

THE EFFECTIVENESS OF GREEN
BUILDING RATING TOOLS IN WATER
CONSERVATION IN THE BUILT
ENVIRONMENT:
AN ASSESSMENT OF GREEN STAR

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of the requirements for the Degree Master of Architecture

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DECLARATION

I declare that this thesis is my own, unaided work. It is submitted for the Degree of Master of Architecture in the University of Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other university. All references have been acknowledged.

Signed

_____ day of _____ of _____

ABSTRACT

Water is a finite resource and inefficient use thereof can exacerbate scarcity. “Green building” provides one approach to functional building design and operation, to increase efficiencies. The Green Star Office rating tool helps gauge countries’ commitment to water conservation in the built environment. This research employed a literature review and comparative assessment of projects in Australia, New Zealand and South Africa. Respondents to a purposefully sampled survey provided additional feedback on the tool, gaps in its approach and points for consideration during tool redevelopment. It was found that Green Star (GS) is changing the building sector landscape, by, *inter alia*, facilitating reduced potable water use and providing an effective mechanism for water conservation. However, as a voluntary system, GS has limited replicability. A key research recommendation is to use performance data from certified buildings to inform the development of South African specific water efficiency guidelines and mandatory standards to guide the ongoing evolution of GS.

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ACRONYMS AND ABBREVIATIONS

ABS	Australia Bureau of Statistics
ACT	Australian Capital Territory
AP	Accredited Professional
AS/NZ	Australia/New Zealand
AUS	Australia
BCA	Building and Construction Authority
BEA	Building Eco-Assessment
BIM	Building Information Modelling
BMS	Building Management System
BRE	British Research Establishment
BREEAM	Building Research Establishments Environmental Assessment Method
CASBEE	Comprehensive Assessment System for Built Environment Efficiency
CBD	Central Business District
CIR	Credit Interpretation Request
COJ	City of Johannesburg
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEH	Department of Heritage and Environment
DTIE	Division of Technology, Industry and Economics
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
ECO	Land Use and Ecology
EGBC	Emirates Green Building Council
EMI	Emissions
ENE	Energy
ESD	Ecologically Sustainable Development
EWR	Environmental Water Requirements
FAO	Food and Agriculture Organization of the United Nations
GBC	Green Building Council
GBCA	Green Building Council of Australia
GBCSA	Green Building Council of South Africa
GBIG	Green Building Information Gateway
GDP	Gross Domestic Product
GFA	Gross Floor Area
GHG	Greenhouse Gas
GLA	Gross Lettable Area
HUC	Hydrologic Unit Code
HVAC	Heating, Ventilation and Air Conditioning
HWT	Household Water Treatment
IACSIT	International Association of Computer Science and Information Technology
IISD	International Institute for Sustainable Development
IMF	International Monetary Fund
IWMI	International Water Management Institute
JASWIC	Joint Acceptance Scheme for Water Services Installation Components
kl	Kilolitre
km	Kilometre
KZN	KwaZulu-Natal
LCA	Life-cycle Assessment

LCIA	Life-cycle Impact Assessment
LEED	Leadership in Energy and Environmental Design
m ²	Square metre
m ³	Cubic metre
MAR	Mean Annual Run-off
N12	National Route 12 in South Africa
NABERS	National Australian Built Environment Rating System
NABERSNZ	NABERS adapted for NZ
NBR	National Building Regulations
NEDLAC	National Economic Development and Labour Council
NGO	Non-Governmental Organisation
NIWA	National Institute of Water and Atmospheric Research
NLA	Net Lettable Area
NSW	New South Wales
NT	Northern Territory
NZ	New Zealand
NZGBC	New Zealand Green Building Council
OECD	Organisation for Economic Co-operation and Development
PEST	Political, Economic, Social and Technological
Pty Ltd	Proprietary Limited
QLD	Queensland
RFWR	Renewable Fresh Water Resources
RO	Reverse Osmosis
R24	South African Provincial Route Number 24
RSA	Republic of South Africa
SA	South Australia
SABS	South Africa Bureau of Standards
SANS	South African National Standards
SBCI	Sustainable Buildings and Climate Initiative
SWC	Sydney Water Corporation
TC	Technical Clarification
the dti ¹	Department of Trade and Industry
TSS	Total Suspended Solids
UK	United Kingdom
UKGBC	United Kingdom Green Building Council
UNEP	United Nations Environment Programme
US	United States
USGBC	United States Green Building Council
USGS	United States Geological Survey
UV	Ultraviolet
v	Version
VIC	Victoria
VOC	Volatile Organic Compound
vs.	Versus
WA	Western Australia
WAN	World Architecture News

¹ In the Republic of South Africa National Coat of Arms Corporate Identity and Branding Guidelines (2005:45) it is set out that reference to the Department of Trade and Industry is done using an acronym all in lowercase letters.

WAT	Water
WE	Water Efficiency
WELS	Water Efficiency Labelling Scheme
WIS	Water Scarcity Index
WITS	University of the Witwatersrand
WRI	Water Resource Institute
Wsci	Water Scarcity Index
WSUD	Water Sensitive Urban Design
WTA	Water to Availability ratio
WWF	World Wildlife Fund

1 INTRODUCTION

The introductory chapter provides the preliminary background, rationale and specific context in which this research project was undertaken. This contextual summary helps set the scene for the Green Star and Water Conservation research problem, including the aim and objectives of the research.

1.1 Background and Rationale

“The growing scarcity of fresh and clean water is among the most important issues facing civilisation in the 21st century.” Simonovic (2002:249)

1.1.1 Water: An Important Natural Resource

The importance of water was highlighted in an article published in the Boston Law Review in 1968: “Along with air, without which man cannot survive for more than a few minutes, water is one of our most essential natural resources². Without replenishing his internal supply of water, man cannot survive for more than about a week” (Aulenbach, 1968:535). However, water is not only important for human and environmental health; water is also used in manufacturing and construction, either as a component of a final product (Aulenbach, 1968:535).

There are competing users and uses for water. Therefore, it is imperative to find the right balance to ensure all water needs are adequately met in a way that supports sustainable economic, social and environmental systems and future growth.

1.1.2 The Global Water Cycle has Limited Water

Water is constantly being recharged through a naturally circulating system (Oki & Kanae, 2006:1068). Consensus among various sources (see American Water Works Association (2002); Aulenbach (1968:538) and Trenberth et al. (2007:758) is that there will never be more water on the planet than there is at present, or ever was in the past. It is therefore essential to consider the most appropriate way in which limited water supply is used.

² Can be defined as materials or substances occurring in nature, which can be exploited for economic gain.

1.1.3 Understanding Water Stress

Water Stress is one concept used in several water assessments as a tool to provide a first estimate on the extent to which there is pressure on a society's water resources. Schulte (2014:1) defined water stress as the capability, or lack thereof, to meet the human and environmental water demand. Schulte (2014:1) goes on to state that in comparison with water scarcity, water stress can be regarded as a more comprehensive concept. Water stress considers the physical characteristics of water resources, of which water scarcity is one component, but it also reflects on the quality of water sources, water flow within the environmental, and accessibility (Schulte, 2014:1).

The United Nations Environment Programme (UNEP) defines *severe water stress* as a situation where withdrawals exceed 40% of renewable resources³ (UNEP, 2007:421).

This accepted threshold is applied in the work of the Centre for Environmental Systems Research at the University of Kassel in Germany as part of WaterGAP 2.1⁴. Modellers investigated whether water use exceeded 40% of availability in that particular grid cell or country. As part of the investigations, data is sourced, reviewed and the findings used to identify the specific portion or percentage of a country believed to be under severe water stress (NationMaster.com, 2014: para. 1).

The findings of the WaterGAP 2.1 research indicate that South Africa is number 28 on the list with 68,5% of the country considered to fall under the threat of water stress; Australia is number 64 and only 8% of its geographic territory is under threat; while New Zealand is 93rd with a score of 0.0 indicating very limited vulnerability (NationMaster.com, 2014: para. 28, 64 and 28). Of the three countries being considered by the current research, South Africa could be considered the most vulnerable to water stress, a small portion of Australia is under threat, and a negligible portion of New Zealand faces a threat. The WaterGAP 2.1 research

³ Although no clear sources are provided by the report for this definition, other researchers also refer to this indicator (see Brown & Matlock, 2011:12; and Raskin et al., 1997:9).

⁴ WaterGAP is a tool for assessing the current water resources situation and for estimating the impact of global change on freshwater issues, on the problem of water scarcity (<https://www.uni-frankfurt.de/45218063/WaterGAP>). The current model version is 2.1.

however fails to provide a map, which shows exactly where the water stress conditions are expected on the ground. Do the areas under threat align to specific geographic locations within these country boundaries? Are these linked to major cities where high population levels are?

Such research does however demonstrate the importance for water management approaches to deal with the geographical implications of water demand and the appropriate location of storage solutions, in addition to water quality issues. Due to the uncertainty around water availability, addressing water efficiency can aid with freeing up water from one use (such as commercial buildings), which could then become available to other uses or users (e.g. supporting environmental resources or human consumption).

1.1.4 The Impact of Urbanisation and Urban Development on Water Resources

Newman & Jennings (2008:2) describe cities as “the defining ecological phenomenon of the twenty-first century”. Going from playing a minor role in the global economy a century ago, cities are now the primary driving force for economic growth (Newman & Jennings, 2008:3). According to Louis Sweet (as cited by Newman & Jennings, 2008:3): “With the advent of the 21st century, for the first time in human history, half the world’s population of more than six billion will be living in cities. The ways in which the urban needs for food, water, shelter and social organisation are met will not only determine the course of human civilisation, but the very future of this planet.”

The United Nations Environment Programme (UNEP) states that approximately 75% of global resources are consumed by cities, which also accounts for at least 20% of annual water usage (UNEP-DTIE, [n.d.]⁵:1). Over the next 20 years, more than two-thirds of the global population will reside in cities, placing further pressure on resources (UNEP-DTIE, [n.d.]:1).

As cities expand, in addition to providing more economic opportunities, it also escalates the environmental disruption associated with increased growth and

⁵ Please note that [n.d.] is used throughout the dissertation to indicate where source material does not provide a publication date as suggested by Hofstee (2006:256).

development (Newman & Jennings, 2008). In the built environment⁶, especially where new developments are concerned, the impact on the water cycle is both local (on site) and regional (impacting the wider area) as illustrated by Figure 1-1.

Figure 1-1 provides a comparison between a natural catchment without any development impacting on the water cycle, with that of an urbanised catchment. In an undisturbed catchment, water is provided with the opportunity to infiltrate and recharge groundwater sources, with transpiration from vegetation also putting more water back into the natural water cycle.

Increased development leads to less permeable⁷ land, which in turn lead to more water runoff with little or no water being retained on site. Less water retention will cause the groundwater table to drop while non-permeable surfaces could lead to a higher risk of flooding during heavy rainfall events.

Urban activity can increase the number of pollutants (e.g. oil, sediments, fertilisers, pesticides, animal waste and litter) that can escalate the level of pollution, which in turn could negatively affect the ecosystem (susDrain, 2012(b): para. 1). These pollutants can be carried away into the municipal system, eventually joining a watercourse downstream, further exacerbating the adverse effect on the water cycle (susDrain, 2012(b): para. 1).

These impacts associated with urban development have long been cited among the reasons for a greater interest and drive towards “green building (also known as green construction or sustainable building)” (Ganorkar et al., 2003:1860).

These authors state that one of the key objectives of sustainable building is the reduction of water consumption and the protection of water quality.

⁶ Saelens and Handy (2008:1) note that there are many definitions of what can be defined as “built environment”, and indicate that the generally used definition defines it “as the part of the physical environment that is constructed by human activity”.

⁷ Pinio (2009:1) described permeable surfaces as those that “allow water to percolate into the soil to filter out pollutants and recharge the water table”.

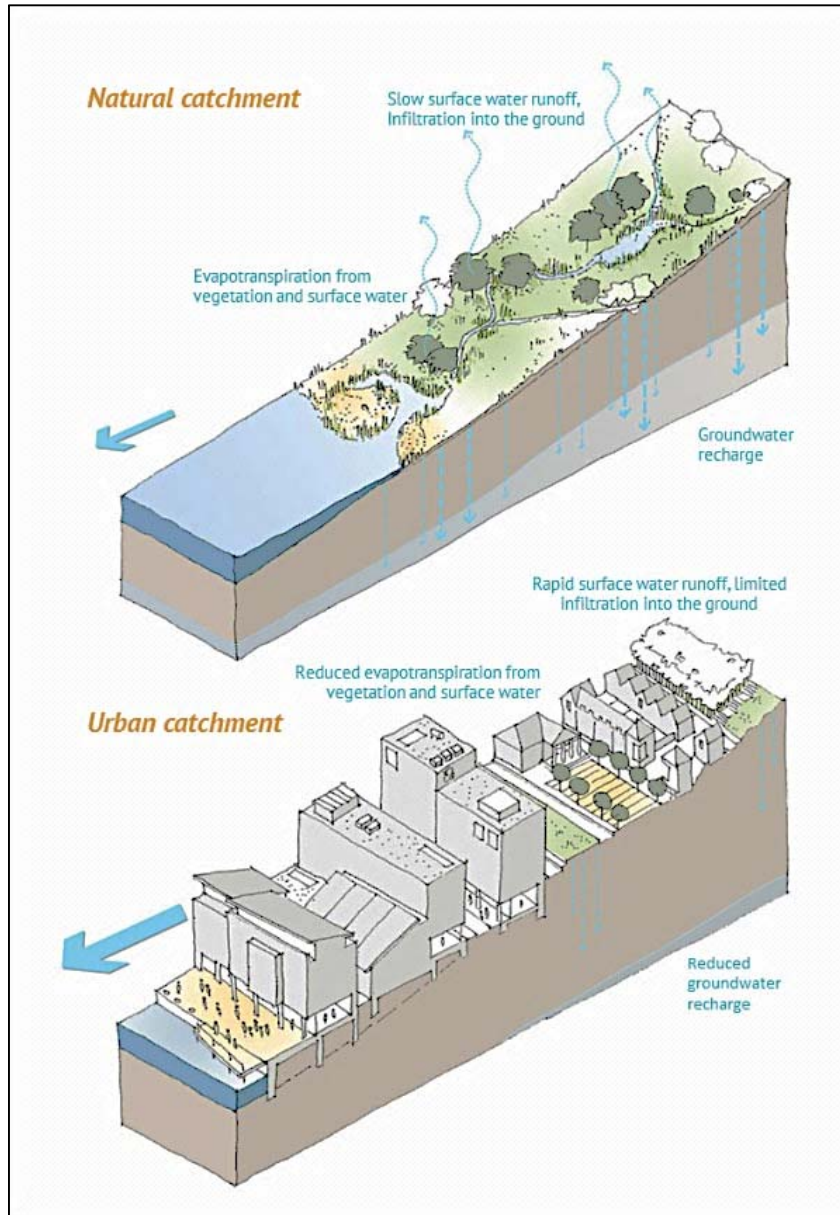


Figure 1-1: Natural Catchment versus Urban Catchment

Source: susDrain, 2012(a):1

It is essential to define ways in which to visualise cities more positively; firstly, by realising the potential cities have for reducing or limiting the negative impacts associated with continued growth and development, and then expanding that vision to include prospective ways in which cities can aid with environmental restoration (Newman & Jennings, 2008:3).

