narrative of Australian domestic water provision. Rainwater tanks have been framed by institutions and individuals, through regulations, policy, and discourse, as:

- offering 'promise' of survival in the context of European colonisation of the continent;
- being a 'villain' in the context of political ideas that aligned dam building with modernity and the nation-state;
- being a 'saviour' in the context of the Millennium Drought and household water restrictions, and;
- offering 'possibility' in the context of ageing mains-infrastructure, population growth and increasing climate variability.

In mapping the discourses that frame rainwater tanks as a source of domestic water provision, the chapter helps explain why the ongoing presence of rainwater tanks in rural and regional areas is silenced. Living with rainwater tanks beyond the metropolis remains largely invisible due to political concerns with water supply for cities. The intertwined narratives of modern water and settler-colonial states provide cause to question the ability of the state to 'see' beyond modern water (Meehan et al. 2020). This chapter contributes to literature offering a critical interpretation of the uneven historical geography of infrastructures of water, both in Australia and internationally.

**Chapters 4, 5** and **6** address research questions 2 and 3. These chapters examined moments in domestic water supply, (re)use and disposal, to help understand how human-water relations are (re)configured through reliance on off-grid water management infrastructures. They illustrate how, when domestic water self-sufficiency is conceived as a relational achievement, water practices are always contingent upon the socio-material arrangements through which people achieve a sense of themselves and home, together.

**Chapter 4** illustrates how familial relations are sustained and challenged through practices and understandings of waste/ing water. This chapter moves deliberately away from conventional understandings of wastewater and wasting water as technocratic problems involving behaviours of individuals and infrastructure, to a framework that instead involves families. The conceptual framing of this chapter brought together insights from family studies literature, that thinks about family as a process or doing, and household sustainability literature, that emphasises the importance of social practices, materials, ethics and the spatial in everyday consumption. When water use is thought of in the context of everyday family life implications for understanding waste/ing water arise through embodied family histories, experiences of living alone and living together apart, and having and raising children and teenagers. These elements are missed in conventional approaches to water governance, which focus on supply and demand (shortage and surplus) and the management of wastewater as a technical problem.

**Chapter 5** seeks to better understand how people who are off-grid for water measure and monitor their water supply without a conventional water meter. Attention turns to better understanding how households reliant upon rainwater tanks regulate water consumption when not subject to the governance regimes of external authorities. Building on scholarship that attends to the politics of measurement (Blue and Brierley 2016; Bouleau 2016; Jackson and Head 2020; Blue and Tadaki 2020), this chapter advances the novel concept of *embodied water metric,* underpinned by the narrative device of *(en)gauge*. An embodied understanding of water consumption is underpinned by physical engagement with proximate and visible water management infrastructure. Sensing tank water volumes relies on embodied skills that take time to develop, and situated knowledge of climate, weather and the water needs of household members.

The interpretation of narratives presented in Chapter 5 underscore the importance of proximity to domestic water supply infrastructures in making visible the invisible flows of water and encouraging conscientious water consumption practices. Participants were (en)gauged in measuring and regulating water use in ways that were relational, place-based and responsive to context. From a policy perspective, these insights may offer more creative ways to reconnect embodied selves with everyday environments to rethink, and reduce, water consumption.

The final discussion chapter, **Chapter 6,** illustrates how water matters to off-grid householders through relationships configured by their immersion in the materiality of tank water and the labour of maintaining off-grid water infrastructure. Taking my cue from literature that advocates for a relational understanding of water values (e.g. Strang 2004; Gibbs 2006; Tadaki and Sinner 2014), the chapter underscores how water qualities are shaped by the agency of water and its associated socio-material infrastructures of supply. It is not only what water *is* (its material composition) or what water *does* (what practices water enables) that matters to people, rather it is how water *comes to be* (drinking water, showering water, water for cooking, laundering and gardening) through the relations of materials, processes and places that is important and valued. Understanding the notion of 'immersion', as always an embodied achievement through consumption and labour, this chapter bring into question the limitation of water quality to purely pathogenic and aesthetic measures, as enshrined in the Australian Drinking Water Guidelines and other related institutions of water governance in Australia.

Together, the empirical discussion chapters offer insight into ways of living well with alternatives to dam-supplied mains water, which in turn challenges the aspirations of modernity embedded in water management in Australia. Addressing the third research question, the significance of these interpretations are twofold. First, the households engaged in my study represent capacity for change and adaptation. It is clear that there are challenges associated with being off-grid for water and sewage. Participants in this research project described the possibility of running out of water, maintaining, and servicing infrastructure, as well as the potential for infrastructure failure. Further, trade-offs are made by householders every day as they self-regulate water use (Gibson et al. 2013). Households navigate dilemmas that occur when sustainability behaviours that restrict water use challenge normative behaviours of comfort, cleanliness, and convenience (Shove 2003). However, my research findings indicate that participants value their autonomy over water use, particularly when it comes to drinking rainwater. Browne et al. (2019, p.18) caution that: 'In visions of how societies might live with water, particularly visions of water futures for the Global North, we see too much hesitancy in imagining what people are capable of and willing to cope with'. The insights from this thesis confirm and extend research that suggests that being off-grid for water 'mustn't be that bad' (Vannini and Taggart 2014, p.322). Living off-grid for water may be onerous in terms of labour (Vannini and Taggart 2016), but water self-sufficiency can be a satisfying and pleasurable way of life (Pickerill 2017). My results therefore have relevance in pushing for policies that enable and encourage greater installation and use of rainwater tanks in mains water contexts. People are willing and can adapt to alternate water sources and infrastructures.

Second, these households are engaged in decision-making and practices of self-regulating and restricting water use every day. We might think of these as 'accidental' sustainability practices brought about by other priorities. But nevertheless, these practices are evidence of existing household capacities to adapt and respond to infrastructural challenges and disruptions to water supply (Allon and Sofoulis 2006; Maller and Strengers 2013; Carr and Gibson 2016). My findings affirm research that has shown that sustainable practices of resource consumption are strongest where people actively understand and participate in networks of supply and distribution (Head and Muir 2007; Woelfle-Erskine 2015).

## 7.3 Future research

As towns and cities begin to rely more on citizen self-sufficiency with respect to water and energy resources, issues relating to infrastructure and governance become paramount. As such, the question arises as to how the everyday experiences of households reliant upon collected rainwater, water tanks and onsite waste management systems can be capitalised upon and extended to people with no embodied histories of managing their own water supply. To conclude, I offer five future research trajectories.

First, future research may extend upon the concept of everyday life. This project has focused on the everyday lives of households that are off-grid for water in the Eurobodalla Shire, a regional local government area on the southeast coast of NSW, Australia. Future research may consider working with households that are off-grid for water in other regional and rural contexts. It may consider different fieldwork contexts along lines of climatic factors (such as rainfall patterns and seasonality, arid areas, and monsoonal areas), population factors (such as ethnicity, age, tenure, and household size), and mains water governance factors (such as mains water sources and quality).

Second, this study has focused largely on participants experiences with household collected rainwater and rainwater tanks as the principal source of domestic water when living off-grid. Equally important are other decentralised alternatives to mains water. Specifically, research may focus on the everyday geographies of bore water and river water in non-mains contexts.

Third, this thesis has drawn upon the experiences of a relatively privileged sample of households, with most being homeowners living on large residential lots and acreage. Equally important are the experiences of renters, who may have less control over managing water infrastructure, and households living on smaller residential blocks, where there is less physical space for water storage. Future household water research that involves minority social groups is crucial to troubling taken-for-granted practices in the Minority World (Waitt 2018).

Fourth, as outlined in **Chapter 1**, this thesis has investigated the everyday geographies of living-off grid for water at times of relative water security for most research participants. Equally important are the everyday geographies of different water availability (including droughts and floods), and the water practices associated with disasters, both slow (e.g. drought) and rapid onset (e.g. flood and bushfire). Attention to such contexts would provide a more nuanced geographical understanding householders' everyday lives in relation to water abundance and scarcity, rather than relying on householders' attempts to recall those events years later, as was the case here.

Finally, future research may consider a generational study of living off-grid for water, with a focus on inter-generational knowledge exchange. This research has revealed that many people embody water saving practices as a result of childhood experiences with off-grid water infrastructure in parental homes. A generational comparison of attitudes and practices within different familial contexts may provide future alternative policy directions for water authorities and governments.

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# Appendix A: Ethics Approval Letter

APPROVAL after review
In reply please quote: HE15/493
Further Enquiries Phone: 4221 3386

28 January 2016

Ms Carrie Wilkinson

Dear Ms Wilkinson

Thank you for your letter responding to the HREC review letter. I am pleased to advise that the Human Research Ethics application referred to below has been **approved.**

| | |
|---|---|
| Ethics Number: | HE15/493 |
| Project Title: | Living with water tanks: An exploration of the practices and experiences of individuals, households and communities that are self-sufficient for water |
| Researchers: | Ms Carrie Wilkinson, Dr Leah Gibbs, Professor Gordon Waitt |
| Documents Approved: | |
| | Initial Ethics Application |
| | Response dated 25/01/2016 |
| | Text for Promotional Flyers and Posters V.2 January 2016 |
| | Text for Postal Survey Pre-notice Letter V.2 January 2016 |
| | Text for Postal and Online Survey participant Information Sheet V.2 January 2016 |
| | Semi-Structured Interview and Home Insight: Draft interview Schedule and Proposed Questions V.2 January 2016 |
| | Project Description V.2 January 2016 |
| | Participant Information Sheet: Semi-structured Interview and home insight V.2 January 2016 |
| | Consent Form for Interview Participants V.2 January 2016 |
| | Participant Information Sheet: Storytelling V.2 January 2016 |
| | Consent Form for Storytelling Participants V.2 January 2016 |
| Approval Date: | 27 January 2016 |
| Study Expiry Date: | 26 January 2017 |

Ethics Unit, Research Services Office
University of Wollongong NSW 2522 Australia
Telephone (02) 4221 3386 Facsimile (02) 4221 4338
Email: rso-ethics@uow.edu.au Web: www.uow.edu.au

The University of Wollongong/Illawarra Shoalhaven Local Health District Social Sciences HREC is constituted and functions in accordance with the NHMRC National Statement on Ethical Conduct in Human Research. The HREC has reviewed the research proposal for compliance with the National Statement and approval of this project is conditional upon your continuing compliance with this document.

A condition of approval by the HREC is the submission of a progress report annually and a final report on completion of your project. The progress report template is available at http://www.uow.edu.au/research/rso/ethics/UOW009385.html. This report must be completed, signed by the appropriate Head of School, and returned to the Research Services Office prior to the expiry date.

As evidence of continuing compliance, the Human Research Ethics Committee also requires that researchers immediately report:

- proposed changes to the protocol including changes to investigators involved
- serious or unexpected adverse effects on participants
- unforseen events that might affect continued ethical acceptability of the project.

Yours sincerely

Associate Professor Melanie Randle
Chair, Social Sciences
Human Research Ethics Committee

cc: Dr Leah Gibbs, Professor Gordon Waitt

Ethics Unit, Research Services Office
University of Wollongong NSW 2522 Australia
Telephone (02) 4221 3386 Facsimile (02) 4221 4338
Email: rso-ethics@uow.edu.au Web: www.uow.edu.au

University of Wollongong

# Project Description

*Living with Water Tanks*

**You are invited to take part in a study conducted by Carrie Wilkinson, a PhD student at the University of Wollongong, under the supervision of Dr Leah Gibbs and Professor Gordon Waitt, School of Geography and Sustainable Communities.**

**The Project:**
The aim of the project is to better understand the practices and experiences of individuals, households and communities who are self-sufficient for water in the Eurobodalla. Specifically, how households live with non-mains water sources such as: rainwater, bore water, river water, trucked water, and/or private dam water, stored onsite in tanks. By asking how people perceive and use water when they are not connected to centralised town water supplies, this study will help to identify different ways of managing water in times of water scarcity and abundance.

**What you will be asked to do:**
To help generate a better understanding of your life with water tanks and tank water, you are invited to contribute to a project structured in two stages. You may contribute to as many components of this project as you choose, and in any order. The stages are:

<u>Survey</u>
The survey will aim to establish baseline information about non-mains water households in the Eurobodalla Shire; that is, to provide insight to the question 'Who are the people subsisting on tank water in the Eurobodalla?' The survey will comprise questions on the following themes: (1) water tanks at home (number, volume, and contents of water tank); (2) previous experience with different water sources; (3) water saving technologies and practices; (4) water tank maintenance and repair; and (5) experience and perceptions of water scarcity and water abundance. Basic demographic information will also be collected through the survey to contribute to understanding of the respondents as a representation of the wider community. You can request a hard-copy of the survey with reply paid envelope or you can fill in the survey online [www.surveymonkey.com/r/watertanksurvey].

<u>Interview and Home Insight</u>
To generate a conversation around your everyday water practices, as part of a tank-water only household, you are invited to take part in an interview about water usage at your property. With your permission, the interview will take place at your home. You will be asked to show Carrie when, where and how you source, store, use, conserve and dispose of water in and around your home. The interview will comprise a number of open questions structured around the following themes: (1) water history; (2) water at home; (3) saving water; (4) using water; (5) maintenance; (6) knowing water (records and lists); and (7) living with water abundance and scarcity. Open questions will be employed as starting points and prompts to generate a story of your life with water tanks and tank water. With your

permission the interview and conversations during the home insight will be audio-recorded and transcribed.

It is anticipated that the project will run throughout 2016.

To participate you need to live in or own a house in the Eurobodalla Shire that is not connected to mains (municipal or town) water infrastructure. Instead, your household draws on non-mains water sources such as rainwater, bore water, river water, trucked water, and/or private dam water, stored onsite in a tank (or tanks) for everyday needs.

**Freedom to consent and withdrawal of consent:**
Your participation in this research is voluntary and you are free to decline to participate. Declining to participate or withdrawing your consent will not affect your present or future relationship with the University of Wollongong. You are also free to withdraw from the research at any point within the timeline of the project (prior to 1 January 2017). You may also withdraw any data you have provided to that point.

**Privacy**
The possible project risks are related to privacy. To minimise these risks we invite you to provide us with a pseudonym and to avoid photographing your face or others. Confidentiality will be maintained in all publications and presentations of the research unless you are willing to be identified. Any photographs that may be used in publications or conferences that contain identifying features will be blurred.

Interviews will be digitally recorded and transcribed verbatim to assist interpretation. However, the transcripts will always remain confidential. Access to the transcript is only by the researchers. With your consent, quotations from the transcripts will be used in a PhD thesis and may be circulated in publications or conference papers to help inform critical debates about people's everyday lives with water tanks and tank water in regional Australia.

**The Project Organiser:**
If you would like to participate or have any enquiries about the research please contact:

- Carrie Wilkinson (PhD Student)
  School of Geography and Sustainable Communities, University of Wollongong
  Email: cw979@uowmail.edu.au or Telephone

The Human Research Ethics Committee of the University of Wollongong has reviewed this research (Approval No. HE15/493). If you have any concerns or complaints regarding the way the research is, or has been, conducted you may contact the Ethics Officer, Human Research Ethics Committee, Office of Research, University of Wollongong on 02 4221 3386 or email rso-ethics@uow.edu.au

***Thank you for your interest in this study.***

# Appendix C: Promotional Flyer


Australian Centre for Cultural Environmental Research | UNIVERSITY OF WOLLONGONG

A project of the School of Geography and Sustainable Communities 2016

Researchers at the University of Wollongong are conducting a study to explore how households in the Eurobodalla perceive and manage water when they are not connected to centralised mains (town) water supplies. We are particularly interested in talking with people who use non-mains water sources at home, such as rainwater, bore water, river water, trucked water, and/or private dam water, stored onsite in tanks.

**If you would like to participate in this project, you may do so in any of the following ways:**

- **Completing an anonymous questionnaire and/or**
- **Participating in an interview.**

To complete an online copy of the questionnaire, please visit www.surveymonkey.com/r/watertanksurvey. If you would prefer to complete a hardcopy of the questionnaire, please contact us to request a copy and reply-paid envelope.

***Thank you for considering participating in this research.***

The project is being conducted by Carrie Wilkinson, a PhD student at the University of Wollongong. If you would like to participate or have any enquiries about any stage of this research please contact: Carrie Wilkinson (School of Geography and Sustainable Communities, University of Wollongong) Email: lifewithwatertanks@gmail.com or Telephone:

This research has been approved by The University of Wollongong Human Research Ethics Committee (No. HE15/493]

## Appendix D: Article from *The Bay Post* Promoting the Research Project

2 BAY POST/MORUYA EXAMINER Friday March 11, 2016

batemansbaypost.com.au

NEWS

TANK WATER: Carrie Wilkinson, 24, wants people on tank water in the Eurobodalla to come forward and answer a survey for her PHD.

# Carrie talking tanks

RESEARCH

BY EMILY BARTON

Eurobodalla

FORMER Batemans Bay student Carrie Wilkinson, 24, wants to find out more about people's experiences with tank water.

As part of a PHD on human geography with the University of Wollongong, Ms Wilkinson is looking for people who live on tank water to fill out a survey and/or be interviewed.

"I am interested specifically in households that are self-sufficient for water, houses that aren't connected to the main water grid, and how they live with water, use water, experience water and perceive their water tanks," she said.

"I want to talk to between 30 and 40 people from the Eurobodalla who use water tanks."

The quality of people's tank water will not be tested as part of the project. Ms Wilkinson was inspired to find out more about different experiences with tank water after growing up using it.

"Everybody's situation is different, so everyone is going to have different positives and negatives and different joys of living with tank water.

"I grew up out the back of [illegible] on tank water. All our water was from rainwater. The information I get will be used for my PHD thesis, which will be thousands of words long."

She hopes her PHD will inform policy in the future.

"In terms of water tanks, everything that is informing policy and academic discussion is about people who have a mains connection and a tank on the side. The voices of people who subsist solely on tank water are not there," Ms Wilkinson said.

"I am interested in seeing people who are solely on tank water, what their experiences can bring to the table in terms of using water more sustainably in a changing climate.

"There is a negative perception about tank water, particularly in houses that are connected to town water but have a tank on the side."

*Residents on tank water in Durras, Congo and Nelligen can expect a survey in their letterbox soon.* To fill out the online survey, visit www.surveymonkey.com/r/watertanksurvey or email lifewithwatertanks@gmail.com for more information.

## MAN IN CRITICAL CONDITION

McKenzies

A MAN remained yesterday in a critical condition at The Canberra Hospital after suffering a heart attack in the surf at McKenzies Beach on Monday.

Surfers conducted CPR on the man, aged in his late 70s, for 20 minutes until paramedics and lifesavers arrived.

A spokeswoman for The Canberra Hospital yesterday said the man remained in a critical condition.

The inicident prompted lifesavers to call for more people to become trained in CPR techniques.

## PATIENT STABLE

**A MAN injured when the car he was driving crashed through bridge works and landed in Candlagan Creek on Sunday remained yesterday in a stable condition in The Canberra Hospital.**

**The 64-year-old man was taken to Moruya Hospital after the accident, which occurred at about 11pm.**

**He was later transferred to Canberra with suspected head and abdominal injuries.**

**Emergency crews said the car became airborne for more than 60 metres.**

University of Wollongong

# Participant Information Sheet for Interview and Home Insight

## *Living with Water Tanks*

A project by Carrie Wilkinson (PhD Student)
Co-supervised by Dr Leah Gibbs and Professor Gordon Waitt
School of Geography and Sustainable Communities, University of Wollongong

**The Project:** The aim of this project is to explore how households perceive and manage water when they are not connected to centralised mains (town) water supplies. **We are particularly interested in talking with people who use non-mains water sources at home, such as rainwater, bore water, river water, trucked water, and/or private dam water, stored onsite in a tank (or tanks).**

**What you will be invited to do:** If you agree to participate in this stage of the project, you will participate in a semi-structured interview with Carrie. The interview can be conducted in a location of your choosing but, with your permission, it is preferable that the interview is conducted at your home. This is because we are interested in finding out more about the places where you source, store, use, conserve and dispose of water in and around your home.

The interview will take approximately 1 – 2 hours and will comprise a number of open questions structured around the following themes: (1) water history; (2) water at home; (3) saving water; (4) using water; (5) maintenance; (6) knowing water (records and lists); and (7) living with water abundance and scarcity. Open questions will be employed as starting points and prompts to generate a story about your life with water tanks and tank water.

You will be asked to create a sketch map of your property during the interview. The sketch map will identify important places for water at your home. You will also be asked to bring along a copy of any records you keep relating to your water tanks and water usage at your property. For example, you might keep a record of the rainfall or daily temperature at your property.

During the property tour photographs may be taken of water tanks and sites of water use in or around your household, with your permission. The interview and conversations during the home insight will be audio-recorded and transcribed. The data (photograph and/or audio and transcript) collected from your participation will be used for a PhD thesis, and may also be published in scholarly articles, conference presentations and reports. Confidentiality will be maintained in all publications and presentations of the research unless you are willing to be identified.

You will be provided with a consent form prior to commencing an interview with Carrie. The consent form will enable you to indicate whether or not you wish to participate in this stage of the research, and whether or not you will allow the interview to be recorded for the purpose of transcription, and photographs to be taken.

**Possible risks, inconveniences and discomforts**
Apart from the 1 – 2 hours of your time for the interview, we can foresee no risks for you. Your involvement in the study is voluntary and you may withdraw your participation in the interview at any time. You are also free to withdraw your interview data within the timeline of the project (prior to 1 January 2017). The decision not to participate, or to withdraw from the study, will not affect any current of future relationship with the University of Wollongong.

- If you have any questions about the research please contact Carrie Wilkinson (School of Geography and Sustainable Communities, University of Wollongong). Contact details: email cw979@uowmail.edu.au or Telephone
- This study has been reviewed by the Social Sciences Human Research Ethics Committee of the University of Wollongong (Approval No. HE15/493). If you have any concerns regarding the way the research is or has been conducted please contact the Ethics Officer on (02) 4421 3386 or email rso-ethics@uow.edu.au .