1.1.5 The Integrated Management Response

The Brundtland Commission⁸ concluded more than 30 years ago, that humankind have the necessary skills to ensure development is sustainable (UNEP, 2007:6). In the Commission's aptly titled report *Our Common Future*, significant importance is placed on the interconnectedness⁹ of the environment and human society. This important connection was first highlighted by Rachel Carson¹⁰, and per the IISD (2006:1), regarded as the turning point in confirming that the economy, environment and society were all intrinsically linked.

Defining the Concept of a Green Economy

Taking the concept of interconnectedness one step further, a policy brief by UNEP in 2010 indicated that moving towards a green economy could explicitly put a value on ecosystem services¹¹ and ensure that when environmental degradation occurs, the true cost to society and people around the world is accounted for (UNEP, 2010:9). It was deemed essential that a new approach is taken in how ecosystems, and the benefits that flow from these systems "are valued and accounted for in the existing economic model and indicators like gross national products (GDP)" (UNEP, 2010:2). Ultimately the brief was clear: "The essence of the Green Economy is that it recognises the sum total [sic] of all ecosystem services and how they collectively provide the complete life system support we need" (UNEP, 2010:9).

The Building Scale Response

From a water-vulnerability perspective the question then arises: What can or should be regarded as a *green or sustainable building*? The home building industry is said to have coined the term "green building" in the early 1980s (Hbrnny.com, 2014:1) but the concept of "organic architecture" was used by Frank Lloyd Wright

⁸Established by the United Nations in 1983 to look at critical environment and developmental challenges. Established at a time of an unprecedented rise in pressures on the global environment, when grave predictions about humanity's future were becoming commonplace (UNEP, 2007:xx).

⁹ Described as forming "part of the terminology of a worldview which sees a oneness in all things" (<https://en.wikipedia.org/wiki/Interconnectedness>).

¹⁰Silent Spring by Rachel Carson brought together research on toxicology, ecology and epidemiology to suggest that agricultural pesticides were reaching to catastrophic levels, linking it to damage to animal species and human health (IISD, 2006:1).

¹¹Ecosystem services are the benefits obtained from ecosystems including food, water, timber, regulation of weather, climate, disease, wastes and water quality, including supporting services such as soil formation, photosynthesis and nutrient cycling. Also, cultural services such as recreation, aesthetics, spiritual benefits (Newman & Jennings, 2008:261).

as early as 1939 when he said: “So here I stand before you preaching organic architecture: declaring organic architecture to be the modern ideal and the teaching so much needed if we are to see the whole of life, and to now serve the whole of life, holding no ‘traditions’ essential to the great TRADITION. Nor cherishing any preconceived form fixing upon us either past, present or future, but - instead - exalting the simple laws of common sense - or of super-sense if you prefer - determining form by way of the nature of materials” (Elman, 2012:2).

Introducing the term *organic* into his philosophy in 1908, Frank Lloyd Wright essentially extended the teachings of his mentor Louis Sullivan when he said that “form follows function” (Elman, 2012:2). This was later changed to “form and function are one”, using nature as the best example of integration (Elman, 2012:2). “Organic architecture” did not simply mean that nature should be copied; it rather referred to a reinterpretation of nature’s principles by astute design professionals to create natural built forms (Elman, 2012:2). The more recent green-building proponents described it as an approach to construction that means “incorporating environmental considerations and resource efficiency into every step of the home building and land development process to minimize environmental impact. It’s a practical response to a variety of issues that affect all of us – like increasing energy prices, waning water resources, and changing weather patterns” (HBRCNY, *ibid*: 1).

Vierra (2011:1) identifies the development of an Environmental Assessment Method by the Building Research Establishment in the 1990s as the catalyst for increased environmental sensitivity in design. Since the creation of BREEAM¹², various other international green building rating system have been developed, which include tools such as the US-based Leadership in Energy and Environmental Design (LEED), US- and Canada-based Green Globes, the National Australian Built Environment Rating System (NABERS) and Green Star.

Green Star

Green Star was originally developed to provide an organised approach to green building in Australia (Mellon, 2012:146) and due to the similarity between industry

¹² Building Research Establishment’s Environmental Assessment Method.

circumstances and environmental conditions; it was adopted elsewhere. The New Zealand Green Building Council (NZGBC) launched its own Green Star Office version in 2007; and with the launch of the Green Building Council of South Africa in 2007, the South African Green Star Office tool was developed and launched in 2008 (GBCSA, 2012(a):31).

The Green Star system formulated distinctive criteria to measure environmental impact (GBCSA, 2014:5). Providing mechanisms to assess building design interventions such as energy and water efficiency, indoor environment quality and performance management (GBCSA, 2014:9).

Measuring the Effectiveness of Green Building Rating Systems

Different countries face location specific challenges in terms of resource availability; the function the built environment plays in addressing certain environmental concerns; and the ability of a strong legal framework to regulate enforcement. Understanding the role and function of a specific rating system could provide insight into how one will determine whether that rating system can be regarded as an effective mechanism to affect change, or not.

The GBCSA (2008:191) highlights that the credits contained within the Water Category is designed to decrease potable water use 'through efficient design of building systems, rainwater collection and water reuse'. Any measurement of the effectiveness of the Green Star system, specifically in terms of potable water use, should use these intent descriptors as a starting point. Because Green Star awards specific points to credits contained within the rating tools as the main reward for projects pursuing certain design elements, the points system can be regarded as the main mechanism Green Star has put in place to facilitate change.

Although strictly not within the scope of the current research, Hes (2007) didn't limit the term '*effectiveness*' only to the improved environmental performance of buildings. The author (Hes, 2007:1) also looked at: 'the long-term effectiveness of the rating tools application and usability; and the ability for the tools to provide the outcomes expected by those using the tools'. More detail on these external factors or benefits that could further motivate teams to choose one credit over another (i.e. greater improvement of working conditions for employees, financial viability, etc.)

is dealt with in more detail in Chapter 6 to provide a rich contextualisation for the external factors that might impact on the choice of design interventions design teams consider. Such external considerations are not captured within the Green Star rating system or the certification process, but it does provide an additional rich layer of considerations project team could review as part of the overall design process.

1.2 Defining the Research

The Green Star rating system consists of nine environmental categories, (applied consistently across AUS, NZ and RSA). Each category consists of several credits, and each credit addresses a specific aspect or theme of improvement toward sustainable performance¹³. Points are awarded based on how well a project delivers against each credit's objectives. It is important to note that the Green Star rating system is not prescriptive about the categories and credits that should be targeted during the design process. The decisions surrounding the choices a project team makes are more project specific and usually influenced by budget, knowledge of existing technologies and design team or client preference.



Figure 1-2: The Green Star Environmental Categories

Source: GBCSA (2012(a):35)

Green Star is a voluntary system aimed at driving best practice beyond existing regulations (GBCSA, 2012(a):35). Figure 1-3 illustrates how building regulations tend to provide baseline requirements that all buildings must abide by to ensure legal structures are created.

In 75% of typical practice, buildings include design elements that go beyond these baseline requirements. The intention of Green Star is to build on typical practice and lead the industry in creating even better buildings, however, "in order to shift

¹³ Refer to Appendix B for a detailed table on each category and its associated credits.

the entire market, more extensive, coordinated green building regulations are needed” (GBCSA, 2012(a):12).



Figure 1-3: The Role of Green Star Rating Tools vs. Regulations

Source: GBCSA (2012(a):35)

If the 75% regarded as *typical practice* perform just slightly better than required by regulation, Green Star aims to provide a system that can acknowledge and reward the top 25% of green building practices in the industry. It is expected that the actions of the top 25% of building industry professionals will ultimately lead to a need for improved regulation and the evolution of the industry.

According to the GBCSA (2008:ix), “Green Star RSA rating tools use the best regulatory standards to encourage the property industry to improve the environmental impact of development”. More importantly, the rating tools are said to “embrace local standards and guidelines, where applicable, to benchmark this improvement” (GBCSA, 2008:ix).

1.2.1 The Research Objective

As pointed out by the GBCA, green buildings use 51% less potable water than its average building equivalent (GBCA, 2013:3), with other sources (Chanan et al., 2003:1) placing that figure as high as 80%. Whether that reduction is realistic or refers to a specific project that implemented extreme measures to achieve the result, is not the focus of this research project.

What the current research seeks to determine, is whether Green Star is merely a marketing tool that provides projects with the opportunity to gain equivocal labels related to the extent to which green building practices are being implemented, or whether it can be regarded as a robust, decision-making tool leading the industry by providing an appropriate methodology for creating sustainable buildings?

The objective of this research project is to determine whether Green Star is leading the transformation of the commercial property industry from a business-as-usual building design approach toward “an environmentally-sustainable built environment” (GBCSA, 2012(a):9), specifically with regards to water usage.

1.2.2 The Research Question

The main research question being addressed:

Is Green Star an effective mechanism for facilitating water conservation in the built environment in Australia, New Zealand and South Africa?

The following sub-questions arise from the above question:

- a) How does one measure the effectiveness of a green building rating tool?
- b) Which water stress indicators are relevant and applicable to commercial buildings?
- c) Has the GBCA taken the concept of water stress and vulnerability into account at Green Star conception? Has subsequent work by the NZGBC and GBCSA, when adapting the tools to local conditions, incorporated any further water conservation or vulnerability related research?
- d) Is the Water Category credits and related water use benchmarks contained in the Green Star rating system appropriate in relation to water issues being experienced in Australia, New Zealand and South Africa?
- e) Does Green Star allow for geographical differentiation in line with varying regional water stress conditions within a specific country? This could include reference to specific weather conditions, but could also include reference to or consideration of water restrictions or other water use limitations that might be implemented in a specific location.

- f) Can Green Star be linked to wider building industry change through an improvement in technological availability or even facilitating more stringent building regulations or government policy changes?
- g) Do green building rating tools, and Green Star specifically, lead to more robust decision-making processes?

1.2.3 Relevance of the Research

Scientific relevance

The scientific relevance of this study is the consolidation of knowledge relating to water conservation in the built environment using green building rating systems. More specifically it provides insight into the actual take-up of potable water use reduction strategies as included in the Green Star rating system used in Australia, New Zealand and South Africa to provide a gauge of the level of commitment from projects to address water issues.

Furthermore, the research translates this knowledge into practical recommendations for the future redevelopment of any of the Green Star rating tools in terms of its focus on water conservation.

Social relevance

Australia and South Africa are countries experiencing high levels of water stress. Although New Zealand does face similar issues, changing global weather patterns could impact on the way water is viewed. There is a clear commitment from these countries to improve water efficiency with the WELS scheme in AUS and NZ, and the current ongoing process to formulate the SANS 10400 XB standards for the South African market. However, especially in South Africa, there are issues relating to service delivery that will take precedence over investigations into water efficiency in the built environment.

This research acknowledges the fractured focus on water efficiency in South Africa, and it looks at Green Star as a potential alternative approach to facilitate water conservation through water efficiency measures as captured by the credits contained within the Water Category of the various rating tools within the system.

Green Building rating tools seem to provide design teams with a guideline toward creating more resource efficient assets. Australia, New Zealand and South Africa

have realised the importance of developing the Green Star system to provide professionals in the building industry with a method to measure the extent to which building performance can be improved through resource efficient approaches.

This research will provide insight into the effectiveness of the Green Star Water Category in facilitating water efficiency by looking at actual achievements in Green Star certified projects in Australia, New Zealand and South Africa.

1.3 Multi-Disciplinary Knowledge Fields

The building design process requires professionals from various fields of study to work together to create a functional end product. Investigating whether there is any link between a green building rating tool that guides design teams in finding ways to reduce potable water use, and understanding the water stress context within which these tools are implemented, will touch on a range of fields of study including climate change and the water cycle, water stress and management research, architecture and urban design, landscape architecture, wet services engineering in building design and facilities management (operations).

The intention is to provide a research outcome that can be considered useful across all sectors involved in water management in the commercial office-building context. Many researchers in the built environment are faced with similar situations where more than one technical field is involved, necessitating the researcher to become familiar with different concepts and jargon to create new avenues of knowledge (see Knight & Ruddock, 2008¹⁴; Trewhella, 2009: para. 2; Pain, 2003: para. 6, and Muskens, 2012: para. 1).

The researcher holds an undergraduate degree in Town-and-Regional Planning, has completed a range of courses to aid specialisation in sustainable development strategy as well as a Postgraduate Diploma in Green Cities for Eco-Efficiency, which solidified the view that cities have significant potential to respond in appropriate ways to the anticipated impacts and effects of climate change.

¹⁴ No specific page number can be listed as the entire book is regarded a valuable source in multi-paradigm research.

In addition, the researcher has also completed most courses offered by the Green Building Council of South Africa, and is also a Green Star RSA Accredited Professional.

Combining different knowledge fields does however pose challenges. It would be crucial to keep a focused view on the investigations to avoid generating too much or even unrelated data that does not specifically address the research question, and to stay within the timeframe available for this investigation. This research project will require a significant understanding of each knowledge field involved to create maximum benefit to the researcher and the fields this research ultimately aims to inform.

1.4 Limitations

Through engagement with the GBC's from Australia and New Zealand, it was determined that electronic access to data associated with building certification outcomes was possible, but with certain limitations. This is mainly due to the absence of a central, electronic filing system which is regularly updated in both instances.

Both the GBCA and NZGBC committed to providing at least the data associated with points achieved during certification as it relates to the Water Category credits, but due to budget and time constraints they were unable to provide data related to any other credits or environmental categories. Although credits in other environmental categories¹⁵ could impact on the approach to water by project teams, specifically as it relates to storm water management or downstream water quality; the current research project does not include detailed references to these credits and the focus remains on the Water Category exclusively.

Due to the nature of the datasets provided by the different GBCs, no distinction is made between projects that created new buildings or projects that entailed refurbishments of existing buildings.