***Thank you for considering participating in this stage of the study.***

## Appendix F: Consent Form – Interview

# Consent Form for Interview Participants

## *Living with Water Tanks*

A project by Carrie Wilkinson (PhD Student)
Co-supervised by Dr Leah Gibbs and Professor Gordon Waitt
School of Geography and Sustainable Communities, University of Wollongong

I have been given information about the *Living with Water Tanks* project. I have had the opportunity to discuss the research project with Carrie Wilkinson who is conducting this research as part of a Doctor of Philosophy (PhD) supervised by Dr Leah Gibbs and Professor Gordon Waitt of the School of Geography and Sustainable Communities at the University of Wollongong. At this time I have asked any questions about the research and my participation.

I have been advised of the potential risks and burdens associated with this research. I understand this includes participating in: an interview of approximately 1 – 2 hours; and a home tour (if relevant). I understand that where photographs are collected, no identifying information will be photographed or used without consent. I understand that my contribution will be confidential and that my details and data will not be supplied to any other person or organisation for any other purpose.

I understand that my participation in the project is voluntary. I am free to withdraw from the research at any time within the timeline of the project (prior to 1 January 2017). I am also free to withdraw any data I have provided to that point. My refusal to participate or withdrawal of consent will not affect me, or my relationship with the University of Wollongong, in any way.

If I have any enquiries about the research, I understand that I can contact Carrie Wilkinson (Email: cw979@uowmail.edu.au or Telephone ) or the research supervisors: Dr Leah Gibbs (02 4289 1547; leah@uow.edu.au) or Professor Gordon Waitt (02 4221 3684; gwaitt@uow.edu.au).

The Human Research Ethics Committee of the University of Wollongong has reviewed this research (Approval No. HE15/493). If I have any concerns or complaints regarding the way the research is or has been conducted (Approval No. HE15/493) I can contact the Ethics Officer, Human Research Ethics Committee, Office of Research, University of Wollongong on (02) 4221 3386 or email rso-ethics@uow.edu.au.

By ticking and signing below I am indicating my consent to:

- ☐ Participate in a conversation of about 1 – 2 hours duration that discusses how my household uses and manages water, my previous experiences with water, and my perceptions of household water practices.
- ☐ The interview being audio recorded and later transcribed for analysis.
- ☐ Participating in a home-tour as part of the interview.

☐ The home-tour being audio recorded by Carrie for later transcription and analysis.
☐ The collection of photographs of water tanks and sites of water use in or around my household, at my discretion.

Please indicate whether you wish for a pseudonym to be used for the data you provide, *(please TICK one)*.

☐ YES, please use a pseudonym. ☐ NO, it is okay to use my real name.

I understand that the data (photograph and/or audio and transcript) collected from my participation will be used for a PhD thesis, and may also be published in scholarly articles, conference presentations and reports, and I consent for it to be used in that manner.

Signed Date

………………………………………………………………… ……./……/……

Name *(please print)*

……………………………………………………………………

# Appendix G: Participant Information Sheet – Survey

## Participant Information Sheet

**Purpose of the research**

You are invited to participate in the survey 'Living with water tanks: A survey of the water practices and experiences of non-mains water households in the Eurobodalla Shire'. This survey is part of a project conducted by Carrie Wilkinson, a PhD student at the School of Geography and Sustainable Communities, University of Wollongong NSW.

The aim of the project is to better understand the practices and experiences of individuals, households and communities who are self-sufficient for water in the Eurobodalla. I want to understand how households live with non-mains water sources such as rainwater, bore water, river water, trucked water, and/or private dam water, stored onsite in a tank (or tanks). By asking how people experience, perceive and use water when they are not connected to centralised town water supplies, the survey will help to identify different ways of managing water in times of scarcity and abundance than might otherwise have been considered.

**How can you help?**

If you choose to participate in this study, please complete the following confidential survey. The survey will ask questions about your household water consumption practices and technologies, as well as your experiences and perceptions of water from your water tanks. I estimate the survey will take about 30 minutes of your time.

**Key questions you may have**

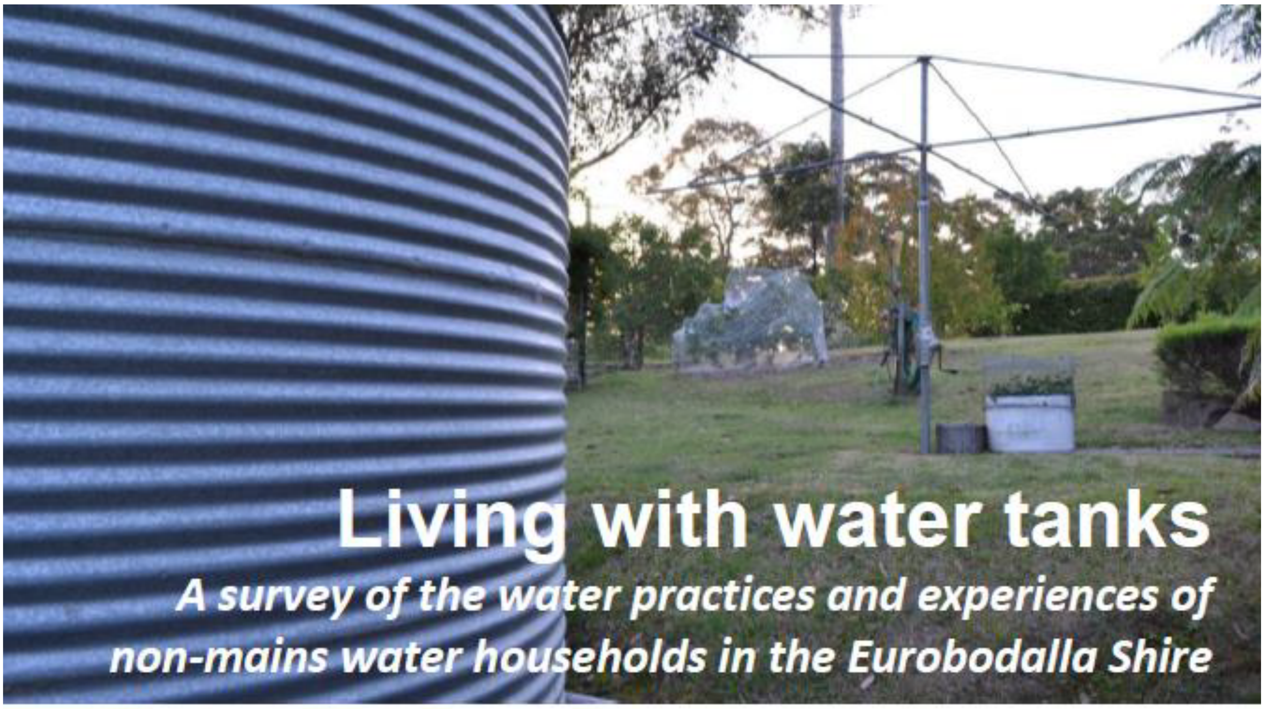
**1. Who will see my answers?**
Results from this survey will be used in a PhD thesis and in other academic publications and presentations. Findings may also be discussed in media interviews. Your answers will remain anonymous. By filling in and returning the survey you have consented to your data being used as described above. Because your answers will remain anonymous, once you submit the survey it will not be possible to withdraw your data at a later date.

**Who can I contact about this project?**
If you have any questions about completing this study you can contact Carrie Wilkinson. Email lifewithwatertanks@gmail.com or telephone .
If you have any concerns about how this research is being conducted please contact the Ethics Officer at the University of Wollongong. Email: rso-ethics@uow.edu.au or telephone (02) 4221 3386.

This research has been approved by The University of Wollongong Human Research Ethics Committee: Approval No. HE15/493.

1

## Appendix H: Pre-Survey Notification Letter




Australian Centre for Cultural Environmental Research | UNIVERSITY OF WOLLONGONG AUSTRALIA

A project of the School of Geography and Sustainable Communities 2016

Hello! My name is Carrie Wilkinson and I am a PhD student at the University of Wollongong. I am conducting a research project in the Eurobodalla Shire to explore how households perceive and manage water when they are not connected to centralised mains (town) water supplies. I am particularly interested in how people live with non-mains water sources at home, such as rainwater, bore water, river water, trucked water, and/or private dam water, stored onsite in tanks.

I am writing to you to ask for your help. **In the next few days you will receive a request to participate in this project by filling in a postal survey.** Questions will focus on your experiences living in a non-mains water household. I am writing in advance because many people like to know ahead of time that they will be invited to fill out a questionnaire. This research can only be successful with the generous help of people like you.

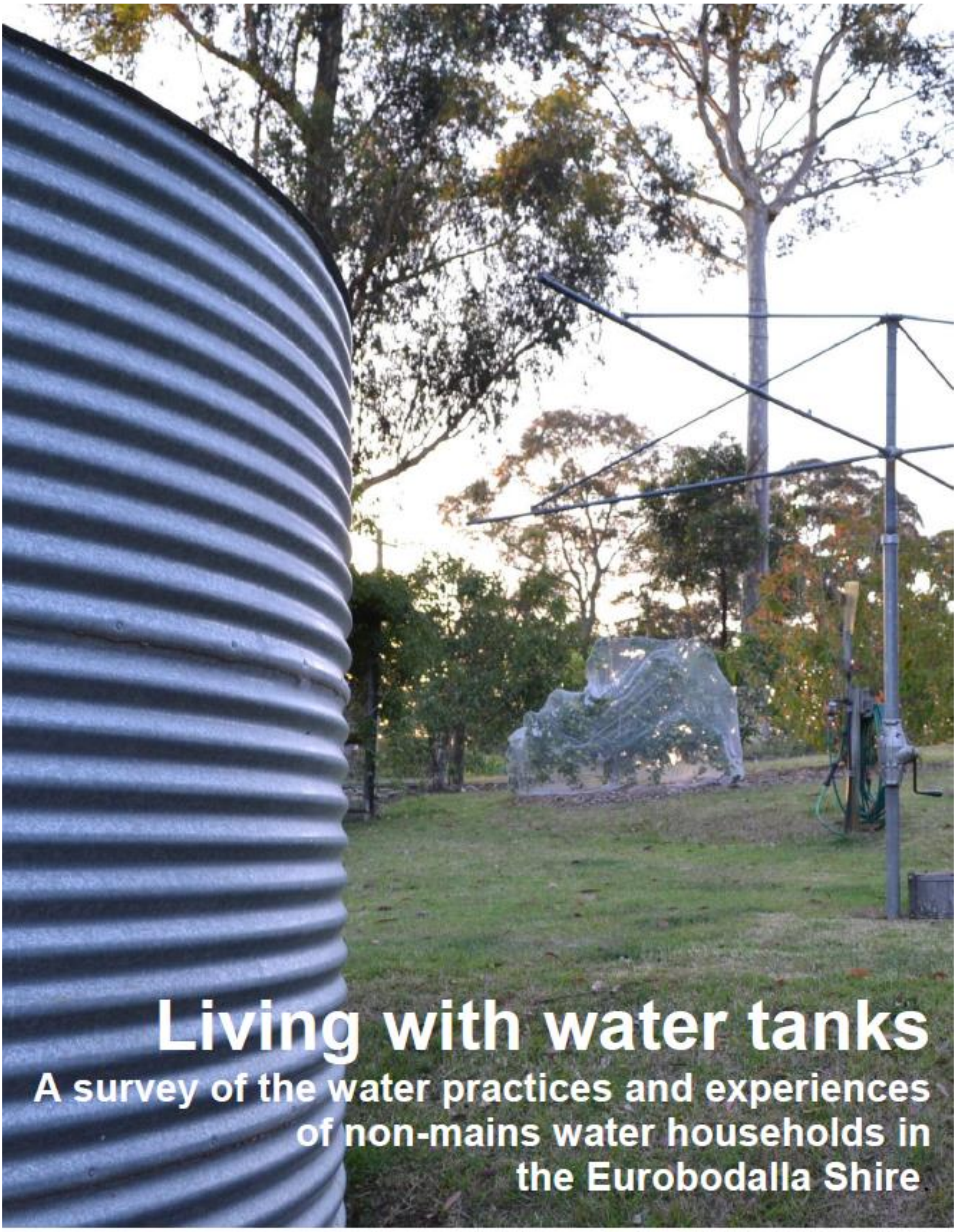
**To say thanks, as a small token of appreciation, the School of Geography and Sustainable Communities will donate $1 to your local bushfire brigade for every completed survey returned by 30 April 2016.**

I hope you will take the time to help me. Most of all, I hope that you enjoy the opportunity to voice your experiences and thoughts about your life with non-mains water and water tanks. If you have any questions about the research please do not hesitate to contact me by email lifewithwatertanks@gmail.com or telephone ( ).

Best wishes,
*Carrie Wilkinson*
School of Geography and Sustainable Communities
University of Wollongong

This research has been approved by The University of Wollongong Human Research Ethics Committee (No. HE15/493)

## Appendix I: Survey Questions




Australian Centre for Cultural Environmental Research

UNIVERSITY OF WOLLONGONG AUSTRALIA

A project of the School of Geography and Sustainable Communities 2016

# "Living with water tanks" Survey

Dear Sir/Madam,

**Participant Information Sheet**

This questionnaire is part of a project conducted by Carrie Wilkinson, a PhD student at the School of Geography and Sustainable Communities, University of Wollongong. The aim of the project is to better understand the practices and experiences of individuals, households and communities who are self-sufficient for water in the Eurobodalla. I want to understand how households live with non-mains water sources such as rainwater, bore water, river water, trucked water, and/or private dam water, stored onsite in a tank (or tanks). By asking how people experience, perceive and use water when they are not connected to centralised town water supplies, this survey will help to identify different ways of managing water in times of water scarcity and abundance than might otherwise have been considered.

***Please enjoy a cup of tea (see enclosed) while you take 30 minutes to complete the survey.***

**Key questions you may have**

1. **Who can complete the survey?**

- An adult who is familiar with the water usage practices and technologies of this household should complete the survey. We realise that your experiences and perceptions of water may differ to those of another adult in your household. If you would like another copy of the survey you can email Carrie or fill in the online survey at www.surveymonkey.com/r/watertanksurvey
- Please complete the survey and return it via the enclosed postage paid envelope as soon as possible, preferably by 30 April 2016.

***For every complete survey returned by 30 April 2016***
***$1 will be donated to your local bushfire brigade.***

2. **Who will see my answers?**

- Results from this survey will be used in a PhD thesis and in other academic publications and presentations. Findings may also be discussed in media interviews. Your answers will remain anonymous. By filling in and returning the survey you have consented to your data being used as described above. Because your answers will remain anonymous, once you submit the survey it will not be possible to withdraw your data at a later date.
- Please contact Carrie if you would like a summary of the study results.

3. **Who can I contact about this project?**

- If you have any questions about completing this study you can contact Carrie Wilkinson. Email lifewithwatertanks@gmail.com or Telephone
- If you have any concerns about how this research is being conducted please contact the Ethics Officer at the University of Wollongong. Email: rso-ethics@uow.edu.au or Telephone (02) 4221 3386 and quote Ethics Approval No. HE/15-493.

**Thank you so much for helping me with my research!**

**If you have further comments relating to any of the questions in this survey, please feel free to attach additional sheets.**

**Q1.** Are you currently connected to a mains (centralised/town) water supply system? (e.g. water is piped to this address by a water supply authority) *Tick ONE response.*

- ☐ Yes
- ☐ No

**Q2.** Have you or anyone else in your household previously filled in the online version of this survey www.surveymonkey.com/r/watertanksurvey. *Tick ONE response.*

- ☐ Yes
- ☐ No

## Current water sources

This section is concerned with the water sources your household currently accesses **at this address**, including how the water is used, stored and managed at home.

**Q3.** What water sources do you **currently use at this address** for the following purposes? *Tick ALL that apply.*

| | Rainwater | Bore | River | Private dam | Grey water | Other (please specify in the appropriate box below, e.g. 'bottled water' or 'trucked mains water') |
|---|---|---|---|---|---|---|
| Drinking | | | | | | |
| Bathing | | | | | | |
| Laundry | | | | | | |
| Toilet flushing | | | | | | |
| Watering edible plants | | | | | | |
| Watering non-edible plants | | | | | | |
| Feeding pets | | | | | | |
| Feeding livestock | | | | | | |
| Firefighting | | | | | | |
| Other (please specify): __________ __________ __________ | | | | | | |

**Q4.** How is water stored in water tanks at your property? *Please indicate how many water tanks you have at this address, their capacity, contents and materials from which they are made.*

| | Volume (please indicate "litres" or "gallons") | Contents (e.g. rainwater, bore water, trucked water, grey water) | What is the tank made of? (e.g. concrete, galvanised steel, plastic/polyethylene, fibreglass) |
|---|---|---|---|
| Tank 1 | | | |
| Tank 2 | | | |
| Tank 3 | | | |
| Tank 4 | | | |
| Tank 5 | | | |

**Q5.** If you have a rainwater tank(s), what is the total roof catchment area ($m^2$) it draws from? This may include a shed and/or house. If you do not know, please write 'Do not know'.

______________________________________________________________

______________________________________________________________

**Q6.** Does your household keep track of how much water is in your water tank(s)?
*Tick ONE response.*

☐ Yes
☐ No

**If yes,** please explain how your household keeps track of how much water is in your water tank(s): ______________________________________________

______________________________________________________________

______________________________________________________________

**Q7.** Does your household keep a **written record** of environmental conditions at this address?
*Tick ALL that apply.*

☐ Yes, we keep a record of rainfall
☐ Yes, we keep a record of temperature
☐ Yes, we keep a record of 'other' environmental conditions (please describe):
______________________________________________________________
☐ No, but we have kept written records of environmental conditions in the past at this address
☐ No, but we have kept written records of environmental conditions at another address
☐ No, we have never kept a written record of environmental conditions at any address

## Previous experience with water sources

This section focuses upon your **previous experience** with a range of water sources. Please consider the water sources you have used **previously** at this home, at a past home or at any other primary/secondary home address.

**Q8.** What water sources have you used **in the past** for the following purposes? *Tick ALL that apply.*

| | Rainwater | Bore | River | Private dam | Grey water | Mains water | Other (please specify below) |
|---|---|---|---|---|---|---|---|
| Drinking | | | | | | | |
| Bathing | | | | | | | |
| Laundry | | | | | | | |
| Toilet flushing | | | | | | | |
| Watering edible plants | | | | | | | |
| Watering non-edible plants | | | | | | | |
| Feeding pets | | | | | | | |
| Feeding livestock | | | | | | | |
| Firefighting | | | | | | | |
| Other (please specify): ____________ ____________ ____________ | | | | | | | |

## Water technologies and practices

In this section I want to build a picture of the connections between your water tank(s), water saving technologies and practices. The questions explore how your use of technologies and adoption of practices inside and outside the home may have changed over time.

**Q9.**What ***water saving technologies*** do you **currently use at this address**, and what water saving technologies have you **used in the past at this or any other primary/secondary home address?** *Tick ALL that apply IN EACH COLUMN.*

| Technologies CURRENTLY in use AT THIS ADDRESS | Technologies used IN THE PAST AT ANY ADDRESS |
|---|---|
| ☐ Dual flush toilets | ☐ Dual flush toilets |
| ☐ Water saving shower heads | ☐ Water saving shower heads |
| ☐ Timers to indicate shower duration | ☐ Timers to indicate shower duration |
| ☐ Front loading washing machines | ☐ Front loading washing machines |
| ☐ Drought tolerant plants | ☐ Drought tolerant plants |
| ☐ Grey water recycling system | ☐ Grey water recycling system |
| ☐ Drip irrigation | ☐ Drip irrigation |
| ☐ Other (please specify): ________________ | ☐ Other (please specify): ________________ |
| ________________ | ________________ |
| ________________ | ________________ |
| ________________ | ________________ |
| ________________ | ________________ |
| ☐ We do not use water saving technologies | ☐ We did not use water saving technologies |

**Q10.If your use of *water saving technologies* has changed over time,** please describe the circumstances leading to your decision to use or stop using these technologies:

________________________________________

________________________________________

________________________________________

**Q11.**What ***water saving practices*** do you **currently adopt**, and what water saving practices have you adopted **in the past at this or any other primary/secondary home address?** *Tick ALL that apply IN EACH COLUMN.*

| Practices CURRENTLY adopted AT THIS ADDRESS | Practices adopted IN THE PAST AT ANY ADDRESS |
|---|---|
| ☐ Reusing laundry, bathing or dishwashing water on the garden (buckets) | ☐ Reusing laundry, bathing or dishwashing water on the garden (buckets) |
| ☐ Not flushing the toilet with every use | ☐ Not flushing the toilet with every use |
| ☐ Running the dishwasher only when full (if you do not have a dishwasher circle 'NA' here) | ☐ Running the dishwasher only when full (if you do not have a dishwasher circle 'NA' here) |
| ☐ Handwashing dishes | ☐ Handwashing dishes |
| ☐ Running the washing machine when full | ☐ Running the washing machine when full |
| ☐ Other (please specify) ________________ | ☐ Other (please specify) ________________ |
| ________________ | ________________ |
| ________________ | ________________ |
| ________________ | ________________ |
| ☐ We do not adopt water saving practices | ☐ We did not adopt water saving practices |

**Q12. If your adoption of *water saving practices* has changed over time,** please describe the circumstances leading to your decision to adopt or to stop certain practices:

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

**Q13.** If your tank water is your drinking water, do you filter or purify this water before consumption? *Tick ONE response.*

- ☐ Yes
- ☐ No, we do not drink our tank water
- ☐ No, we do not filter or purify our tank water
- ☐ Unsure

**If yes,** please indicate how you filter or purify your tank water. *Tick ALL that apply*

- ☐ UV filter
- ☐ Carbon cartridge filter
- ☐ Boiling water
- ☐ Other (please specify): ____________________________________________

## Water security

**Q14.** How would you describe your current water consumption practices? *Tick ONE response.*

- ☐ Unrestricted
- ☐ Conservative
- ☐ Restricted
- ☐ Other (please describe): ____________________________________________

**Please describe what factors are influencing your current water consumption practices:** _____
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

**Q15.** Do you feel that your household has ample, adequate or insufficient water in reserve to maintain your current water consumption practices over the next 4 months? *Tick ONE response.*

- ☐ Ample
- ☐ Adequate
- ☐ Insufficient
- ☐ Don't know

**Please explain your response:** ____________________________________________
______________________________________________________________________________
______________________________________________________________________________

**Q16.** Has your household ever bought water from a water carrier to top up a tank (or tanks)? *Tick ALL that apply.*

- ☐ Yes, at this address
- ☐ Yes, at a previous address
- ☐ No, I have never had to purchase water to top up my water tank(s)

**If yes,** please describe the circumstances of water purchase:______________________________

**Q17.** For day-to-day household functions, how does the water from your tank(s) get to the taps **within** your home? (For example: electric pump, header tank, PVC pipes, copper pipes, unsure)

**What do you do if your regular method for getting water from your tanks into your home fails?** (e.g. the pump fails, there is a blackout) ______________________________

## Reflecting on life with water tanks

**Q18.** What does living in a household not connected to mains water mean to you? _______________

**Q19.** Describe three **challenging aspects** of living in a household not connected to mains water:

1. ______________________________
2. ______________________________
3. ______________________________

**Q20.** Describe three **positive aspects** of living in a household not connected to mains water:

1. ______________________________
2. ______________________________
3. ______________________________

**Q21.** Looking to the future, if you were to move, would you want to live in a house that draws on water from a non-mains source? *Tick ONE response.*

☐ Yes, even if it was the sole source of water
☐ Yes, but only if there was also a mains water connection
☐ No

**Please explain your response:** ______________________________

## Thinking about water scarcity, abundance and uncertainty

This section is concerned with better understanding the resilience and vulnerabilities of non-mains water households at times of water scarcity, abundance and uncertainty. This includes how households perceive and respond to natural hazards such as drought, bushfire, floods, and storms, which may influence water security.