¹⁵ For the Green Star Office v1 rating tool the water-related credits are contained within the Emissions category. More specifically it refers to EMI-5: Watercourse Pollution and EMI-6: Discharge to Sewer.

The datasets utilised in this research did also not include any information on the specific potable water use reductions that buildings hoped to achieved because of implementing the various water efficiency strategies or interventions for which points were awarded using Green Star.

1.5 Conceptual Definitions

Effective

The South African Concise Oxford Dictionary (2005:370) defines the term as “Producing a desired effect or intended result”.

For the current research, the focus of the investigation will be on whether Green Star is an effective mechanism to facilitate water conservation in the built environment in Australia, New Zealand and South Africa.

Green Building Rating Systems

Reed et al. (2011:1) suggest that rating tools were developed and introduced by many countries to advance industry’s understanding of environmental sensitivity of the built environment.

Referring specifically to building stock, these researchers indicate that the Emirates Green Building Council (EGBC) describes green building assessment tools as instruments that guide the development of sustainable buildings, communities and projects by involving the relevant experts (Reed et al., 2015: para. 1). The EGBC further holds that “the purpose of many of the assessment tools is to help drive building design and construction beyond regulatory minimums”.

Green Star

The Green Star rating system forms the basis of the current research project. Throughout this dissertation, when referring to the rating system in general, the term Green Star is used freely. When the discussions require reference to a country-specific version of the rating system, a country descriptor is added, i.e. Green Star AUS and Green Star NZ.

The South African version is usually referred to as Green Star SA but to avoid confusion with the possible use of SA about South Australia, the acronym for the Republic of South Africa (RSA) will be used to reference the local system.

Green Star Accredited Professional

Referred to as Green Star AP's in short, it describes industry specialists with a verified knowledge of the Green Star rating system of a specific country, with a clear understanding of the advantages associated with holistic design approaches (GBCSA, 2008:xii).

The three GBCs all have systems in place for industry professionals to qualify as Green Star AP's. These systems require prospective candidates to attend a Green Star foundation course – a full or half-day participatory training session, followed in most cases by an online exam.

Market Transformation

The vision for the GBCSA is to “lead the transformation of the South African property industry to ensure that all buildings are designed, built and operated in an environmentally sustainable way that will allow South Africans to work and live in healthy, efficient and productive environments” (GBCSA, 2012(a):34). Market transformation is used in the context of the current research as any “transformation in the building industry towards sustainability” (GBCSA, 2012(a):48).

Water Conservation

The process whereby the amount of water used for an activity is reduced without impacting on the outcomes of the activity (The Stakeholder Accord on Water Conservation, 2009:viii).

Water Efficiency

Defined by the Pacific Institute as “measures that reduce water use while maintaining the benefits water provides” (Pacific Institute, [n.d.]:1). The Stakeholder Accord on Water Conservation (2009:viii) provides a more detailed definition for water efficiency: “The accomplishment of a function, task, process, or result with the minimal amount of water feasible. Water efficiency aims to reduce

the wastage of water and not restrict the use thereof". This second definition is used in this research dissertation.

1.6 Delineation of Scope

The focus of the current research falls on the Green Star rating system, purposely created and subsequently adapted for the specific challenges and conditions of Australia, New Zealand and South Africa.

The first Green Star rating tool created in each country was Green Star Office. Being the longest serving tool, the expectation is that an assessment of buildings rated under this tool will provide a larger pool of data. Buildings certified under Green Star Office in all three countries will be assessed.

Green Star provides projects with the opportunity to obtain certification in two distinct phases of development: during the *Design* stage but also in terms of *As Built* outcomes on the ground. Both certification categories will be considered.

The aim of the research project is to investigate the effectiveness of Green Star in water conservation in the built environment. The focus of this research therefore falls specifically on the credits contained within the Water Category of the Green Star Office rating tool.

The intent behind this approach is to create an understanding based on which of the available credits are most frequently chosen by project teams for inclusion in their design (either due to ease of proof documentation required, limited design changes required to deliver on specific aspects – such as a xeriscape garden¹⁶ or availability of specific technology).

The ultimate goal is to determine if any of the available credits require additional investigation and development to increase worth, and whether credits have benchmarks that should ideally be increased or adjusted to ensure constant forward movement of the green building industry.

¹⁶ The GBCSA (2008: xxxiii) defines a xeriscape garden as "a water-conserving garden". The Green Star RSA Office v1 technical manual further states that "for Green Star RSA purposes, it is acceptable to irrigate a xeriscape garden during the first years, but once established the garden must not be irrigated" (GBCSA, 2008: xxxiii).

There are also credits that fall outside the Water Category that have a link to water but no impact on potable water demand. This includes EMI-5 Watercourse Pollution and EMI-6 Discharge to Sewer in Green Star RSA Office V1 and V1.1; EMI-4 Storm Water Management in the NZ Office 2009 tool; and EMI-5 Watercourse Pollution and EMI-6 Discharge to Sewer in the GBCA Office v3 tool. These credits however fall beyond the scope and focus of the current research, with only limited reference made to these credits to ensure a holistic understand of the role of water in the built environment.

Although it is understood that innovation points can be targeted under any of the nine categories within Green Star and therefore some innovation points could relate to water issues, information provided by the three GBCs were limited and reference to any points awarded outside the Water Category will fall beyond the scope of the research.

It should be noted that although the intention is to ascertain the reasons behind the choices of credits design teams target, the fields of cognitive psychology and behavioural finance are regarded as only peripheral subfields in these investigations. This is mainly due to the expectation that information relating to the motivation behind these choices would not necessarily have been captured accurately, if captured at all, and because it is very subjective fields.

1.7 Dissertation Overview

This dissertation is divided into seven main chapters, with the current introduction section providing the background and rationale around the research problem.

Chapter 2 contains a thematic literature review, focussing on water stress and vulnerability; a green economy and the role of green building rating systems; followed by a focus on Green Star and the role of water within the rating system. It touches on the behavioural psychology driving decision-making in Green Star certifications and water demand management in general.

Chapter 3 provides detail on the specific research methods that were used, identifying data sources utilised as well as the tools used for data collection and data analysis.

Chapter 4 provides an assessment of the Green Star system created by Australia and subsequently adopted for New Zealand and South Africa. This section provides a detailed comparison of each of the Water Category credits contained within the different versions of the Green Star Office rating system; to determine the suitability of comparing certified projects across the three focus countries.

Chapter 5 presents the results of the Green Star certified buildings data analysis, aiding in creating a universal understanding of the uptake of the water credits contained in the Green Star office rating tool, and the implications it might have had for water use. Due to the Green Star rating system relying on the provision of points rewarding project teams for incorporating specific design interventions, this is also regarded as the main internal mechanism the system has in facilitating a change away from business as usual to a more resource sensitive approach. Selected examples of Green Star certified projects in Australia, New Zealand and South Africa are also highlighted. The chapter provides insight into water related credits within Green Star that fall outside the Water Category and it touches on alternative interventions to be considered during the redevelopment of Green Star.

Chapter 6 delves into several external impacts or benefits associated with green building that further contributes as motivating factors in driving design teams to change their approach from business-as-usual to a more resource efficient outcomes driven process.

Final conclusions are drawn in Chapter 7, highlighting the key findings of the research, and further concluding with recommendations and suggested areas and topics for future research.

2 LITERATURE REVIEW

To place the research in perspective, the following chapter provides an overview of the literature that was assessed. The literature relevant for the contextualisation of this study falls into four major fields of study:

- 1) Water stress risk and vulnerability;
- 2) The green economy and green building rating systems;
- 3) Water as a component of green building rating systems; and
- 4) Behavioural psychology as it relates to water demand management.

More detail regarding how each field relates to the study, and insight into the associated literature, is set out in the remainder of this Chapter.

2.1 Water Stress Risk and Vulnerability

Water issues were discussed on a global scale as early as the 1970's with the most notable research considered being publications in 1974¹⁷. According to Shiklomanov (1998:3) this was followed by a publication by Baumgartner & Reichel in the monograph entitled *World Water Balance* in 1975. The most imperative finding flowing from the research suggests that global cooperation is essential when assessing water supply and the impact of human activity on availability.

Many of the issues that are plaguing the water cycle are due to human interference. Mogelgaard (2011:2) identifies population increase as a significant contributing factor to water scarcity. The global population reached the 7 billion mark on the 31st of October 2011, a day symbolically termed by the United Nations (UN) as Seven Billion Day (Coleman, 2011: para. 7). There are conflicting views on future population growth trends, with some authors saying that the world's population will not go beyond the 10 billion mark and even predicting a reduction in population size by 2100 (Lutz, Sanderson & Scherbov, 2001; Wise, 2013 and Gongloff, 2014); while others predict further growth, which will place additional pressure on resources (McDonald et al., 2011; Lu, 2012 and Richardson, Steffen & Liverman,

¹⁷ Limited information is included in the summary document on the "World Water Resources" monograph compiled by Shiklomanov (1998) regarding the origins of the original data and research efforts to uncover more detail on this topic was unsuccessful.

2011). By 2016, the global population increased to 7,5 billion (United Nations estimates elaborated by Worldometers¹⁸).

As population numbers increase, the demand for food and food production rises. Additionally, the water requirements for human consumption increase. There is an increase in the number of people looking for economic opportunities who will turn to cities, which drives urbanisation and the associated need for increased urban development. City development and population growth intensifies the pressure on existing infrastructure and natural resources.

To reduce global resource use, increase the availability of green jobs, and improve living and workspaces, it is essential to acknowledge the role of green or sustainable buildings throughout the supply chain (UNEP-DTIE, [n.d]:1).

2.1.1 Water Availability

Although one of the biggest issues relating to water is accessibility, Aulenbach (1968:540) realised the importance of focussing on water that forms part of hydrological cycle¹⁹. A sentiment elaborated on by Oki & Kanae (2006:1068), set out in their research on Global Hydrological Cycles and World Water Resources. They argue that any assessment on availability should concentrate mainly on the flows of water in the hydrological system as set out in Figure 2-1.

A staggering 75% of the world's fresh water is unavailable for use by man, captured in glaciers and the polar ice caps (Aulenbach, 1968:539). Adding the waters of the ocean to the 75% represented by those glaciers and ice caps a staggering 99.2% of all Earths' water is unavailable (Aulenbach, 1968:539). Based on calculations using Aulenbach's data (1968), this seemingly leaves less than 1% fresh water available for human consumption, a figure calculated slightly higher at 2,5% by Oki & Kanae (2006:1068).

¹⁸ <http://www.worldometers.info/world-population/>

¹⁹ "The hydrological cycle is the cycle of condensation, precipitation, evaporation, and condensation". He further states that "between precipitation and evaporation there may be varying degrees of run-off, storage, or removal from the cycle" and that "some precipitation evaporates before it even reaches the earth" (Aulenbach, 1968:540).

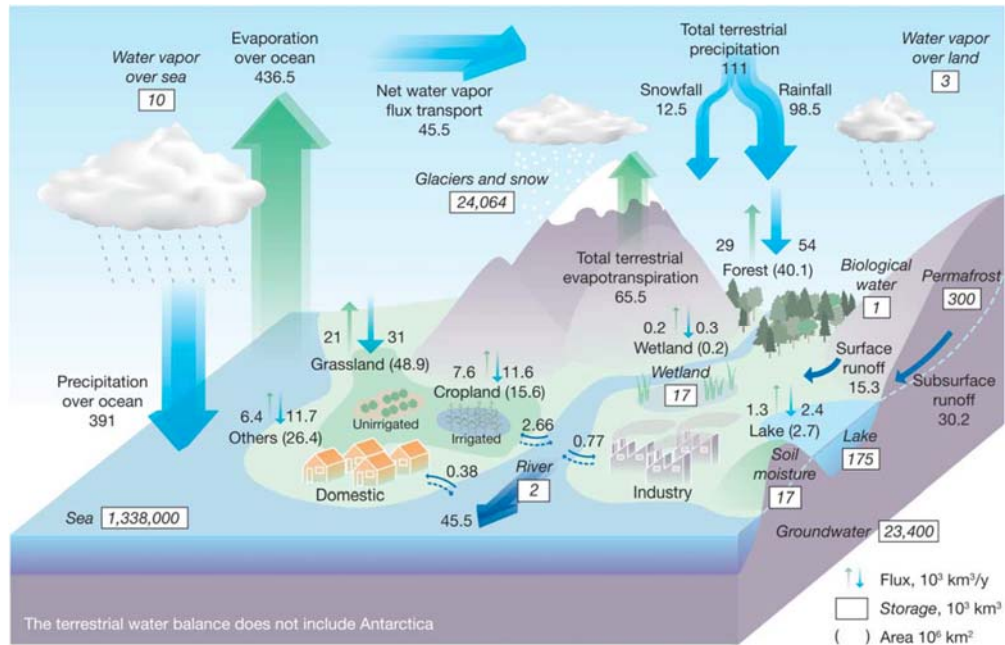


Figure 2-1: Global Water Cycle Flows and Storage

Source: Oki & Kanae (2006:1069).

In their research, Oki & Kanae (2006:1068) asked whether the circulating Renewable Freshwater Resources (RFWR) could satisfy human water demand. They theorised that the answer is both positive and negative stating that “even though RFWR is naturally recycled, the circulation rate is determined by the climate system²⁰, and there is an upper limit to the amount of RFWR available to human society” (Oki & Kanae, 2006:1068).

Annual water withdrawal is approximately 3 800 km³/year, and with only 2 000 km³ of water stored in the world’s river, the dire situation with availability is clear (Oki & Kanae, 2006:1068). They therefore argue that a more accurate assessment of resource availability should focus on the 45,500 km³/year of annual discharge, flowing through the rivers from continents to the oceans (Oki & Kanae, 2006:1068).

They further note that due to the “high variability of water resource availability in time and space, it is impractical to use 100% of the available RFWR for human

²⁰ Oki & Kanae (2006) do not elaborate specifically in their research on exactly what the climate system is or how it impacts on the RFWR circulation rate. Other sources do however provide insight. Goosse (et al., 2010:1) and Baede (et al., 2001:87-89) illustrate that the climate system consists of five components: the atmosphere, hydrosphere, cryosphere, land surface and biosphere. This also links to the graphics included in the Oki & Kanae article (2006:1069).

society” (Oki & Kanae, 2006, 1068). They also declare that it is due to this unpredictability of water availability, that two billion people live in what they call *highly water-stressed areas*, although current global water withdrawals are regarded to be below the upper limit (Oki & Kanae, 2006:1068).