**Q22.** What does ***water scarcity*** mean to you? ______________________________

______________________________________________________________

______________________________________________________________

**a.** What are **the three most important things** your household does when water is scarce?

1. ______________________________________________________
2. ______________________________________________________
3. ______________________________________________________

**Q23.** What does ***water abundance*** mean to you? ______________________________

______________________________________________________________

______________________________________________________________

**a.** What are **the three most important things** your household does when water is **abundant?**

1. ______________________________________________________
2. ______________________________________________________
3. ______________________________________________________

**Q24.** Do you think your previous experience of water scarcity and/or water abundance has changed how you value water? *Tick ONE response.*

☐ Yes

☐ No

**Please explain your response:** ______________________________________

______________________________________________________________

______________________________________________________________

**Q25.** Do you think a changing climate is impacting water availability at your property?

☐ Yes

☐ No

**If yes,** how so? ______________________________________________

______________________________________________________________

______________________________________________________________

**Q26.** Do you have previous experience of a natural hazard arising from an abundance or scarcity of water threatening your home (e.g. bushfire, flood, severe storm, drought)? *Tick ONE response.*

☐ Yes

☐ No (please skip to **Question 28**)

**If yes,** please *tick ALL THAT APPLY IN EACH COLUMN*

| As a resident at this address | As a resident at a previous address |
| --- | --- |
| ☐ Bushfire | ☐ Bushfire |
| ☐ Flood | ☐ Flood |
| ☐ Severe storm | ☐ Severe storm |
| ☐ Drought | ☐ Drought |
| ☐ Other, please specify: ____________ | ☐ Other, please specify: ____________ |

**Q27.** Do you think your previous experience of water scarcity or abundance from a natural hazard has changed your relationship with water? *Tick ONE response.*

☐ Yes

☐ No

**Please explain you response:** ______________________________________________

______________________________________________

______________________________________________

**Q28.** Thinking about being disconnected from the mains water grid, do you feel that your household is better equipped to cope with the impacts of natural hazards than other households in Australia that are connected to mains water?

☐ Yes

☐ No

**Please explain you response:** ______________________________________________

______________________________________________

______________________________________________

## Who are the people that live with water tanks?

In this final section, I'd like to ask some questions about you and your household. This information will help me to better understand survey respondents as a representation of the wider community, and what sorts of factors might influence water practices and the nature of the water tanks at your home.

**About you**

**Q29.** Gender: ☐ Male ☐ Female ☐ Prefer not to say

**Q30.** What is your age? *Circle ONE response.*

18-29 30-39 40-49 50-59 60-69 70-79 80-89 90+

**Q31.** Which of the following best describes you? *Tick ONE response.*

☐ Australian-born (non-Indigenous) ☐ Overseas-born (English-speaking background)

☐ Indigenous-Australian ☐ Overseas-born (Non-English-speaking background)

**Q32.** Which of the following best describes your current employment status? *Tick ALL that apply.*

☐ Employed full time ☐ Unemployed ☐ Home duties

☐ Employed part time ☐ Full time student ☐ Retired/pensioner

☐ Self employed ☐ Part time student

**About your household**

**Q33.** In addition to you, who usually resides at this address?

| Gender | Age | Employment status | Relationship to you (e.g. wife, partner, son, father, mother-in-law, flatmate) |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

If more than six people live here please attach another sheet.

**Q34.** Including ALL members of your household, what is your TOTAL household weekly income before tax? *Tick ONE response.*

| | |
|---|---|
| ☐ Prefer not to say | ☐ \$800 - \$999 per week (\$41,600 - \$51,999 per year) |
| ☐ \$1 - \$199 per week (\$1 - \$10,399 per year) | ☐ \$1,000 - \$1,249 per week (\$52,000 - \$64,999 per year) |
| ☐ \$200 - \$299 per week (\$10,400 - \$15,599 per year) | ☐ \$1,250 - \$1,499 per week (\$65,000 - \$77,999 per year) |
| ☐ \$300- \$399 per week (\$15,600 - \$20,799 per year) | ☐ \$1,500 - \$1,999 per week (\$78,000 - \$103,000 per year) |
| ☐ \$400 - \$599 per week (\$20,800 - \$31,199 per year) | ☐ \$2,000 or more per week (\$104,000 + per year) |
| ☐ \$600 - \$799 per week (\$31,200 - \$41,599 per year) | |

**Q35.** Do members of your household ever discuss household water use? *Tick ONE response.*

☐ Yes
☐ No

**If yes,** please provide an example of a discussion your household has had about water use:

______________________________________________________________
______________________________________________________________
______________________________________________________________

**About your property**

**Q36.** Where is your property located? [redacted] ____________________

**Q37.** What is the approximate size of your property? ________ ☐ Hectares ☐ Acres

**Q38.** Do you own, rent or manage this property? ______________________________

**Q39.** Do you have insurance that covers loss from e.g. bushfire or flood? *Tick ALL that apply.*

☐ Yes, home and contents
☐ Yes, property including water tanks, equipment, fences etc.
☐ No

**Q40.** Which of the following best describes your dwelling? *Please tick ONE response.*

☐ Detached house
☐ Townhouse
☐ Unit/apartment
☐ Acreage (hobby/lifestyle)
☐ Acreage (commercial farm)
☐ Other (please specify): ______________________________

**Q41.** Is this address your primary residence or secondary residence? *Please tick ONE response.*

☐ This is my PRIMARY residence **(go to Question 42)**
☐ This is my SECONDARY residence **(go to Question 43)**

**Q42. If this residence is your PRIMARY address:**

**i.** How long have you lived at this address? ____________________

**ii.** Before moving to this address did you live in a household connected to mains water? *Tick ONE response.*

☐ Yes

☐ No

☐ I have always lived at this address

**Please go to Question 44.**

**Q43. If this residence is your SECONDARY address:**

**i.** What is the postcode of your primary address? ______________

**iii.** Is your primary address connected to mains water? *Tick ONE response.*

☐ Yes

☐ No

**ii.** Approximately how many weeks of the year do you live at this secondary residence? _____

**Q44.** Please rate the importance of each of these qualities when you purchased and/or moved to this address. *Please tick ONE box for EVERY statement listed.*

| | Very important | Important | Somewhat important | Not at all important |
|---|---|---|---|---|
| Affordability of housing/cost of living | | | | |
| To operate a commercial farm | | | | |
| To operate a hobby farm | | | | |
| To operate a tourism/rental property | | | | |
| For work other than the above | | | | |
| To be near family/friends | | | | |
| Lifestyle/amenity value (“sea change” or “tree change”) | | | | |
| Opportunity to use water without council restriction | | | | |
| Good environment to bring up a family | | | | |
| Investment property | | | | |

**Q45.** Do you have any other comments you would like to add about your life with water tanks and tank water?

______________________________________________

______________________________________________

______________________________________________

______________________________________________

______________________________________________

______________________________________________

______________________________________________

______________________________________________

______________________________________ Please turn over page →

# Thank you for completing this survey!

**This research will help us to better understand how a diverse range of households use and experience water. Speaking with a subset of survey respondents will enhance our understanding of how non-mains water households experience, perceive and use water. If you are willing to participate in a follow-up conversation please tick the box and write your contact details in the space below. We'll remove your contact details from your survey booklet so your answers remain anonymous. Alternately you can contact Carrie directly by email or phone.**

Name: ______________________________

Address: ______________________________

______________________________

Telephone: ______________________________

Email: ______________________________

☐ I am willing to be contacted regarding a possible follow-up conversation

Carrie Wilkinson
PhD Student
School of Geography and Sustainable Communities
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Email: lifewithwatertanks@gmail.com
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Australian Centre for Cultural Environmental Research

UNIVERSITY OF WOLLONGONG AUSTRALIA

A project of the School of Geography and Sustainable Communities 2016

# Appendix J: Semi-structured Interview Schedule

**Semi-structured Interview**

| | **Theme** (*Aim*) | **Prompts** |
|---|---|---|
| | **Water History**<br>*Determine participant's life with water, water tanks and tank water. Identify centrality of water tanks to identity/lifestyle.* | → What has been your experience with the following types of water: mains water, private dam water, river water, rainwater, bore water, grey water etc.<br>→ How long have you lived with tank water? Have you always lived with tank water?<br>→ Have you always lived without mains water? How long have you lived without mains water? |
| Drawing Exercise | **What is a "water tank"?**<br>*Explore the meanings attached to water tanks* | → What is a water tank?<br>→ What does a water tank do?<br>→ What does your water tank/tank water mean to you?<br>→ Could you please tell me about what you have drawn? |
| Mapping Exercise | **Water at home**<br>*Identify range and location of water sources on the property.* | We are interested in the flows of water into, around and out of your water tank(s).<br>→ Could you please map the location of your water tank(s), the sources of water for your tanks, and the places where you use your tank water?<br>→ Could you please tell me about the places you have drawn/highlighted?<br>→ How many water tanks do you have on the property? What is the capacity of the water tank(s)? What are the contents? Where is this water captured/sourced from? What are the water tank(s) made of?<br>→ How would you describe the water in your water tank? What qualities characterise your tank water?<br>→ Why do you live with tank water? Why do you not live with mains water?<br>→ How did you acquire your water tank(s)? |
| | **Water practices**<br>*A focus on practices has the potential to reveal how, and why, individuals value and use certain water sources and infrastructures.* | → How would you describe your current water consumption practices?<br>→ What practices utilise water? What times utilise water? Where is this water from? Where does this water go?<br>→ How do you dispose of water from the home? Do you have a functioning grey water system?<br>→ How does your household make decisions about what water practices or water saving features are adopted?<br>→ Do members of your household ever disagree about household water use? |
| | **Water tank maintenance**<br>*Explore the interplay of technology with water behaviour and cultural meanings* | → Do you have any water saving technologies installed? (e.g. flow restricting shower heads, shower times, sprinkler timers)<br>→ How does water get from your tank to the tap? Do you use an electric pump?<br>→ What do you do if something goes wrong with your water tank/pump/gutters/pipes etc.?<br>→ Are there any features of the house that impact on the functionality of the tank? e.g. roof size (catchment area), tank size, property size, wood heaters etc.<br>→ When/do you or another member of your household ever inspect your tank or tank water? Do you perform maintenance of your water tank? How do you maintain your water tank?<br>→ Who is responsible for maintaining your tank water? What does this involve? |

| | | |
|---|---|---|
| | | → Who is responsible for maintaining infrastructure of water capture, storage and (re)distribution? What does this involve? (e.g. cleaning gutters, fixing pipes)<br>→ How confident are you in managing/maintaining your water tank?<br>→ How do you/do you know how much water is in your tank(s)?<br>→ What do you do when the water tank(s) is empty/nearly empty?<br>→ Do you/have you ever supplemented your tank water with water from another source? E.g. trucked water, dam water<br>→ Have you ever had to buy water to top up your tank(s)? |
| Ethnography – discussing the participant's records | **Knowing water at home**<br>*Examine how water is known at home through the maintenance of records of rainfall, temperature, dam levels, water tank levels etc.* | → Could you please tell me about the record you have brought with you today? How do you use it? How do you maintain it?<br>→ How long have you been keeping this record? What prompted you to start keeping this record?<br>→ Is this the only record you keep? Do you also keep a record of temperature, stream flow, dam levels etc.? Could you please describe to me what (other) records of environmental conditions you keep at this property?<br>→ Is there anything you enjoy about keeping this record?<br>→ Is there anything you dislike about keeping this record?<br>→ What technologies/how do you know the temperature, rainfall, dam levels, water tank levels, stream flow etc.?<br>→ How disciplined are you in maintaining this record?<br>→ Do you share this record with others? Why/why not? How do you share it?<br>→ Do you reflect back on previous entries in this record? |
| | **Living with water abundance and scarcity**<br>*Establishing the participant's previous experience with (and perceptions of) times of drought and flood/storm.* | → What does water abundance meant to you?<br>→ What does water scarcity mean to you?<br>→ Tell me about a time when this household experienced water scarcity/water abundance? How did this impact on your water/water tank practices, and your relationship with your water tank/tank water? Do you use water differently at times of scarcity and abundance?<br>→ Thinking about your previous experiences with different water sources and times of water scarcity and abundance, do your experiences differ to other members of your household? |
| | **Reflecting on life with water tanks and tank water**<br>*What do people learn about themselves and water by living with water tanks?* | → What does living in a household not connected to mains water mean to you?<br>→ What has life with a water tank taught you about yourself?<br>→ What has life with a water tank taught you about water?<br>→ What are the most challenging/positive aspects of living in a household not connected to mains water?<br>→ Do you think your household is more at risk from the impacts of natural hazards than other households in Australia that are connected to mains water? |
| | **Conversation wrap-up** | → Would you install or live in a house with tank water again?<br>→ We have spoken about your experiences, practices and memories of life with water tanks and tank water. Is there anything you would like to add? |

**Home-insight**

| | **Theme** *(Aim)* | **Prompts** |
|---|---|---|
| Property tour | **Embodied water talk**<br>*Learn more about the situated, in-place experiences and practices of life with water tanks and tank water.* | Tour the property to see water tanks, water sources, and key sites of water consumption/conservation<br>→ How would you describe the look of your water tank?<br>→ Have you done anything to make the tank "blend in" or "stand out" from the landscape?<br>→ What dictated the location of the tank? Was it a matter of functionality or aesthetics?<br>→ What dictated the materiality of the tank? Was it a matter of functionality or aesthetics?<br>→ How would you describe the smell, taste, texture, hardness of your tank water? Do you filter/purify your water? |

# Appendix K: Selected Results of the Survey

This appendix presents key findings from 209 surveys completed via post and online by households that are off-grid for water in the Eurobodalla Shire.

### Age

**Q29:** What is your age? Circle one response.

| **Response** | **n** | **%** |
|---|---|---|
| 18–29 years | 3 | 1.44 |
| 30–39 years | 2 | 0.96 |
| 40–49 years | 16 | 7.66 |
| 50–59 years | 55 | 26.32 |
| 60–69 years | 81 | 38.76 |
| 70–79 years | 41 | 19.62 |
| 80–89 years | 10 | 4.78 |
| 90 + years | 1 | 0.48 |
| Did not respond | 0 | 0.00 |
| **Total (n)** | **209** | |

### Ethnicity

**Q31:** Which of the following best describes you? Tick one response.

| **Response** | **n** | **%** |
|---|---|---|
| Australian born (non-Indigenous) | 169 | 80.86 |
| Indigenous-Australian | 1 | 0.48 |
| Overseas-born (English-speaking background) | 30 | 14.35 |
| Over-seas born (Non-English-speaking background) | 8 | 3.83 |
| Did not respond | 1 | 0.48 |
| **Total (n)** | **209** | |

**Employment status**

**Q32:** Which of the following best describes your current employment status? Tick all that apply.

| Response | n | % |
|---|---|---|
| Retired/pensioner | 120 | 57.42 |
| Employed full-time | 38 | 18.18 |
| Self-employed | 34 | 16.27 |
| Employed part-time | 21 | 10.05 |
| Home duties | 6 | 2.87 |
| Part time student | 3 | 1.44 |
| Full time student | 2 | 0.96 |
| Unemployed | 1 | 0.48 |
| Did not respond | 0 | 0.00 |
| **Total (n)** | **209** | |

**Household composition**

**Q33:** Who usually resides at this address?

| Response | n | % |
|---|---|---|
| Single person | 34 | 16.26 |
| 2 people | 132 | 63.15 |
| 3 people | 15 | 7.17 |
| 4 people | 21 | 10.04 |
| 5 people | 6 | 2.87 |
| 6 people | 1 | 0.47 |
| Did not respond | 0 | 0.00 |
| **Total (n)** | **209** | |

## Gender

**Q29:** Gender

| Response | n | % |
|---|---|---|
| Male | 115 | 55.02 |
| Female | 94 | 44.98 |
| Prefer not to say | 0 | 0.00 |
| Did not respond | 0 | 0.00 |
| **Total (n)** | **209** | |

## Dwelling type

**Q40:** Which of the following best describes your dwelling? Please tick one response.

| Response | n | % |
|---|---|---|
| Detached house | 155 | 74.16 |
| Townhouse | 0 | 0.00 |
| Unit/apartment | 0 | 0.00 |
| Acreage (hobby/lifestyle) | 43 | 20.57 |
| Acreage (commercial farm) | 3 | 1.43 |
| Other | 5 | 2.39 |
| Did not respond | 3 | 1.43 |
| **Total (n)** | **209** | |

## Home ownership

**Q38:** Do you own, rent or manage this property?

| Response | n | % |
|---|---|---|
| Own | 194 | 92.82 |
| Rent | 9 | 4.31 |
| Manage | 2 | 0.96 |
| Did not respond | 4 | 1.91 |
| **Total (n)** | **209** | |

**Primary or secondary address**

**Q41:** Is this address your primary residence or secondary residence? Tick one response.

| Response | n | % |
|---|---|---|
| Primary | 157 | 75.12 |
| Secondary | 52 | 24.88 |
| Did not respond | 0 | 0.00 |
| **Total (n)** | **209** | |

**Q42:** If this residence is your primary address:

**(i)** How long have you lived at this address?

| Response | n | % |
|---|---|---|
| 12 months or less | 10 | 6.37 |
| More than 1 year to 5 years | 24 | 15.29 |
| More than 5 years to 10 years | 29 | 18.47 |
| More than 10 years to 15 years | 28 | 17.83 |
| More than 15 years to 20 years | 22 | 14.01 |
| More than 20 years | 41 | 26.11 |
| Did not respond | 3 | 1.91 |
| **Total (n)** | **157** | |

**(ii)** Before moving to this address did you live in a household connected to mains water?

| Response | n | % |
|---|---|---|
| Yes | 112 | 71.34 |
| No | 41 | 26.11 |
| I have always lived at this address | 0 | 0.00 |
| Did not respond | 4 | 2.55 |
| **Total (n)** | **157** | |

**Q43:** If this residence is your secondary address:

**(i)** Where is your primary address?

| **Response** | **n** | **%** |
|---|---|---|
| Canberra area | 32 | 61.53 |
| Greater Sydney area | 9 | 17.3 |
| Melbourne area | 2 | 3.84 |
| Regional NSW | 6 | 11.53 |
| Other | 3 | 5.76 |
| Did not respond | 0 | 0.00 |
| **Total (n)** | **52** | |

**(ii)** Is your primary address connected to mains water?

| **Response** | **n** | **%** |
|---|---|---|
| Yes | 46 | 88.46 |
| No | 6 | 11.54 |
| Did not respond | 0 | 0.00 |
| **Total (n)** | **52** | |

**(iii)** Approximately how many weeks of the year do you live at this secondary residence?

| **Response** | **n** | **%** |
|---|---|---|
| Up to 1 month | 8 | 15.38 |
| 1 – 2 months | 15 | 28.85 |
| 2 – 3 months | 9 | 17.31 |
| 3 – 4 months | 6 | 11.54 |
| 4 – 5 months | 6 | 11.54 |
| 5 – 6 months | 1 | 1.92 |
| More than 6 months | 1 | 1.92 |
| Did not respond | 6 | 11.54 |
| **Total (n)** | **52** | |

**Importance of factors for purchasing and/or moving to the surveyed address**

**Q44:** Please rate the importance of each of these qualities when you purchased and/or moved to this address. Please tick one box for every statement listed

| **Responses** | **Very important** | **Important** | **Somewhat important** | **Not at all important** | **Total respondents (n)** |
|---|---|---|---|---|---|
| Affordability of housing / cost of living | **42.23% (80)** | 26.98% (51) | 13.76% (26) | 17.46% (33) | 189 |
| To be near family/friends | 15.38% (24) | 15.38% (24) | 11.54% (18) | **57.69% (90)** | 156 |
| Lifestyle/amenity value ("sea change" or "tree change") | **68.11% (126)** | 21.08% (39) | 4.86% (9) | 5.95% (11) | 185 |
| Opportunity to use water without council restriction | 12.28% (21) | 14.04% (24) | 13.45% (23) | **60.23% (103)** | 171 |
| Good environment to bring up a family | **35.43% (62)** | 23.43% (41) | 10.29% (18) | 30.86% (54) | 175 |

Figures in brackets are numbers of responses; figures in bold indicate the largest response group for each factor.