The number of people expected to have access to water resources is expected to decline. Water stress is expected to become a more prominent issue, with only 60% of water demand being satisfied within 20 years (Addams, Boccaletti, Kerlin, and Stuchtey (2009), as cited in UNEP, 2011:21).

2.1.2 Changing Global Weather Patterns

Investigations into global weather patterns have revealed that there is an increased inconsistency in rainfall patterns worldwide; wet areas are receiving more rain, while dry and arid areas are receiving less (Dore, 2005:1167). Altomonte (2008:102) highlights that areas already prone to drought have an increased possibility of fires and decreased precipitation events are likely to intensify such water issues.

Along with the changing rainfall patterns, urban areas have an increased risk of exposure to significant weather events such as flooding and greater care will need to be taken when choosing the right sites for development to minimise that risk (Gee, Even-Har & Adam, 2009:10).

2.1.3 Measuring water stress

Over the last 20 years, several indices were created to determine the extent of water resources vulnerability (e.g. water scarcity or water stress) (Brown & Matlock, 2011:1). In their report, entitled “A Review of Water Scarcity Indices and Methodologies”, Brown & Matlock provide insight into these indices and in most instances also provide maps detailing the results of the relevant analysis undertaken by the creators of each specific index. This helps to gain an understanding into the different methods available to calculate the status of water resource, but in some instances, it also provides insight into what the original estimators determined the water availability situation to be for the three countries under investigation.

Brown & Matlock (2011:1) divide the existing “primary water scarcity indices and water resource methodologies” into four groups:

- A. Indices based on human water requirements;
- B. Water resource vulnerability;
- C. Indices incorporating environmental water requirements; and
- D. Life cycle assessments and water foot printing.

Each of these groups of indices have different indicators that can be utilised, and each index have both advantages and disadvantages that guide decision makers in choosing the most suitable method.

A) Indices based on Human Water Requirements include:

- i. The Falkenmark Indicator;
- ii. Basic human water requirements;
- iii. The social water stress index; and
- iv. Water resources availability and cereal import (Brown & Matlock, 2011:i).

The Falkenmark Indicator is regarded as the most widely used measure of water stress (Brown & Matlock, 2011; Perveen & James, 2010; and OECD, 2013), and looks at the percentage total annual runoff specifically accessible for human consumption (Brown & Matlock, 2011:1). The authors explain that this index allows for water conditions to be categorised as: no stress, stress, scarcity, and absolute scarcity. This indicator is also referred to as *social water stress* and it provides information on the average per capita water available per annum (Perveen & James, 2010:1). The Falkenmark Indicator might under-measure the impact of smaller populations by failing to measure water stress at more localised levels, therefore other indices were developed (Brown & Matlock, 2011).

Both the Falkenmark Indicator and the **Basic Human Water Requirements** (BHW) method developed the *benchmark indicator* of 1,000 m³ per capita per year as a standard, and have been accepted by the World Bank (Brown & Matlock, 2011:2). BHW looks at the minimum amount of water required to sustain certain basic human needs: “Water scarcity index as a measurement of the ability to meet

all water requirements for basic human needs: drinking water for survival, water for human hygiene, water for sanitation services, and modest household needs for preparing food" (Brown & Matlock, 2011:2). It seems short-sighted not to consider other users of water – especially the environment and economic uses.

Abrams (2003:1) states that there are several issues that impact on water availability and consumption, and assessing water scarcity will require a location specific quantification methodology to ensure accuracy. The author therefore cautions against using "a global figure to indicate water scarcity" (Abrams, 2003:1). He further states that whilst it may be convenient to use a "threshold such as 1000m³/capita... for purposes of comparison, it should be carefully used because it may understate situations of potentially serious water stress" (Abrams, 2003:1). As South Africa is widely known to be a water stressed country, the researcher tends to agree with this author. The water issues in South Africa are far more complex than just availability and demand. There are also severe infrastructure constraints, where access to water becomes a much larger issue than just a per capita usage figure.

The **Social Water Stress Index** also took the Falkenmark Indicator as its basis but aimed at accounting for the community's ability to adapt to water stress (Brown & Matlock, 2011). Created by Ohlsson (2000:213), who said of water scarcity "scarcity by definition implies diminishing resources and/or a pressure on the supply of available resources from an increasing demand". Ohlsson (2000:233) linked water scarcity to conflict potential within countries; which can destabilise countries and threaten the quality of life of its citizens, especially in developing nations. Ohlsson further identified the "key factors in these mechanisms" (which drives the pervasive conflicts) "to be population increase, frustrated development expectations and a lack of adaptive capacity to manage shrinking per-capita allotment and renewable resources, water ranking high among them" (2000:233-234).

The final index in the series is the **Water Resources Availability and Cereal Import Index**. As Brown & Matlock (2011:3) describe it, it is a way to measure the extent to which a country is vulnerable to water stress by assessing data related to cereal imports. Worldwide agriculture is one of the largest users of freshwater

resources, and where insufficient resources are available for food production, cereal imports could be expected to increase. This index differs from the Falkenmark Index by allowing for a more dynamic threshold to be considered (Brown & Matlock, 2011:3). Instead of using a fixed value threshold like the Falkenmark Index, this method, developed by Yang et al. (2003), created the threshold to be more flexible, able to adapt depending on specific irrigation methods or improved water efficiencies (Brown & Matlock, 2011:3).

B) The Water Resources Vulnerability Indices start incorporating renewable water supply and national annual demand for water into their methodologies, and includes:

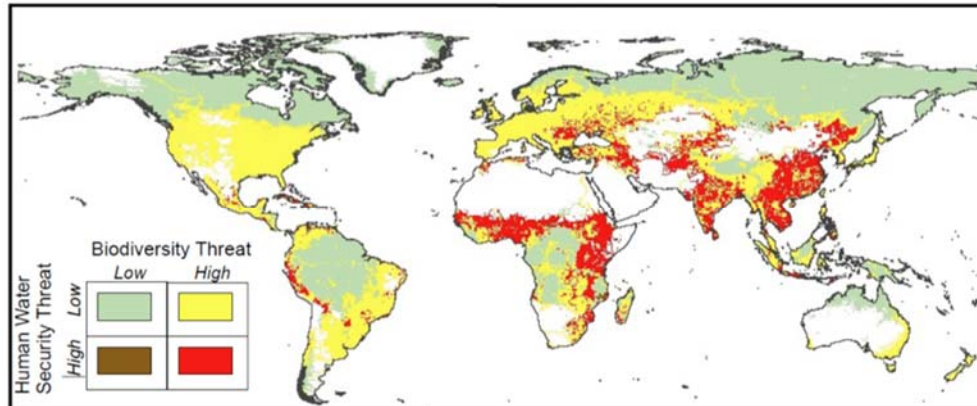
- i. the index of local relative water use and reuse;
- ii. the watershed sustainability index;
- iii. the water supply stress index; and
- iv. physical and economical water scarcity (Brown & Matlock, 2011:i).

The indices separate water use according the following sectors: industrial, agricultural, and domestic sectors, while also incorporating water lost from reservoir evaporation with population and economic factors used as the major variables (Brown & Matlock, 2011:4). This seems to provide an opportunity to make more accurate estimations regarding localised water resource availability. Under this index, which is also referred to as the criticality ratio²¹, a country is considered water scarce if annual withdrawals are between 20-40%, and severely water scarce if withdrawals exceed 40% (Brown & Matlock, 2011:4).

From what is set out by Brown & Matlock (2011:4), the **Index of Local Relative Water Use and Reuse** takes geospatial data into account when assessing water stress risk and vulnerability. Vörösmarty et al. (2005:287), the original authors of this index state that: “To secure a more complete picture of future water vulnerabilities, it will be necessary to consider interactions among climate change and variability, land surface and groundwater hydrology, water engineering, and human systems, including societal adaptations to water scarcity”. The index

²¹Refers to the “ratio of water withdrawals for human use in relation to total renewable water resources” (Alcamo et al., 1997:3).

divides a geographic area into 8km cells and assesses water usage per application (i.e. domestic, agriculture, etc.) and it considers water use of more than 40% to be a good indicator of high water stress levels (Brown & Matlock, 2011:4).



Map 1: Prevailing Patterns of Threat to Human Water Security and Biodiversity
Source: Vörösmarty et al. (2010:28)

The map illustrates the outcome of various layers of information considered by the researchers. The findings indicate that there is indeed expected to be a high human and biodiversity water scarcity threat in certain areas within AUS, NZ and RSA.

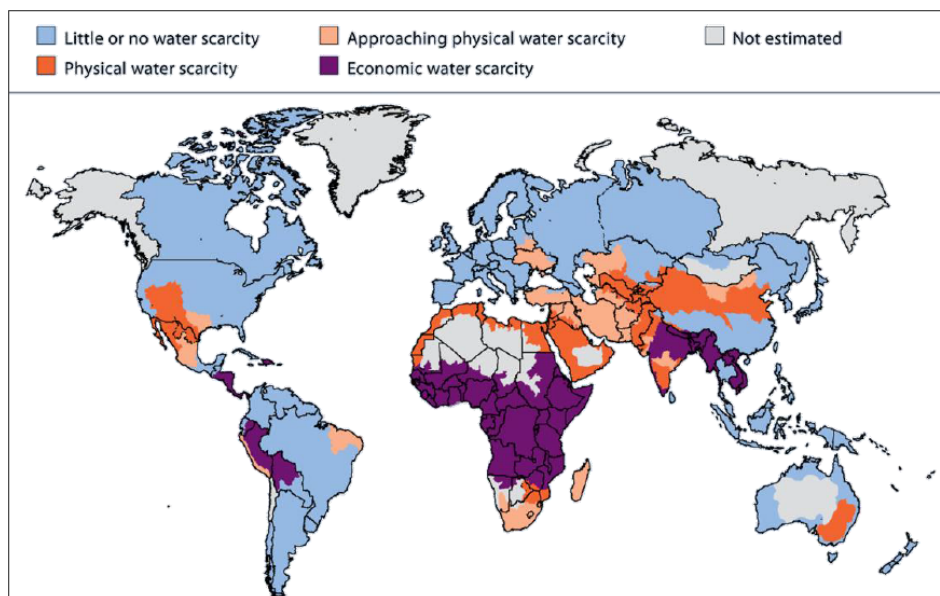
According to Brown & Matlock (2011:4), Chaves & Alipaz proposed **The Watershed Sustainability Index** in 2007. This index “incorporates hydrology, environment, life, and policy; each having the parameters pressure, state, and response”. Due to the dependence of the model on watershed-specific data, with limited availability in many areas, limits the feasibility applying this methodology universally (Brown & Matlock, 2011:5).

The Water Supply Stress Index developed by McNulty et al., (2010:103-114) proposed a new hydrologic term to quantitatively assess the relative magnitude of water supply and demand at the 8-digit USGS Hydrologic Unit Code (HUC)²² level

²² Nechero ([n.d.]:2) states that “a standardized hydrological unit system, referred to as the Hydrologic Unit Code (HUC) System was developed in the mid-1970s by the U.S. Geological Survey (USGS) under the sponsorship of the Water Resources Council”. The HUC system has the intention of creating “a topographically defined set of drainage areas organized in a nested hierarchy based on surface feature size”. The system “divided the country into 21 Regions, 222 Sub-regions, 352 Basins, and, 2149 Sub-basins Units Nechero ([n.d.]:2). Nechero ([n.d.]:2) explains that “a hierarchical hydrological unit code containing 2 digits for each of

(Brown & Matlock, 2011:7). This index is similar in its approach to WTA²³, but this technique also factors in “anthropogenic water demand” (Brown & Matlock, 2011:7).

The final index in this category is **Physical and Economical Water Scarcity**. In this analysis, conducted by the International Water Management Institute on a global scale, the percentage of renewable freshwater resources, which is accessible for human consumption, were considered (Brown & Matlock, 2011:8). The outcome of the analysis described areas as either “none or little, physical, approaching physical and economic water scarcity” (Brown & Matlock, 2011:7). A country was labelled “physically water scarce” when “more than 75% of river flows are withdrawn for agriculture, industry, and domestic purposes”, while “economically water scarce” countries were using “less than 25% of water from rivers” for human purposes but that required “significant investment in existing water infrastructure to make resources available for use” (Brown & Matlock,



2011:8).

Map 2: Areas of Physical and Economic Water Scarcity on a Basin Level in 2007

Source: IWMI (2008) as used in Brown & Matlock (2011:9)

the four levels was assigned to identify the hydrological units; these four levels are the basis for the 8-digit hydrological unit code”.

²³ Water to availability ratio.

From the preceding map, it is once again possible to determine the estimated impact for Australia, New Zealand and South Africa. It seems that while New Zealand is expected to have little or no water scarcity, certain segments of Australia could face physical water scarcity while almost the entire South Africa is approaching physical water scarcity.

Alignment between water scarcity and densely populated areas, especially in Australia can be noted from the following map.

C) The Indices Incorporating Environmental Water Requirements include:

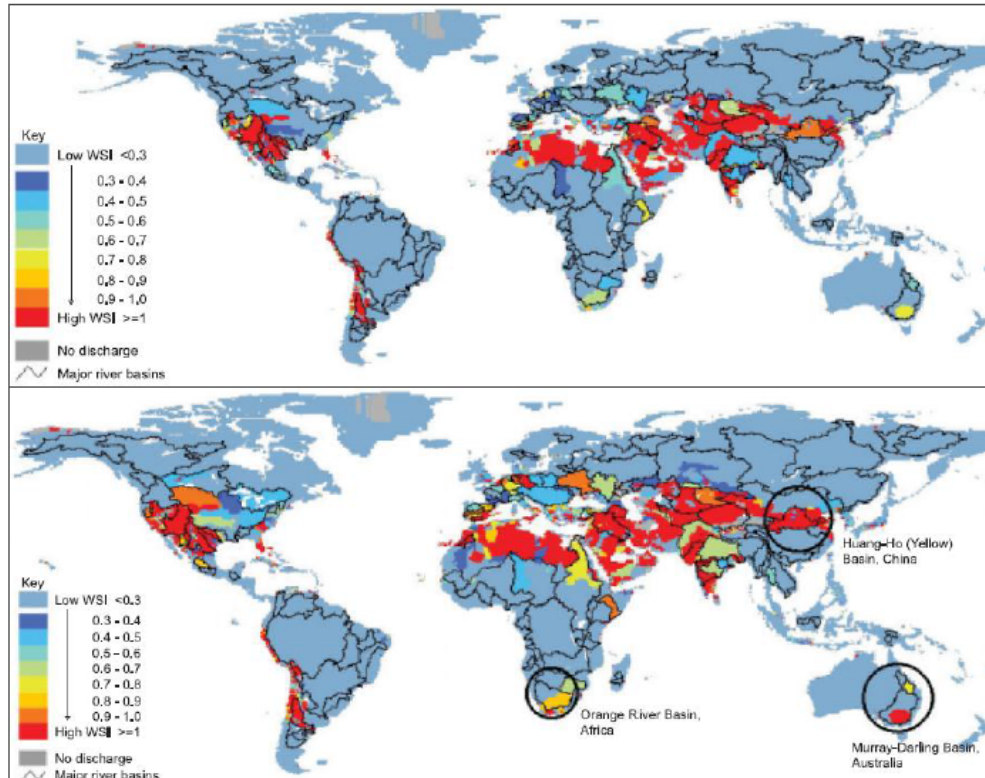
- i. population growth impacts on water resource availability (also called the water scarcity index); and
- ii. assessing water resource supplies using the water stress indicator (Brown & Matlock, 2011).