**Living with water tanks in future**

**Q21:** Looking to the future, if you were to move, would you want to live in a house that draws on water from a non-mains source?

| **Response** | **n** | **%** |
|---|---|---|
| Yes, even if it was the sole source of water | 158 | 75.60 |
| Yes, but only if there was also a mains water connection | 28 | 13.40 |
| No | 13 | 6.22 |
| Did not respond | 10 | 4.78 |
| **Total (n)** | **209** | |

**Sources of water by practice.**

**Q3:** What water sources do you currently use at this address for the following purposes? Tick all that apply.

| Responses | Rainwater | Bore water | River water | Private Dam | Grey (recycled) water | Other | Total respondents (n) |
|---|---|---|---|---|---|---|---|
| Drinking | 96.65% (202) | 0.95% (2) | 0.00% (0) | 0.00% (0) | 0.00% (0) | 6.22% (13) | 209 |
| Bathing | 99.52% (208) | 3.83% (8) | 0.48% (1) | 0.00% (0) | 0.00% (0) | 0.48% (1) | 209 |
| Laundry | 98.06% (202) | 3.4% (7) | 0.00% (0) | 0.49% (1) | 0.00% (0) | 0.49% (1) | 206 |
| Toilet flushing | 97.09% (200) | 3.88% (8) | 0.49% (1) | 0.97% (2) | 1.94% (4) | 0.49% (1) | 206 |
| Watering edible plants | 74.60% (141) | 16.40% (31) | 1.06% (2) | 16.40% (31) | 4.23% (8) | 1.06% (2) | 189 |
| Watering non-edible plants | 67.69% (132) | 18.97% (37) | 1.03% (2) | 16.41% (32) | 22.56% (44) | 0.51% (1) | 195 |

Figures in brackets are numbers of responses.

In analysing responses to an open-ended question that asked participants to describe their use of 'other' water sources for drinking water (n = 13), thirteen (13) households noted that they drank bottled water, with seven (7) drinking bottled water exclusively. Of the households that drank bottled water, four (4) were primary residences and nine (9) secondary.

**Tank water treatment practices by occupancy type**

**Q13:** If your tank water is your drinking water, do you filter or purify this water before consumption? Tick one response.

| Responses | Total | Residence is primary | Residence is secondary |
|---|---|---|---|
| Yes | 38.28% (80) | 38.85% (61) | 36.54% (19) |
| No, we do not filter or purify our tank water | 56.46% (118) | 58.60% (92) | 50.00% (26) |
| No, we do not drink our tank water | 4.31% (9) | 1.27% (2) | 13.46% (7) |
| Did not respond | 0.95% (2) | 1.27% 2 | 0% (0) |
| **Total (n)** | 209 | 157 | 52 |

Figures in brackets are numbers of responses.

**Q13a:** If yes, please indicate how you filter or purify your tank water. Tick all that apply.

| Response | Frequency |
|---|---|
| UV filter | 3 (3.75%) |
| Carbon cartridge filter | 55 (68.75%) |
| Boiling water | 24 (30%) |
| Other (please specify) | 25 (31.25%) |
| **Total (n)** | **80** |

Respondents could choose multiple methods. Of those who provided a response to 'other', 11 of these used methods other than those described above e.g. limestone filter, ceramic filter, external micron filters between pump and house.

**Water storage**

**Q4:** How is water stored in water tanks on your property? Please indicate how many water tanks you have at this address and their capacity, contents and materials from which they are made. *E.g. 'Tank 1 – 12,000L, rainwater, galvanised steel', 'Tank 2 – 15,000L, rainwater, concrete' etc. 209 households provided detail on the number of rainwater tanks the household had.*

| **Response** | **n** | **%** |
|---|---|---|
| One rainwater tank | 41 | 19.61 |
| Two rainwater tanks | 86 | 41.14 |
| Three rainwater tanks | 47 | 22.48 |
| Four rainwater tanks | 18 | 8.61 |
| Five rainwater tanks | 12 | 5.74 |
| Six rainwater tanks | 5 | 2.39 |
| **Total (n)** | **209** | |

**Water saving practices**

**Q11:** What water saving practices do you currently adopt, and what water saving practices have you adopted in the past at this or any other primary/secondary home address? Tick all that apply.

| **Response** | **Adopt practice presently (n = 209 respondents)** | **Adopted practice in the past (n = 189 respondents)** |
|---|---|---|
| Reusing laundry, bathing or dishwashing water on the garden (buckets) | 48.80% (102) | 58.20% (110) |
| Not flushing the toilet with every use | 67.46% (141) | 52.91% (100) |
| Running the dishwasher only when full | 47.85% (100) | 51.85% (98) |
| Handwashing dishes | 70.33% (147) | 61.38% (116) |
| Running the washing machine when full | 76.08% (159)[a] | 67.20% (127)[b] |
| We do not adopt water saving practices | 3.83% (8) | 12.70% (24) |
| Other* | 25.35% (53) | 25.93% (49) |

Figures in brackets are numbers of responses

a Of those who indicated that they currently hand-washed dishes, 51 households (24.40%) did so as they did not have a dishwasher machine

b Of those who indicated that they hand-washed dishes in the past, 5 households (2.65%) did so as they did not have a dishwasher machine

*Mostly repetition of prescribed categories

**Measuring and monitoring tank water**

**Q6:** Does your household keep track of how much water is in your water tank(s)?

| Response | n | % |
|---|---|---|
| Yes | 170 | 81.34 |
| No | 39 | 18.66 |
| Did not respond | 0 | 0 |
| **Total** | **209** | |

**Q6a.** If yes, please explain how your household keeps track of how much water is in your water tank(s). *(Open-Ended Response)*

| Theme | n | % of respondents | Examples |
|---|---|---|---|
| Dipsticks | 16 | 9.41 | *Open the lid and measure with a very long stick.*<br>*"Dip stick" which shows us relative use compared to what a full tank would hold.* |
| Looking in | 66 | 38.82 | *By occasionally climbing a ladder and taking the lid off and looking inside.*<br>*By looking in tank and guestimating how much water there is* |
| Knocking/Tapping (broadly) | 56 | 32.94 | *A thump on the side usually does the trick.*<br>*Knock on side to determine level, count ribs down and estimate percentage full and empty.* |
| Knocking - Sound/Echo | 10 | 5.88 | *Occasionally tap on the side to 'hear' water level.*<br>*Tank 2 and 3 - hit the sides and listen - you can tell from sound where top of water level is.* |
| Knocking - Thermoreception | 6 | 3.53 | *When sun is on the tank, start at top, run hand down until there is a change in temperature on side of tank.*<br>*Feel the water level on the side of the tanks.* |
| Floaty/External Gauge | 21 | 12.35 | *Empty bottle and fishing line and weight. Inverse measurement of inside tank.*<br>*Visual level gauges on collection tanks, wireless level data transmitted for storage tanks.* |
| Rainfall/Rain gauge | 8 | 4.71 | *Experience. I acknowledge rainfall compared to use and intrinsically know.*<br>*Excel spreadsheet used to calculate run-off from roof.* |
| Other | 6 | 3.53 | *Occasional external measurement with electronic wooden stud finder.*<br>*Sight glass on main house tank.* |
| Unclear | 14 | 8.23 | *Checking the water level.* |

**Positive aspects of water self-sufficiency**

**Q20:** Describe three positive aspects of living in a household not connected to mains water. *(Open-Ended Response)*

| Theme | n | % of respondents (n = 202) | Examples |
|---|---|---|---|
| **Water quality** | 154 | 76.23 | *Pure unadulterated water.*<br>*Water tastes better, doesn't taste like chlorine.* |
| **Cost** | 122 | 60.39 | *No water rates/bills.*<br>*Free water.*<br>*Cheaper.* |
| **Independence and control** | 80 | 39.60 | *No external restrictions on use.*<br>*No one is 'third party' to our water.*<br>*Satisfaction harvesting own water.* |
| **Sense of awareness and connectedness** | 41 | 20.29 | *Ability to 'recycle' nature.*<br>*More aware of our surrounds.*<br>*You get excited when it rains.* |
| **Perception that self-sufficiency is better for the environment** | 15 | 7.42 | *No digging up for pipes.*<br>*Environmentally friendly.*<br>*Lower environmental impact.* |
| **Other** | 15 | 7.42 | *The town cannot grow too much more.*<br>*Enables living in a remote location we like.*<br>*Water is available to fight fires (mains supply can fail).* |

Note: 202 people identified at least 1 positive aspect of water self-sufficiency (41 provided 1 response, 33 provided 2 responses, and 128 provided 3 responses). In sum, respondents provided 491 responses to the question. Where respondents described the same theme in more than one response, they are counted once, e.g. where a respondent identified positive aspects of water self-sufficiency as "You don't have huge water bills" and "Don't pay water rates" both are illustrative of "cost".

**Challenging aspects of water self-sufficiency**

**Q19:** Describe three challenging aspects of living in a household not connected to mains water. *(Open-Ended Response)*

| Theme | n | % of respondents (n = 195) | Examples |
|---|---|---|---|
| **Water quantity** | 80 | 41.02 | *Possibility of running out and having to buy water.*<br>*Worry about prolonged dry weather.*<br>*Need to monitor collection and usage.* |
| **Infrastructure maintenance** | 69 | 35.38 | *Clean gutters and check mesh filters on tank.*<br>*Pump maintenance.*<br>*Transferring water from one tank to another.* |
| **Infrastructure failure** | 63 | 32.31 | *Having backup system when power fails.*<br>*When the pump isn't working there's no water.*<br>*Repair, very rarely, split or damaged pipes.* |
| **Practicing restriction and conservation** | 60 | 30.77 | *Water conserving requires more physical effort.*<br>*Not having baths very often.*<br>*No car/boat washing. Limited laundry use.* |
| **Managing water quality** | 48 | 24.61 | *Have to disconnect when some trees flower as water becomes tainted.*<br>*Making sure water quality is not compromised.*<br>*Boiling drinking water.* |
| **Maintaining gardens and lawns** | 27 | 13.85 | *Keeping garden alive in a heatwave.*<br>*Not able to have a vegetable garden.*<br>*Not able always to have green lawns.* |
| **No challenge** | 17 | 8.72 | *No challenge, just be water wise.*<br>*None unless we have an extended blackout.*<br>*Used to it. Not an issue.* |
| **Cost** | 13 | 6.67 | *Cost of tank and pump installation.*<br>*More electricity used for the water and sewage pumps.*<br>*Costly to buy [water] if you run out.* |
| **Provision of water for bushfire suppression** | 13 | 6.67 | *When power fails in bushfire, system does not offer good access.*<br>*If there was a fire and also a blackout.* |
| **Managing waste water** | 9 | 4.61 | *Relying on septic pump out for water disposal.*<br>*Septic care and septic trench problems.* |
| **Other** | 16 | 8.20 | *Less water pressure.*<br>*Noise of pump.*<br>*Having to work out how to get rainwater tanks through development approval.* |

Note: 195 people identified at least 1 challenging aspect of water self-sufficiency. (51 provided 1 response, 31 provided 2 responses, and 113 provided 3 responses). Respondents provided 452 responses to the question in total. Where participants described the same theme in more than one response, they are counted once, e.g. Where a respondent identified challenging aspects of water self-sufficiency as “Keep gutters clean” and “Keep litter screens clean” both are illustrative of “Infrastructure maintenance”.