Since depleted freshwater sources can be linked to the conditions of ecosystems it is essential for measurement methods to include appropriate references to ecosystems, communities, economies and cultures (Brown & Matlock, 2011; and Sullivan, 2002). The **Water Scarcity Index (WIS)** incorporates the population growth rate, water availability, and of course domestic, industrial and ecological water uses (Brown & Matlock, 2011). The method development by Asheesh (2003), measures the water scarcity index by considering a diverse range of issues such as population increases, the availability of water, household, commercial and environmental water consumption. The intent of this water scarcity index (Wsci) is to assess fluctuations of localised water availability, and then identifying the amount of water required to return equilibrium between supply and demand (Brown & Matlock, 2011:9).

Assessing Water Resource Supplies Using the Water Stress Indicator, developed by Smakhtin et al. (2005), recognizes environmental water requirements as an important parameter of available fresh water (Brown & Matlock, 2011:10). This method used annual international water extraction data, obtained

from the FOA²⁴ and the IWMI²⁵ for industrial, agricultural, and domestic uses, to enable the evaluation of world-wide water assets, taking ecological requirements into consideration (Brown & Matlock, 2011:10).

The findings of the assessment, shown in the maps below, classified areas in terms of: slightly exploited, moderately exploited, heavily exploited, and overexploited (Brown & Matlock, 2011:10).



Map 3: (Top) Traditional Water Stress Indicator²⁶; (Bottom) Map of a Water Stress Indicator that accounts for EWR

Source: Smakhtin, et al. (2005) as used by Brown & Matlock (2011:10).

The top map provides an overview of the traditional water stress indicator findings, while the bottom map also considers Environmental Water Requirements (EWR). In the bottom map, the areas marked in red are “those where EWR presented in the top map may not be satisfied under current water use” (Brown & Matlock, 2011:11). The maps further illustrate that “most of the areas with variable flow

²⁴ The Food and Agriculture Organization of the United Nations.

²⁵ International Water Management Institute

²⁶ Indicating water withdrawals as a proportion of mean annual river runoff (Brown & Matlock, 2011:10).

regimes (and consequently the modest EWR of 20-30% of MAR²⁷) fall into the areas of environmental water scarcity”.

The circles in the bottom map, identifies areas that might experience a higher level of human water scarcity if the ecological water needs are met; which in turn mean that the risk of not adequately meeting EWR remains high, especially if water extractions increase (Smakhtin et al., 2005 as cited by Brown & Matlock, 2010:11).

Once again, the vulnerability of Australia and South Africa is highlighted by these findings.

D) The Life cycle assessment and water footprint indices include:

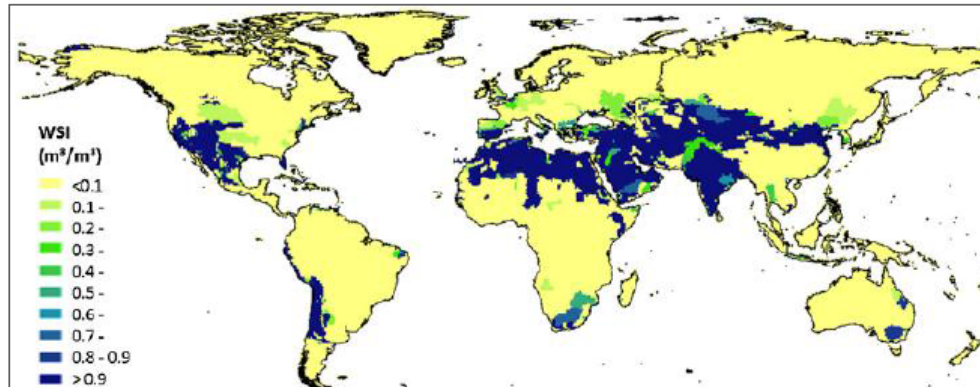
- i. Life cycle assessment and water stress index;
- ii. Water foot printing; and
- iii. A revised approach to water foot printing (Brown & Matlock (2011:11).

Brown & Matlock (2011:11) provides insight into the method devised by Pfister, Koehler and Helweg in 2009, where they utilised “the **Water Scarcity Index (WSI) as a general screening indicator or characterisation factor for water consumption used in Life Cycle Impact Assessment (LCIA)** to measure potential environmental damage of water use for three areas: human health, ecosystem quality and resources”.

The methodology focussed “on the effects of consumptive water use as a function of total water availability”, with the minimal water stress being expressed as 0.01, and with a value greater than 0.5 considered to be indicative of an area under severe water stress (Brown & Matlock, 2011:12).

The scale of these maps makes an accurate assessment of the presented data extremely difficult. What the current researcher can observe with some ease, is that various incidences of severely stressed areas are present in both South Africa and Australia, while the situation in New Zealand seems more stable.

²⁷ Mean Annual Runoff



Map 4: Global Representation of the Water Stress Index

Source: Pfister, et al. (2009) as used by Brown & Matlock (2011:12)

Hoekstra (2003) introduced **Water foot printing** as an indicator of fresh water use as explained by Brown & Matlock (2011:13). The water footprint of a product is defined as “the volume of freshwater used to produce the product, measured over the full supply chain” (Brown & Matlock, 2011:13). In this method, “water scarcity is evaluated in terms of green water²⁸ scarcity and blue water²⁹ scarcity as well as grey water³⁰ production” (Brown & Matlock, 2011:13). It is explained, “the overall assessment of water scarcity can be obtained by adding all of the water footprints” (Brown & Matlock, 2011:13).

The **Revised Approach to Water Footprinting**, devised by Ridoutt et al. (2010) compared the theory behind carbon and water footprinting and suggested improvement to the water footprint concept to create an improved, practical methodology (Brown & Matlock, 2011:13). It was argued (Ridoutt et al., 2010) that the issue with current water footprinting methodologies related to the fact that current approaches to product water footprints are not comparable due to the significant variance in the social and/or environmental impacts from water consumptions associated with the product life cycle (Brown & Matlock, 2011:14). The focus of this tool falls mainly on the use of water foot printing for agri-based

²⁸ “The green water footprint refers to the consumption of green water resources (rainwater stored in the soil as soil moisture)” Hoekstra, Chapagain, Aldaya and Mekonnen (2009:8).

²⁹ “The blue water footprint refers to consumption of blue water resources (surface and ground water) along the supply chain of a product” (Hoekstra et al. 2009:8).

³⁰ “The grey water footprint refers to pollution and is defined as the volume of freshwater that is required to assimilate the load of pollutants based on existing ambient water quality standards” (Hoekstra et al. 2009:8).

products and therefore no further assessment is included in the current research dissertation, as it does not pertain directly to the subject matter at hand.

Summative Remarks

There is a diverse range of methodologies available to determine the likely water stress a country or geographic area could be vulnerable to. These methods don't all refer to or incorporate the same water stress indicators into the assessment frameworks but even with a lack of fine grain detail, it was possible to determine the extent of potential water stress conditions in Australia, New Zealand and South Africa.

Creating some understanding of what the context specific water conditions are that each of these countries are facing, could provide valuable insight in understanding the potential role of green building rating systems, and Green Star in addressing water conservation concerns.

2.1.4 A Summary of the Water Conditions in Australia, New Zealand and South Africa

All three countries are in the Southern Hemisphere and share significant climatic and even economic similarities. According to geography expert, Briney (2016: para. 2), the Southern Hemisphere has less land but more water, which is one of the reasons why the "climate in the Earth's southern half is more mild overall".

Although the climate in the Southern Hemisphere is regarded as milder than its Northern counterpart, a drying of the Southern Hemisphere has been documented since the late 1970's (Live Science, 2012: para. 2). Through research conducted by the Commonwealth Scientific and Industrial Research Organisation (2012) the "southward expansion of a meteorological feature known as the Hadley cell" (Live Science, 2012: para. 4) is what the researchers regard as the most probable driving force behind the drying out of parts of Australia and southern Africa noted to date.

The Hadley cell is described as a "large-scale pattern of atmospheric circulation that transports heat from the tropics to the subtropics", but unfortunately it seems that scientists have no real understanding of the driving forces behind the shifting Hadley cell, with uncertainty regarding the role of human activity on climate

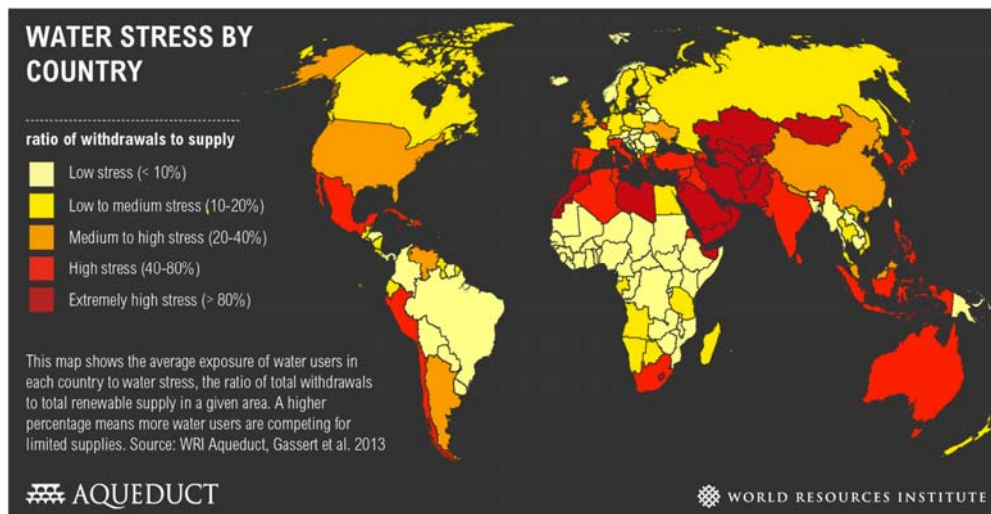
change, and the expected duration, or even why the southward shift is more pronounced during autumn (Live Science, 2012: para. 5).

The impact of the Hadley cell is however undeniable and severe droughts, both historic and currently ongoing in both Australia and South Africa clearly highlights the changing weather and increasing water stress vulnerability.

In an article published by Huffington Post (Ferner, 2013: para. 1), the author reiterates “stable and abundant water supplies are becoming increasingly difficult to come by on a warming planet with a growing population”. Ferner refers to research conducted by the Aqueduct project of the World Resources Institute, which assessed 100 river basins in 181 countries, to assess such country-level water risk (2013: para. 4).

During the research, the investigators took “a close look at regional baseline water stress, flood and drought occurrence over several years, inter-annual variability and seasonal variability as well as the amount of water available to a particular region every year from rivers, streams and shallow aquifers” (Ferner, 2013: para. 4). Using the findings, Ferner (2013: para. 4) states that the “WRI was able to give each country a score of 0 to 5, with a 5 being the greatest level of water risk”. Ferner (2013: para. 5) goes further by stating that “baseline water stress is defined as the ratio of annual water withdrawals to total available annual renewable supply, a higher percentage, as illustrated in WRI’s map (below), means more water users competing for increasingly limited water supplies.”

The implications of the WRI’s findings are clear from the map below. Although New Zealand seems to be only exhibiting low to medium levels of water stress, both Australia and South Africa are experiencing high water stress already. This is also further exacerbated by the high vulnerability of these two countries to prolonged droughts.



Map 5: WRI's World Map of Water Stress by Country

Source: Ferner, 2013: below para. 5

If the researchers are to be believed, the changing weather patterns and drying out of the Southern Hemisphere will keep placing severe pressure on the water resources in Australia, South Africa and New Zealand – albeit in varying degrees and different ways (e.g. droughts in Australia and South Africa and more frequent extreme rainfall events in New Zealand).

In Chapter 1, the need to understand more detail of water stress conditions in the three focus countries were highlighted. The research thus far already shows that South Africa is most vulnerable, followed by Australia and then New Zealand (which might be facing different issues altogether). More insight into the country-specific challenges is provided below:

Water in Australia – a Growing Concern

Chartres & Williams (2006), indicate that Australia's water resources are well above the criticality ratio which is used to indicate a country's vulnerability to water stress, the highly variable nature of water resources have however been flagged as a concern. Australia has highly diverse climatic conditions and terrain, but it seems that there is a mismatch between water resource availability and the location of people and agricultural activities (Chartres & Williams, 2006:17). Irrigated agriculture is also on the rise, which in turn requires additional water sources to support the growth of the industry (Chartres & Williams, 2006).

But Chartres & Williams (2006:22) also highlight the need for Australian urban communities to look for ways to conserve water supply and investigate water efficiency. Demand management and water pricing are techniques that have been used by some Australian cities to ensure stable supply to accommodate rising demand (Chartres & Williams, 2006).

Understanding Water Better: New Zealand

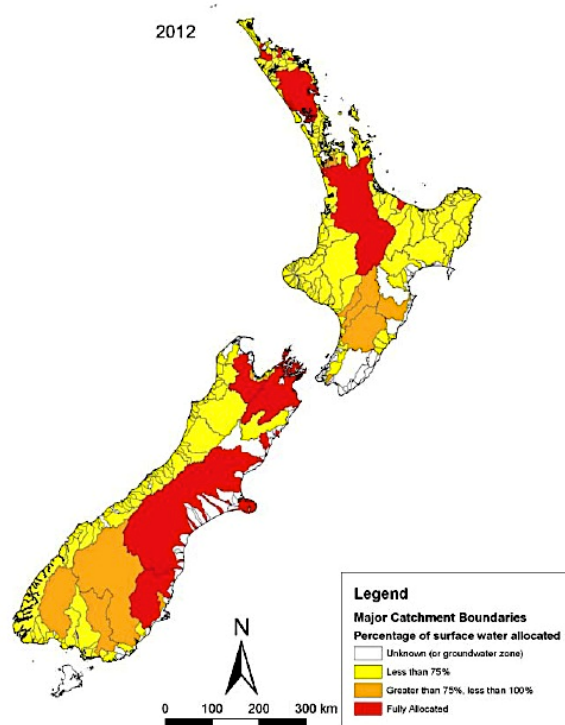
McGregor ((2007) as used by Bint (2012:3)) states that New Zealand has always been a *water-rich* country, and this is supported by the findings of various water assessment indices as set out in Chapter 2 of this dissertation. This has led to a situation where “water’s true uniqueness and necessity to both human and all other environmental features is not yet understood” (McGregor, (2007) as cited by Bint, (2012:3)).

Demand for water is growing and “there is no longer sufficient water to meet all our needs, in all places, at all times” (Stewart, (2008) as cited by Bint, (2012:3)). Seasonality of water availability is becoming an increasing concern and the Land and Water Forum (2010) identified water scarcity as becoming an increased reality for the country.

New Zealand lacks appropriate data on the extent to which buildings utilise water and this is highlighted as one of the major shortcomings the country is facing in trying to plan effectively for future management approaches as there are no clear water use reduction targets in place (Bint, 2012:4-5).

Map 6 reveals the full extent to which water resources are nearing critical allocation issues, which “demonstrates the current percentage of surface water allocation; showing that major centres of Auckland, Hamilton and Christchurch are already appropriating or are at full allocation” (Gudgeon, (2004) as used by Bint, (2012:13)). The National Institute for Water and Atmospheric Research (NIWA) has also acknowledged the overall warming trend being experienced by New Zealand (2009³¹) which increases the chances for vulnerability.

³¹ As referenced by Bint (2012:16)



Map 6: Major Catchment Boundaries of NZ
Source: Gudgeon (2004) as used by Bint (2012:13)

South Africa: Water

The Department of Water Affairs (2013:13) supports the assertion that South Africa is a water scarce country. The Department further sets out that a comprehensive water resource infrastructure network was created to manage “the variability of surface water runoff and to supply water to locations of economic activity” (DWA, 2013:14).

South Africa is currently experiencing the worst drought the country has seen in 30 years (Mojapelo, 2016: para. 7), and although only declared a disaster in 2016, Muller already indicated in 2015 that the situation could have been avoided through better planning (2015: below picture 2). In July of 2016, eight of the nine provinces were declared a state of disaster, and after severe flash floods that wreaked havoc within the province; certain areas of Gauteng (the only province previously spared the state of disaster declaration) were declared disaster areas (TMG Digital, 2016: para. 1).

In Chapter 1 of this dissertation, the imbalance between demand for water and where supply is located was noted. In South Africa, the entire country is currently being crippled by the reality of just such a situation. Certain areas experiencing flooding, while many our dams are running dry.

2.1.5 Understanding Risk

Now that there is a basic understanding of the different methods available for determining the degree to which an area might be susceptible to water availability issues, it is imperative to understand why it is essential to unpack the potential risk.

Insufficient information about water risks and the anticipated scale of events is usually the most noteworthy hurdle to improving water security (OECD, 2013:4). Having a clear understanding of the extent of the vulnerability a country might be faced with creates the opportunity to target the risk. By assessing risk acceptability countries can identify areas prone to "high-severity events, including tail events (i.e. low probability/high impact risks), and slow-developing catastrophic risk areas" (OECD, 2013:6).



Figure 2-2: Three-step Risk Based Approach to Water Security
Source: OECD, 2013:4

The preceding figure sets out a three-step risk based approach to water security set out by the OECD (2013:4). The approach assumes that there is clear

knowledge of the risk, allowing countries to target specific interventions to manage risks.

It seems that in most instances, conclusions on tolerable levels of water risks are reached covertly without appropriate public discussion (OECD, 2013:5). Often, concern about water risk is inspired by disaster (natural or man-made), rather than appropriate long-term planning to manage such risk (OECD, 2013:5).

The OECD indicates that there are many policy interventions available to countries to manage water risk. These are referred to as “traditional command and control instruments such as regulations, standards and permits, as well as market-based instruments such as taxes, charges and tradeable quota schemes” (OECD, 2013:8).

To affectively assess, target and manage any risk management interventions, constant feedback from practice is required. An integrated approach by public and private sector can drive the success of such efforts.

2.1.6 An Integrated Approach to Water Management

According to Herbertson & Tate (2001), a greater balance between supply and demand is necessary and can be achieved only if water supply engineers address both sides of the scale. This need is identified in a technical report Herbertson & Tate (2001:v) compiled for the World Meteorological Organisation, which identifies management aspects essential to effective demand management. Herbertson & Tate (2001:4) set out in their report that “the traditional approach of hydrologists and water resources engineers has been to focus on the supply side and the assessment of available water resources”.

It is indicated that water demand forecasts are most often dependant on information from other departments or even external consultants, which could increase the level of uncertainty of such projections. This is due to:

- Insufficient historical water use data;
- Elevated ambiguity in ascertaining the role of water efficiency in the irrigation, urban and industrial space, due to significant water losses linked to these sectors; and

- Reservations around economic, social and demographic expectations used in calculating future water demand (Herbertson & Tate, 2001:v).

These issues in turn lead to extreme doubt around supply and demand forecasts on a local, regional and global scale (Herbertson & Tate, 2001:v). They also linked to the assertion of Aulenbach (1968:538) and Oki & Kanae (2006:1069) when they state “there are large variations in local availability - both in space and time”. Herbertson & Tate (2001:v) further indicate that already at the time of writing their report, it was generally accepted that a complete move away from focussing exclusively on water supply management was required in favour of an attempt to a more balanced approach incorporating water conservation and appropriate demand management considerations.

They describe water demand management as: “The management of the total quantity of water abstracted from a source of supply using measures to control waste and undue consumption” (Herbertson & Tate, 2001:4). Another group of researchers (Sadr et al., 2015:77) share their views, and classified water conservation in buildings under water demand management, specifically in terms of its aim in reducing water demand by improving efficiency of use, and educating end users “on more sustainable approaches to water consumption” (Ozumba & Aduda, 2015:4).

In the first three countries to implement Green Star (Australia, New Zealand and South Africa), and which is the focus of the current research, various pieces of legislation govern water. There are various legal statutes, policy frameworks, building regulations and municipal by-laws that impact on how water in the built environment is managed and used.

The Legal Context

Legislation and other policy documents provide guidance on the enabling environment within which a development will function or operate. It is standards and regulations, which apply specifically to buildings that guide the entire design process.

Section 27(b) of the South African Constitution (Act 108 of 1996) provides everyone with the right to sufficient water. Part B of Schedule 4 of the same act places concurrent competence to legislate over issues relating to water and sanitation services with the National and Provincial legislatures.

In 1998 the National Water Act (Act 36 of 1998) was implemented and it legislated the way in which water resources would be protected, used and developed. The 2001 Policy on Free Water established the provision that each indigent household is to receive 6 kilolitres of free water per month (Shai, 2013: para. 8). This amount is based on the World Health Organisation standard of 25 litres per person per day, and might be applied differently by provincial or local governments throughout South Africa (eWISA³², [n.d.](b): para. 8).

According to Crouse (2013:8) the Department of Water Affairs (DWA) “provides a national and regional legislative framework for water resources and potable³³ water provision in South Africa under the auspices of the National Water Act (RSA, 1998), the Water Service Act (RSA, 1997) and regulations made in terms of the preceding Act”. Local government could use model by-laws to enforce the act (Crouse, 2013:8), but unfortunately, the absence of a suitable custodial body to ensure consistent implementation leads to extreme fragmentation in guidance provided to the market (Alan, 2013:1).

In 2003 the Strategic Framework for Water Services introduced the concept of the water ladder – a system that aims to ensure that there is a progression from access to basic water to higher levels. The National Water Resources Strategy was drafted in 2004, providing a framework, within which water resources throughout the country must be protected, used, developed, conserved, managed and controlled.

Still, Erskine, Walker and Hazelton (2008:148) analysed 14 sets of municipal bylaws to determine the extent to which these covered “water conservation and water efficient devices specifically”³⁴, and their findings indicated the following:

³² eWISA is the capacity building, information and knowledge-sharing arm of the Water Institute of Southern Africa (eWISA [n.d.](a): para. 2).

³³ Potable water is defined as “water that is drinkable, i.e. safe to be consumed” (GBCSA, 2008:xxx).

³⁴ Although the authors do not provide an extensive overview of the specific methodology used for this analysis, they do state that by comparing the provisions of Model Water Services Bylaws, “which are

- Tshwane and Ekurhuleni placed limits on shower flows and basin taps; and 5 of the assessed municipalities specified a maximum shower flow of 10 litres per minute;
- Automatic flushing urinals were declared illegal in 5 municipalities specifying that only user activated urinal flushing mechanisms may be used;
- Bylaws provided limits on cistern capacity with 7 municipalities specifying the maximum limits ranging between 6 and 9 litres; and
- Bylaws also addressed issues related to weather based irrigation control devices.

The researchers (Still et al., 2008:202) determined that there was very little consensus on the specific content of the bylaws, and it seemed to differ from municipality to municipality. The Department of Trade and Industry (the dti³⁵) (2011:3) state that although “the municipal bylaws do not cover taps, toilets, basins, baths or galvanised steel pipes specifically they do require that all water supply components must comply with South African National Standards (SANS) and be listed on their schedule of accepted components” (normally referred to as the JASWIC list).

JASWIC stands for the “Joint Acceptance Scheme for Water Services Installation Components” and it provides municipalities with information on local and imported plumbing products that adhere to SANS requirements (dti, 2011:4).

The dti (2011:4) further states that since the JASWIC scheme is based on conformity to SANS there is a close relationship between the SABS and JASWIC. “The South African Bureau of Standards (SABS) mark is often used by the plumbing industry to prove that the products were tested and inspected for continuous compliance against the requirements of the appropriate SANS by the SABS” (dti, 2011:4).

recommendations intended to assist municipal authorities in the formulation of their own bylaws dealing with the supply of potable water and incidental matters” with a “combination of all the municipalities’ measures taken together” provides “an overview of the kinds of water conservation measures currently in force” (Still et al., 2008:150). Also, refer to Appendix A for the comparison tables compiled by Still et al., 2008:E1-E14.

³⁵ This acronym in small letters is used widely on the Department’s website, and therefore this method for referring to the Department is used throughout this dissertation; in some instances, only *dti* is used.

Crouse (2013:6) further indicates that the National Building Regulations (NBR) “governs the building and the property within the boundaries of such property”. At present, the regulations do not include water supply installations but a proposal was made to include a new part XB to address water efficiency in buildings (Crouse, 2013:10). SANS 10252 does stipulate some water efficiency requirements, but these are deemed insufficient (Crouse, 2013:10). In an interview conducted on the 19th of October 2016 with Rudolph Opperman, National Building Regulations Architectural Technical Advisor at the SABs, it was indicated that the ultimate intent would be to create mandatory implementation requirements under SANS 10400 XB, in a similar manner that was done for SANS 10400 XA and SANS 204 (Opperman, 2016)³⁶. Sans 10400 and SANS 204 related to energy efficiency in buildings, and to address the water issues, the dti has stipulated that “a common national approach to regulations for water efficiency in buildings will be developed by the inclusion of water efficiency in the National Building Regulations” which in turn will mean that “Municipalities will be required to withdraw their bylaws once the Water Efficiency Building regulations are in place” (dti, 2013:7).

The dti (2013:4) highlights the fact that international experience shows water efficiency standards on its own will not accomplish sustained change. Appropriate design and water efficient installations, require suitable maintenance of such fittings and fixtures, and focussed behaviour change by end users to be effective (dti, 2013:4).

In Australia, a mandatory Water Efficiency Labelling and Standards (WELS) Scheme is in place, as required by the Australian Water Efficiency Labelling and Standards Act 2005 (Joint Standards Australia/Standards New Zealand Committee WS-032, 2005:2). The aim of these standards is to stimulate advancement of and communication around water efficient products and to help end users to distinguish between such products from existing stock, with confidence (Joint Standards Australia/Standards New Zealand Committee WS-032, 2005:2).

³⁶ Interview held on the 19th of October 2016, notes of the meeting are in the possession of the researcher.

Bint (2012:42) identifies the New Zealand Building Act of 2004 as the only document to contain a legislative statement focussed on demand management or water efficiency by users. In Part 1 Section 4 it states: “In achieving the purpose of this Act, a person to whom this section applies must take into account the following principles that are relevant to the performance of functions or duties imposed, or the exercise of powers conferred, on that person by this Act”; with specific mentioned being made of sub-clause (o) which refers to “the need to facilitate the efficient use of water and water conservation in buildings” (Building Act, 2004:26).

Further to the statements set out above, several New Zealand codes of practice and standard documents emerged. Mostly these related to the supply of water (Bint, 2012:42) and the only standard that relates directly to the consumption of water is the AS/NZS 6400:2005 Water Efficiency Labelling Scheme (WELS) adopted from Australia to promote strong trans-Tasman trade relations.

2.1.7 Summative Remarks

There are a wide variety of indices that can be used to determine the extent to which countries could potentially be facing water stress conditions, each with its own advantages and disadvantages. The intention of the current research was not to provide a critique of the various systems, but rather to understand the complexities at play when water availability scenarios are being investigated.

The preceding sections, referencing the findings of diverse investigations of water scarcity issues does, however, confirm that at least two of the countries being considered as part of the current research will likely face a relatively high level of water stress. The geographic disconnect between water resource availability and water demand creates a significant water security risk.

Appropriate water management mechanisms, such as legislation, policies and water efficiency standards have a crucial role to play in addressing the anticipated risk. Clear directives around enforcement are required to facilitate effective and long-term change.

Before unpacking the usefulness of green building rating systems in addressing water conservation issues, it is essential to understand the role of water in a larger economic system.

2.2 The Green Economy and Green Building Rating Systems

2.2.1 Understanding the Green Economy

“At its most basic level, a green economy is one that generates increasing prosperity while maintaining the natural systems that sustain our societies and our economies” (UNEP, 2012:14).

A report compiled by Allen & Clouth (2012:7) aimed to provide an overview of recent literature on Green Economy and the related concepts of Green Growth and Low-Carbon Development, which has seemingly been used interchangeably over the past years. As per their report (Allen & Clouth, 2012:7) the term “Green Economy” was first coined in a pioneering 1989 report for the Government of the United Kingdom by a group of leading environmental economists (Pearce et al., 1989), entitled Blueprint for a Green Economy. The authors highlight that there is no internationally agreed definition of a green economy, but it sets out some of the most widely known and accepted definitions (Allen & Clouth, 2012:7).