# Appendix L: Interview Participant List

Overview of interviewees, including household composition, house type, connection to the energy grid and type of septic tank.

| Interviewee(s) | Age | Household composition | Property type | Primary or secondary residence | Length of residence | Rent or Own | Connection to energy grid | Septic System Type | Completed survey | Interview date | Recruitment |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ailsa** | 70-79 | 1 adult | Acreage (commercial farm) | Primary | 20+ years | Own | Off-grid | Absorption | No | 3 March 2016 | ABC Local Radio |
| **Alice** | 70-79 | 2 adults | Detached house in residential area | Secondary | 18 months | Own | Grid-connected | Pump-out | Yes | 7 August 2016 | Survey |
| **Alison**<br>**Jane** | 60-69<br>60-69 | Varies (intergenerational holiday home) | Detached house in residential area | Secondary | 20+ years | Own | Grid-connected | Pump-out | Yes | 14 April 2016 | Survey |
| **Alison**<br>**Ed** | 60-69<br>60-69 | 2 adults | Detached house in residential area | Secondary | 20+ years | Own | Grid-connected | Pump-out | Yes | 10 May 2016 | Survey |
| **Barb**<br>**Mark** | 50-59<br>50-59 | 2 adults | Acreage (hobby/lifestyle) | Primary | 20+ years | Own | Grid-connected | Absorption | Yes | 9 May 2016 | Snowball |
| **Carolyn** | 40-49 | 2 adults<br>2 teenagers | Detached house in residential area | Primary | 12 years | Own | Grid-connected, solar hot water | Absorption | No | 9 May 2016 | Snowball |
| **Col**<br>**Bron** | 70-79<br>70-79 | 2 adults | Acreage (hobby/lifestyle) | Primary | 20+ years | Own | Grid-connected solar system | Absorption | Yes | 21 March 2016 | Survey |

| Interviewee(s) | Age | Household composition | Property type | Primary or secondary residence | Length of residence | Rent or Own | Connection to energy grid | Septic System Type | Completed survey | Interview date | Recruitment |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Daniel** | 40-49 | 1 adult<br>1 tenant | Detached house in residential area | Primary | 11 years | Own | Grid-connected | Pump-out | Yes | 17 April 2016 | Survey |
| **Dave**<br>**Kim** | 40-49<br>40-49 | 2 adults<br>Various visitors (guest house) | Acreage (other: accommodation) | Primary | 18 months | Own | Grid-connected solar system | Bio-Cycle | No | 22 March 2016 | ABC Local Radio |
| **David R** | 60-69 | 1 adult | Detached house in residential area | Primary | 18 months | Own | Grid-connected solar system | Bio-Cycle | Yes | 25 March 2016 | Survey |
| **David Z** | 40-49 | 2 adults<br>2 children | Acreage (commercial farm) | Primary | 10 years | Own | Grid-connected solar system | Absorption | Yes | 9 May 2016 | Survey |
| **Don**<br>**Liz** | 70-79<br>70-79 | 2 adults | Acreage (hobby/lifestyle) | Primary | 3 years | Own | Grid-connected solar system | Absorption | No | 23 March 2016 | ABC Local Radio |
| **Fergus**<br>**Tricia** | 60-69<br>60-69 | 2 adults | Acreage (hobby/lifestyle) | Primary | 38 years | Own | Off-grid | Absorption | No | 22 March 2016 | ABC Local Radio |
| **Frank**<br>**Jan** | 80-89<br>80-89 | Varies (intergenerational holiday home) | Detached house in residential area | Secondary | 12 years | Own | Grid-connected | Pump-out | No | 12 March 2016 | Survey |
| **Fraser** | 40-49 | 2 adults<br>2 children | Acreage (commercial farm) | Primary | 10 years | Own | Off-grid | Absorption | No | 12 May 2016 | Snowball |

| Interviewee(s) | Age | Household composition | Property type | Primary or secondary residence | Length of residence | Rent or Own | Connection to energy grid | Septic System Type | Completed survey | Interview date | Recruitment |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Glenn**<br>**Betsy** | 50-59<br>50-59 | 4 adults | Detached house in residential area | Secondary | 12 years | Own | Grid-connected | Absorption | Yes | 11 June 2016 | Survey |
| **Grahame** | 60-69 | 2 adults | Acreage (hobby/lifestyle) | Primary | 8 months | Own | Grid-connected | Absorption | Yes | 17 April 2016 | Survey |
| **Harvey** | 40-49 | 2 adults<br>3 children | Detached house in residential area | Primary | 10 years | Own | Grid-connected solar system | Absorption | Yes | 7 August 2016 | Survey |
| **Helen** | 60-69 | 1 adult | Detached house in residential area | Primary | 18 months | Own | Grid-connected solar system | Absorption | Yes | 13 April 2016 | Survey |
| **Jan**<br>**Martyn** | 60-69<br>60-69 | 2 adults | Acreage (hobby/lifestyle) | Primary | 30 years | Own | Off-grid | Absorption | No | 3 March 2016 | ABC Local Radio |
| **Jayne** | 60-69 | 1 adult | Detached house in residential area | Primary | 6 years | Own | Grid-connected | Compost toilet and grey water treatment system | Yes | 17 April 2016 | Survey |
| **Jen**<br>**Trin** | 50-59<br>70-79 | 2 adults | Acreage (hobby/lifestyle) | Primary | 18 years | Own | Grid-connected solar system | Absorption | Yes | 20 April 2016 | Survey |
| **Jill**<br>**Mal** | 60-69<br>60-69 | 2 adults | Detached house in residential area | Primary | Unknown | Own | Grid-connected solar system | Pump-out | No | 19 April 2016 | Snowball |

| Interviewee(s) | Age | Household composition | Property type | Primary or secondary residence | Length of residence | Rent or Own | Connection to energy grid | Septic System Type | Completed survey | Interview date | Recruitment |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Jim** | 70-79 | 1 adult | Detached house in residential area | Primary | 36 years | Own | Grid-connected | Pump-out | Yes | 13 March 2016 | Survey |
| **John**<br>**Jean** | 70-79<br>70-79 | 2 adults | Detached house in residential area | Primary | 20 years | Own | Grid-connected | Absorption | Yes | 14 April 2016 | Survey |
| **John T** | 50-59 | 1 adult | Detached house in residential area | Primary | 5 years | Rent | Grid-connected | Absorption | Yes | 25 March 2016 | ABC Local Radio |
| **John W** | 80-89 | 2 adults | Detached house in residential area | Secondary | 21 years | Own | Grid-connected | Pump-out | Yes | 14 June 2016 | Survey |
| **Kate**<br>**Henk** | 60-69<br>70-79 | 2 adults | Detached house in residential area | Primary | 18 months | Own | Grid-connected, solar hot water | Pump-out | Yes | 10 May 2016 | Survey |
| **Kerry**<br>**Brian** | 70-79<br>70-79 | 2 adults | Detached house in residential area | Secondary | 25 years | Own | Grid-connected solar system | Absorption | Yes | 21 March 2016 | ABC Local Radio |
| **Kerryn** | 40-49 | 1 adult<br>3 adolescents | Detached house in residential area | Primary | 10 years | Own | Grid-connected | Pump-out | Yes | 8 May 2016 | Survey |
| **Kim** | 60-69 | 2 adults | Detached house in residential area | Primary | 2 years | Own | Grid-connected solar system | Pump-out | Yes | 19 April 2016 | Survey |

| Interviewee(s) | Age | Household composition | Property type | Primary or secondary residence | Length of residence | Rent or Own | Connection to energy grid | Septic System Type | Completed survey | Interview date | Recruitment |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Leonie** | 70-79 | 1 adult | Detached house in residential area | Primary | 30 years | Own | Grid-connected, solar hot water | Absorption | Yes | 19 April 2016 | Survey |
| **Linda** | 40-49 | 2 adults<br>2 children | Acreage (hobby/lifestyle) | Primary | 12 years | Own | Grid-connected solar system | Absorption | Yes | 7 August 2016 | Survey |
| **Margot**<br>**Ben** | 60-69<br>70-79 | 2 adults | Acreage (hobby/lifestyle) | Primary | 17 years | Own | Grid-connected | Absorption | Yes | 8 May 2016 | Survey |
| **Marian** | 60-69 | 1 adult | Detached house in residential area | Primary | 1 year | Own | Grid-connected, solar hot water | Pump-out | Yes | 11 March 2016 | Survey |
| **Marisha** | 60-69 | 2 adults | Acreage (hobby/lifestyle) | Primary | 15 years | Own | Grid-connected | Absorption | No | 5 March 2016 | ABC Local Radio |
| **Mark** | 60-69 | 4 adults | Detached house in residential area | Primary | 25 years | Own | Grid-connected | Pump-out | Yes | 15 April 2016 | Survey |
| **Mike** | 70-79 | 1 adult | Detached house in residential area | Primary | 11 years | Own | Grid-connected, solar hot water | Pump-out | Yes | 14 April 2016 | Survey |
| **Olenka** | 50-59 | 4 adults | Detached house in residential area | Primary | 6 months | Own | Grid-connected solar system | Absorption | Yes | 13 April 2016 | Survey |
| **Paul** | 70-79 | 2 adults | Acreage (hobby/lifestyle) | Primary | 5 years | Own | Grid-connected, solar hot water | Bio-Cycle | Yes | 18 April 2016 | Survey |

| Interviewee(s) | Age | Household composition | Property type | Primary or secondary residence | Length of residence | Rent or Own | Connection to energy grid | Septic System Type | Completed survey | Interview date | Recruitment |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Penny** | 50-59 | 2 adults<br>1 teenager | Acreage (hobby/lifestyle) | Primary | 14 years | Own | Off-grid | Absorption | Yes | 11 May 2016 | Survey |
| **Robert** | 60-69 | 2 adults | Acreage (hobby/lifestyle) | Primary | 3 years | Own | Grid-connected, solar hot water | Bio-Cycle | Yes | 18 April 2016 | Survey |
| **Robynne**<br>**Robert** | 60-69<br>60-69 | 2 adults | Acreage (hobby/lifestyle) | Primary | 1 year | Own | Off-grid | Absorption | Yes | 12 June 2016 | Survey |
| **Rudi**<br>**Barbara** | 70-79<br>70-79 | 2 adults | Acreage (hobby/lifestyle) | Primary | 10 years | Own | Grid-connected, solar hot water | Absorption | Yes | 8 May 2016 | Survey |
| **Sharon**<br>**Ross** | 40-49<br>40-49 | 2 adults | Acreage (hobby/lifestyle) | Primary | 8 years | Own | Grid-connected | Absorption | Yes | 18 April 2016 | Survey |
| **Stuart** | 60-69 | 1 adult | Acreage (hobby/lifestyle) | Primary | 17 years | Own | Off-grid | Absorption | Yes | 18 April 2016 | Survey |
| **Francine**<br>**Henry** | 60-69<br>60-69 | 2 adults | Detached house in residential area | Secondary | 9 years | Own | Grid-connected | Pump-out | Yes | 12 June 2016 | Survey |
| **Trevor** | 50-59 | 2 adults<br>2 teenagers | Detached house in residential area | Primary | 15 years | Own | Grid-connected | Absorption | Yes | 13 June 2016 | Community email list |
| **Val** | 80-89 | 2 adults | Acreage (hobby/lifestyle) | Primary | 50 years | Own | Grid-connected | Absorption | No | 21 March 2016 | Newspaper |
| **Vicki** | 60-69 | 2 adults | Detached house in residential area | Primary | 3 years | Rent | Grid-connected | Pump-out | Yes | 11 May 2016 | Survey |