The UNEP defines a green economy as “one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities. It is low carbon, resource efficient and socially inclusive” (UNEP, 2011:16). Another definition offered by the Green Economy Coalition (a group of NGO's, trade union groups and others doing grassroots work on a green economy) succinctly defined a Green Economy as “a resilient economy that provides a better quality of life for all within the ecological limits of the planet” (Allen & Clouth, 2012:9).

“Central to the notion of a green economy is the recognition that economic activities operate within the global ecosystem and rely on it to provide resource inputs and assimilate wastes and emissions” (UNEP, 2012:14).

Water is vital to the development of the green economy in three ways:

- 1) “It is an asset essential for life and the common good for human well-being;
- 2) It is a production factor and economic asset essential for economic prosperity;
and
- 3) It is a vital environmental asset essential for the maintenance and regulation of the ecosystem services that ensure the long-term sustainable provision of the

economic and social goods and services on which prosperity depends” (UNEP, 2012:78).

The role of water in the green economy has been highlighted by several organisations and researchers (see Venema & Lawford, 2012; Ardakanian & Jaeger, 2012; UNEP, 2012 and the IISD, 2012) but it is imperative that policy makers and markets acknowledge that it is both quantity and quality of water resources that is important (UNEP, 2007:141).

The issues around water availability mentioned earlier can therefore be regarded as both a challenge and an opportunity. On the one hand investigations into the risks allow countries to adequately plan, and it creates the opportunity for new and innovative technology development. On the other hand, effective communication and raising industry awareness through policy or green building rating tools such as Green Star could also facilitate sufficient alignment between the actual risk and response by the market.

If the Green Economy could be used to place an economic value on scarce resources, especially water, all sectors within that economy would have to adjust as to how water is viewed and consumed. It is essential to understand what would drive such behavioural change. In a study conducted in Australia on water use in households, it was found “that stronger overall intentions to engage in water conservation practices - both everyday actions and the installation of efficient devices - were associated with more positive attitudes to these actions, a greater sense of personal obligation to engage in the actions, and a greater sense of self-efficacy (i.e. confidence that one can save water)” (Spinks et al., 2011:2).

It is fundamental that people’s attitudes and behaviours change if water management and conservation efforts are to be successful (Sathapornvajana et al., 2006:436). For people to really know that the changes they make in their behaviour would have lasting and longer term benefits, universally accepted guidelines are required to help end-users identify which changes to make as well as the anticipated effect these would have. This is where Green Building guidelines start playing a role.

2.2.2 The Role of Green Buildings in the Green Economy

In a Policy Brief by UNEP-SBCI (2010:3) it is indicated that “collectively the building sector is responsible for one-third of humanity’s resource consumption” which includes 12% of all fresh-water use. The Brief further highlights the fact that the building sector accounts for almost 10% of the global labour force and considering the high levels of urbanisation expected in the future, appropriate building practices are needed to create sustainable cities or nodes (UNEP-SBCI, 2010:3).

Green building forms an important subsector of the green economy. Starting as early as the 1990s with the advent of BREEAM, followed by the creation of the US Green Building Council in 1993 and the World Green Building Council in 1999 (GBCSA, 2012(a):31).

The timeline associated with Green Star is more recent. The first Australian project³⁷ was certified in 2004 (GBCA, 2006: 17). The Meridian Building in Wellington and 80 Queen St in Auckland share the honour of first buildings certified buildings in New Zealand in 2007³⁸ (NZGBC, 2015: para. 3), and Nedbank Phase II was the first Green Star RSA Office certified building, awarded 4-stars in 2009 (GBCSA, 2012(a):31).

Although there are a range of differences between the various rating systems available on the market, there seems to be a shared theme in guiding design professionals to think in fresh new ways (HBRCNY, 2014:1). The ultimate aim of green building rating tools seems to be assisting professionals in the built environment with changing their approach to building design, construction and operation by providing a decision-shaping framework.

Saunders (2008:11) determined that green building rating tools such as LEED, Green Star and BREEAM all have similar strategies for addressing environmental issues.

As part of the investigations into rating systems similarities and differences, Saunders (2008:11) provides a comparison between how LEED, Green Star (and

³⁷ 8 Brindabella Circuit awarded a 5-star Green Star Office Design Certified Rating (GBCA, 2006:17).

³⁸ With both buildings receiving a 5-star Green Star Office rating (NZGBC, 2015: para. 3).

with limited success, CASBEE), perform in terms of the weightings assigned by these tools to the different environmental categories. Saunders (2008:11) states that “for the purposes of the comparison the weightings have all been compared to the BREEAM environmental issue categories” and the results of the comparison are set out in the table below.

The higher the numeric value assigned to a specific category, the higher the weight assigned to that category.

Table 2.1: Issue Value / Weightings Comparison - Summary³⁹

Category	BREEAM (UK)	LEED (USA)	Green Star (AUS, NZ, RSA)
Management	15	8	10
Energy	25	25	20
Transport			10
Health and Wellbeing	15	13	10
Water	5	5	12
Materials	10	19	10
Land-use and Ecology	15	5	8
Pollution	15	11	5
Sustainable Sites	-	16	-

Source: Saunders (2008:11)

In the table, Saunders illustrated that the highest-ranking weightings across the three tools seem to be linked to energy efficiency and transport. It seems that Green Star placed significantly more emphasis on water efficiency than the other two systems. Per the data set out by Saunders (2008:11), Green Star assigned an issue value or weighting of 12 while BREEAM and LEED only assigned a 5.

Water Availability Concerns for Commercial Office Buildings

A Canadian study (Gee et al., 2009:5-6) identified the following key ways in which water availability might impact businesses:

- “Higher costs for water due to restricted availability and/or increased demand from industry;
- Regulatory caps impacting access to water resources due to limited availability;
- Pressure on social licenses to operate due to conflicts with local communities and other large-scale water users;

³⁹ To provide additional insight, alongside the name of each rating tool the researcher included a reference to the country in which the tool was developed. It should however be noted that BREEAM and LEED are used throughout the world, even in South Africa. Green Star has also been adapted for other African countries.

- Reductions in operational capacity due to production delays in areas where drought may occur – also resulting in reduced hydro power supply;
- Political and economic instability both within and between countries due to water related stresses and competition;
- Reduced consumer demand for water-intensive products and services due to increasing costs and/or growing awareness of water conservation issues; and
- Growing demand for water efficient products and technologies”.

These challenges illustrate the necessity to formulate appropriate responses or mechanisms to assist in addressing the growing concerns around water availability and how it could likely impact the built environment and economic productivity.

Research related to water management in green buildings included investigations focused on environmental assessment of residential buildings with an emphasis on water conservation conducted by Ilha et al., in 2009. The article looked at the water conservation themes found in various international building assessment systems with the objective of identifying topics to include in a Brazilian system for residential buildings. The authors (Ilha et al., 2009:11) identify the following requirements regarding water conservation as indispensable: “foreseeing the installation of saving components in the fixtures; foreseeing efficient irrigation systems; specifying vegetation that requires little water; stimulating the use of rainwater for activities not requiring drinking water; discouraging water reuse except for the direct use of rinsing water from clothes washing for washing other clothes; washing the floor or garden irrigation, until the system is consolidated and can ensure the safety of users”.

In an article that featured in the IACSIT International Journal of Engineering and Technology, Cheng & Venkataraman (2013:556) provide an “analysis of the scope and trends of world green building assessment standards”. In addition to providing a timeline of the evolution of green building standards around the world, they also set out a comparison of LEED, UK-BREEAM, Building Environmental Assessment Method (BEAM)⁴⁰, Green Mark⁴¹ and Green Star. They indicate that a comparison

⁴⁰ This is a green building assessment standard introduced by the Hong Kong Green Building Council in 2009.

⁴¹ Established by the Building and Construction Authority (BCA) of Singapore in 2005.

of the credits under the Water Category show the following common strategies included by all standards: storm water management, water metering, efficient irrigation and landscaping methods, efficient equipment for water use, plumbing and leakage detection and water recycling (Cheng & Venkataraman, 2013). The authors highlight that although originally focussed on reducing water use in the buildings, focus has shifted to reducing water used in equipment and amenities present in those buildings (Cheng & Venkataraman, 2013:558), leading one to deduce that a transformation has taken place in the market, requiring a more detailed approach when identifying the specific ways in which to pursue water use reduction.

Another author states that over recent years the perceptions related to green building have changed from the stereotypical hippie view⁴² towards a more business minded perception related to decrease operational cost, increased productivity, fewer absences and increased potential to attract and retain high calibre staff (Lockwood, 2006:1).

Chanan et al (2003:2) links sustainable water management to the water quality cascade principle. They define this as the condition where water sources match the end uses in terms of water quality requirements, as set out in Figure 2-3.

At the time of the research, the authors (Chanan et al., 2003) realised that although significant improvements were being made in terms of residential water management strategies, the commercial sector was not. They reiterated the fact that commercial buildings typically represent 10-20% of total urban water demand creating significant opportunities for sustainable water management and potential water use reduction strategies (Chanan et al, 2003:2). The commercial sector was also identified as an easy target for water conservation measures because of the similarities of indoor water uses between commercial and residential buildings (Chanan et al, 2003).

⁴² "Just five or six years ago, the term 'green building' evoked visions of tie-dyed, granola-munching denizens walking around barefoot on straw mats as wind chimes tinkled near open windows" (Lockwood, 2016:1).

Increasing perception of risk ↓	Source	End Use	↑ Increasing quality requirement
	Scheme water OR Treated and disinfected rainwater	Drinking Kitchen Showers Basins	
	Treated and disinfected greywater	Cleaning Cooling tower make up Toilet flushing	
	Treated and disinfected cooling tower blowdown	Cleaning Toilet flushing	
	Treated and disinfected blackwater and blackwater blowdown	Roof garden irrigation	

Figure 2-3: Water Quality Cascade with End-uses

Source: Chanan et al., 2003:2

The authors looked at two case studies to determine the best ways in which commercial buildings could contribute to water conservation. The first case study was the 60L Building that was created as a test case for the Australian Conservation Foundation; and the second entailed the identification of sustainable water management options for a commercial high-rise building by the Institute for Sustainable Futures at the request of the Sydney Water Corporation.

The two case studies demonstrated that it is possible to achieve an 80% reduction in municipal water demand, and 90% sewer discharge when compared to a conventional building “through the integration of innovative water efficiency measures, rainfall capture and use, treated effluent reuse and roof gardens” (Chanan et al, 2003:1). They also found that there is significant potential for reduced costs and enhanced benefits if issues around energy and water use are considered in an integrated manner. They flag the need for these approaches to be incorporated into regulatory guidelines to ensure the take-up of these strategies in all new buildings, and they also identified the important role water industry professionals should play in “meeting the challenges and pushing the boundaries of what is possible and devising integrated approaches rather than single solutions to sustainable water management” (Chanan et al, 2003:2).

2.2.3 Summative Remarks

The intention of the Green Economy is to place appropriate economic value on the environment and ecosystem services such as water. Only when environmental

resources are adequately valued, can a global change in the management of these resources be facilitated.

Green building rating systems provide users with a feasible way to assess the life cycle implications of specific building designs, facilitating a longer-term view of resource use and sustainable asset creation. Realising the importance of identifying appropriate interventions to guide water use reduction, balancing that with the importance of investing in alternative sources of water, and then facilitating a move away from reliance on municipal infrastructure and supply.

2.3 Green Star and Water

2.3.1 Why Green Star?

It has been said that the Sydney Olympics in 2000, recognised worldwide as the “Green Games”, catalysed the green building movement in Australia (GBCA, 2008(a):8). At the time of the games no local industry approved tool existed to define and encourage sustainable development and in 2002 a group of industry leaders recognised the need for an impartial agency to drive the green building concept forward (GBCA, 2008(a):8). Subsequently, the Green Building Council of Australia was formed, and the first tool focussed on new office buildings launched in 2003.

The GBCSA (2008:xv) indicate that a “Green Star RSA Office v.1 certification identifies projects that have demonstrated a commitment to a specific level of environmental sustainability by informing the industry of the design performance of the project in terms that are widely understood and accepted”.

Only buildings with a minimum of 80% of the building’s gross floor area (GFA), measured to exclude internal car park(s) classified as Commercial Office space are eligible to apply for the Green Star Office certification (GBCSA, 2008:xvi). Should the 80% minimum requirement not be met, the building might be able to apply for certification under a different rating tool (i.e. retail, multi-unit residential, etc.) (GBCSA, 2008:xvi). For the current research, it is however not the intention of the researcher to question the eligibility criteria associated with certification under Green Star Office, or to question the relevance of such a criterion in a time when city planners and developers alike have realised the benefits associated with

the creation of mixed-use, transit orientated developments. Rather, the focus only falls on the relevance of the specific credits contained within the Water Category of such a tool.

Green Star rating tools in Australia, New Zealand and South Africa cover both the *Design* and *As Built*⁴³ phases of new developments or base building refurbishment, the main distinction being the different documents required for submission for assessment (GBCSA, 2008). The *Design* certification was created to ensure that environmental impacts were considered at the design stage while the *As Built* certification assesses the same design initiatives but requires actual proof documentation to illustrate that the initiatives have indeed been put in place as designed.

The focus of the research set out in this dissertation was to determine the overall trends in targeting credits in the Water Category, and more specifically how Green Star Office certified buildings target available points within those credits. Figure 2-4 provides an overview of the Green Star rating system and the certification process.

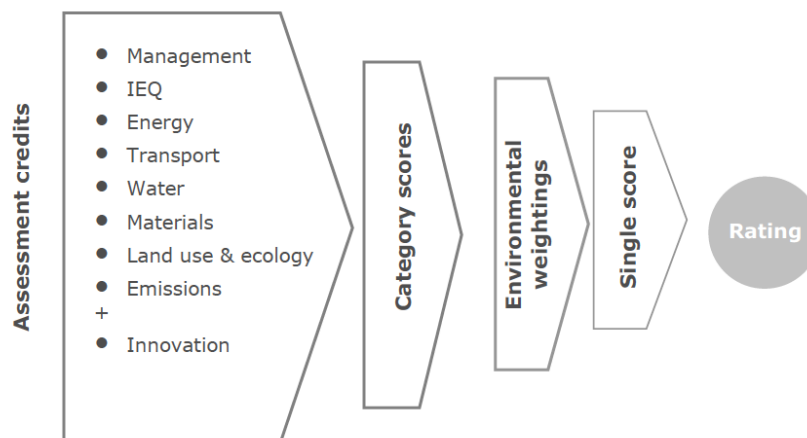


Figure 2-4: Structure of the Green Star RSA Rating System⁴⁴

Source: GBCSA, 2008:x (technical manual office v1)

⁴³*Design* and *As Built* are terms used consistently by the Green Building Council of South Africa and will therefore be used in a similar manner in all research reports.

⁴⁴More detail on the nine environmental categories and the specific credits included in each is provided in Appendix B of this dissertation.

From the researcher's own experience of the Green Star certification process, project teams debate about which credits to target early on. The level of effort and investment required would ultimately inform which available points are pursued. Insight into this issue is expected to flow from the Green Star and Water Conservation survey undertaken as part of the research process, and is described in more detail in Chapter 3, with the findings of the survey referred to in Chapter 5. Once all targeted and achieved credits (and therefore available points) within each category are determined, a percentage score is calculated and a Green Star environmental weighting factor is applied to reach a single score.

The GBCSA (2008:x) state that "Green Star environmental weighting factors vary across rating tools to reflect differing environmental concerns and imperatives for different building types and lifecycle phases. By applying an environmental weighting to each Category Score, Green Star RSA ensures that each category is appropriately represented within the rating tool, in line with current knowledge and GBCSA opinion"⁴⁵.

Table 2.2 provides an overview of the weightings for the Australian, South African and New Zealand Office tools. The higher the numeric value assigned to a specific category, the higher the weight assigned to that category, indicating a greater level of importance linked to that issue.

Table 2.2: Green Star Category Weighting Factors (Per Country)

Category	Green Star AUS Office v3	Green Star NZ Office 2009	Green Star RSA Office v1
Management	10	10	9
Indoor Environment Quality	20	20	15
Energy	25	25	25
Transport	10	10	9
Water	12	10	14
Materials	10	10	13
Ecology	8	10	7
Emissions	5	5	8
TOTAL	100	100	100

Source: Compiled using data from GBCSA, 2008:365 and NZGBC, 2008:[n.p.]

⁴⁵ NOTE: "Green Star RSA rating tools have the flexibility to allow for periodic updating of credits and weightings within the various tools. This is necessary to allow Green Star RSA to adapt to best practice and remain at the leading edge of industry practice" (GBCSA, 2008:xi).

No weighting factor is applied to the Innovation category as it could represent points targeted under any of the environmental categories (GBCSA, 2008:xi). The importance placed on the Water Category by the GBCs of the three countries vary but seems to be in line with the statement that “weighting factors vary across rating tools to reflect differing environmental concerns and imperatives” (GBCSA, 2008:xi). Local issues would clearly determine the importance assigned to specific interventions.

More detail regarding the specific weighting factors used, and how the factors were determined is provided in Chapter 4. The intent of this section is however to provide a high-level introduction to that Chapter. After applying the relevant weighting factor, it is possible to calculate the required single score to determine the certification outcome by comparing the final overall score to the following rating scale:

Table 2.3: Green Star Rating Tool Scores

Point Score	Green Star Rating	Outcome
45 – 59	4 Star	Best Practice
60 – 74	5 Star	National Excellence
75+	6 Star	World Leader

Source: Adapted from information obtain in GBCSA, 2008:xii

The following versions of the original Green Star Office tool is considered by the current research:

Australia:

- Green Star – Office *Design* v2; and Green Star – Office *As Built* v2 – both tools are listed as *legacy tools*⁴⁶ on the GBCA website and registration for certification under these tools is no longer possible
- Green Star – Office v3 replaced the previous tools and registration for certification under this tool was still possible until December 2015.

New Zealand:

- Green Star – Office *Design* and *As Built* v1
- Green Star Office 2009

⁴⁶ According to the GBCA website, *legacy tools* refer to the discontinued versions of Green Star tools, which are no longer available to projects to use to register and certify their projects (GBCA, 2017: para. 1).

South Africa:

- Green Star – Office v1; which, although still available for use has been improved to Green Star – Office v1.1.

Based on information obtained from the different Green Star Office rating tools listed above, the following table provides an overview of the different water credits available to teams across the Green Star systems in the three focus countries, and the specific points associated with each.

Table 2.4: Overview of Green Star Water Category Credits⁴⁷

Credit	GBCA		NZGBC			GBCSA	
	Office As Built v2	Office Design v2	Office V3	Office v1	Office 2009	Office V1	Office v1.1
Occupant amenity water	5	5	5	5	7	5	5
Water meters	2	2	1	2	2	2	2
Landscape irrigation	1	1	1	1	1	3	3
Heat rejection water	4	4	4	4	2	4	4
Fire System Water Consumption	1	1	1	*48	*49	1	1
Category Total Points Available	13	13	12	12	12	15	15

Sources: Information extracted from the various technical manuals (GBCSA, 2009:3; GBCA, 2008(b):3 and NZGBC, 2008:[n.p])

The details of the Green Star Water Category are unpacked in more detail in Chapter 4 of this dissertation. Describing each credit in detail, identifying similarities and differences between the versions of the tool in used; and determining whether comparison across the different versions is appropriate.

In summary, the following differences are noted:

- The overall number of points assigned to the Water category is not uniform across all three countries, ranging from 12 to 15 points;

⁴⁷ It should be noted that the different rating tools used slight variances of the credit titles but this was not regarded as a differentiating factor in the comparison.

⁴⁸ Based on information provided by the NZGBC, no corresponding WAT-5 credit is included in any of the Green Star NZ Office rating tools. (NZGBC, 2008:[n.p.]).

⁴⁹ Based on information provided by the NZGBC, no corresponding WAT-5 credit is included in any of the Green Star NZ Office rating tools but points for water based heat rejection, or more specifically the absence of water based heat rejection is included in the WAT-1 credit of the 2009 revision of the Office NZ rating tool. (NZGBC, 2014(a):144).

- The latest version of the Australian tool reduced the number of points associated with the WAT-02: Water Meters credit from 1 to 2 points;
- The South African tool assigns much greater importance to the WAT-03: Landscape Irrigation credit by providing a total of 3 points in comparison with the 1 point provided by its counterparts;
- The latest version of the New Zealand tool only assigns 2 points to WAT-04: Heat Rejection Water credit, the balance of which is now incorporated into the WAT-01: Occupant Amenity Water credit; and
- The New Zealand tools also do not include WAT-05: Fire System Water Consumption (something that has subsequently been addressed in the latest version of the Green Star NZ system but which falls outside the scope of the current research).

To place the credits and associated interventions in greater context, it is essential to unpack data relating to water use in commercial office buildings.

2.3.2 Understanding Commercial Building Water Use and the Role of Green Star to Reduce Consumption

Water Consumption in Commercial Buildings

In typical commercial buildings water is “consumed by varying types of equipment and the end-uses used by the occupants, each with a specific but different purpose” (Bint, 2012:49). Bint (2012) determined through international research that the largest water uses in commercial office buildings are:

- Heating, Ventilation, and Air-Conditioning (HVAC) Equipment;
- Domestic Amenities;
- Leakage; and
- Other (which Bint (2012:60) argues “covers the categories of irrigation, water use features (both internal and external), and other ground floor spaces if tenanted differently (i.e. retail/restaurant)” (Quinn et al, 2006).

Research conducted in Australia, by the Sydney Water Corporation, which focussed specifically on creating best practice guidelines for water conservation in commercial office buildings and shopping centres found that “commercial buildings account for almost 20 per cent of business water use in Sydney – or nearly 75 million litres of water every day” (Sydney Water Corporation, 2007:8). This figure

“includes water used by the many cafes and restaurants that are located in commercial office buildings and shopping centres” (Sydney Water Corporation, 2007:8). This seems to be the most appropriate way to reflect total water use in commercial office buildings.

The following table sets out median water consumption intensity⁵⁰ in the major centres of Australia in public, commercial and industrial buildings (GHD Pty Ltd, 2006:17).

Table 2.5: Median Water Consumption Intensity for Major Centres

Centre	Median water consumption intensity (l/m ² per annum)
Brisbane	1560
Sydney	1130
Canberra	720
Melbourne	700
Adelaide	700
Perth	610

Source: GHD Pty Ltd, 2006:17

These benchmarks were “established on the basis of a normalised water consumption intensity figure that adjusts for climatic impacts”, and these benchmarks were also used to inform the best practice benchmark of the National Australian Built Environment Rating System (NABERS) rating tool. The Sydney Water Corporation (2006:12) identifies the current economic best practice benchmark for office buildings in Sydney to be 0.84kl/m²/annum⁵¹.

The Guideline for Baseline Water Use Determination and Target Setting in the Commercial Sector, created for the South African Trade and Industry Chamber (The Stakeholder Accord on Water Conservation, 2009:7) states that “the use of quantitative measures of water use performance allows individual sites to track performance over time as well as to benchmark performance against that of other sites”. The report also highlights the fact that there are “two key measures regarding water use at site-level in the commercial sector:

⁵⁰ Although the GHD Pty LTD (2006) report does not specifically define the concept of water consumption intensity, it is defined in a related study report it is defined as “water consumed by m²” and expressed as kilolitres per m² (The Department of Environment and Heritage, 2006:40).

⁵¹ This is defined as “economic best practice”, which is regarded as the median for implementing water savings projects with year-to-year paybacks as the benchmark.

- i. The absolute volume of water used over a defined time period, which is an indicator of the demand that a site places on freshwater resources; and⁵²
- ii. Water intensity⁵³, which is an indicator of the sustainability of the site's water use" (The Stakeholder Accord on Water Conservation, 2009:7).

It is further stated that "individual water users each have their own context within which water use has to be managed" which impacts on the usability of a general benchmark uniformly; but at the same time, it is stated that "benchmarks do however provide an important reference point against which targets may be reviewed" (The Stakeholder Accord on Water Conservation, 2009:26).

The report advocates for the use of benchmarks "to provide context for target-setting" (The Stakeholder Accord on Water Conservation, 2009:26). This is mainly ascribed to the fact that "benchmark values achieved by a modern, state-of-the art building may simply be unachievable for an older building, for example. By the same token, benchmark water use in a water rich country may be higher than what is appropriate for a water-scarce country such as South Africa" (The Stakeholder Accord on Water Conservation, 2009:26).

Water use can also be impacted by seasonality, for instance HVAC and irrigation demands will be higher in warmer, drier seasons. Green building designers need to understand the major uses of water to identify specific ways in which to approach each use and determine where the efficiency potential lies. Based on these assessments, appropriate strategies to reduce the pressure on potable water demand, can be selected.

Green Star and Reducing Potable Water Demand

Through further audits conducted by the Sydney Water Corporation (SWC), it has been determined that up to 30% of water usage for an average building occurs in

⁵² "Absolute water use is simply the total volume of water used by a site over a defined time period" (The Stakeholder Accord on Water Conservation, 2009:7).

⁵³ "An efficient water user uses the minimal amount of water feasible to achieve a given outcome or result" (The Stakeholder Accord on Water Conservation, 2009:8).

the cooling tower⁵⁴, a statistic that is even higher in summer. Indoor water use (domestic/restrooms) accounts for 37%, leakage⁵⁵ 26%, retail use 3% and landscaping only 1%. The same report compares the data to a study conducted in California, and the results are very similar showing that 48% of office water use is for cooling/heating, 31% for indoor use, 18% for landscaping and 3% for other uses (GHD Pty Ltd, 2006:18). A gap in the data exists because neither study accounts for water used for fire testing. The authors argue that this is regarded as a major water use component but unfortunately rarely metered. Green Star does however include a credit on this issue, so it is already facilitating a change in how industry approaches fire system water consumption.

Kats (2003:2) highlights that “green or sustainable buildings use key resources like energy, water, materials, and land more efficiently than buildings that are just built to code”. The Water Category of Green Star is focused on incentivising design teams towards finding suitable ways in which to reduce potable water consumption.

Waidyasekara et al. (2013:108-117) provides a comparative overview of different green building rating systems in terms of water efficiency and conservation. In the paper presented at the second world construction symposium in 2013, the researchers set out the findings from their investigation into which water strategies were likely to be included in green building rating systems.

The researchers looked at 11 rating systems, including Green Star (Waidyasekara et al., 2013:111). They found that although many of the rating systems are concerned with the conservation of water and the reduction of potable water use during a building’s operational phase, they do not pay attention to water use during construction. This oversight is regarded as a missed opportunity toward facilitating improved water conservation throughout the entire building life cycle.

In a study by Edwards (2011), the author focussed on the role that plumbing systems could play in unlocking water and energy savings in buildings. The study

⁵⁴ A cooling tower is a component of a building cooling system (GHD Pty Ltd, 2006). “Water is used in cooling towers by evaporation (which provides cooling), bleed (to prevent build-up of dissolved and suspended solids), drift (water droplets entrenched in exhaust air), splashes, overflow, and leaks” (GHD PTY Ltd, 2006:18).

⁵⁵ This could be from dripping taps and toilet cisterns.

argues that the Green Star tool allows a Green Star building to be compared with reference-case buildings, providing valuable insight on anticipated benefits of different design options.

Vierra provides the reader with information on a range of available green building rating tools, with the focus of assessing the development of green product certification systems. One of the product certification systems the author refers to is WaterSense, a US-based partnership programme by the United States Environmental Protection Authority, which “seeks to protect the future of our nation’s water supply by offering people a simple way to use less water with water-efficient products” (Vierra, 2011:2). Green product standards started to appear as early as the 1980’s driven mainly by “concerns for product toxicity and its impact on children’s health and indoor environment quality”. Later, product development was also driven by increased consideration of climate change and depletion of valuable resources (Vierra, 2011:1).

Research done by Xia, Zuo, Skitmore, Pullen, and Chen (2013) assessed which category scored the highest points when comparing 4-star, 5-star and 6-star certified projects. Their research determined that management-related credits were the easiest to obtain while innovation credits were the hardest (Xia et al., 2013). Additionally, they found that 6-star buildings tend to score more points in the energy category, while 4-star buildings score higher in the materials category. Their findings also suggest that on average building that achieved a 6-star certification attained 91.4% of points associated with Water Category credits (Xia et al., 2013:306). This could indicate that projects are willing to do the more difficult credits if it means a higher certification level could be attained, but that if the credit achievement difficulty is too high, these will most likely be discarded in favour of other, easier to reach credits.

Goosen (2009:83) investigated the validity of Green Star for the South African context, and found that it is indeed a system worth using to improve the industry in general. There has also been critique of Green Star. Van Der Heijden (2014:1) described Green Star as a “simple and elegant idea”, but he openly critiques the system as only being implemented in the central business districts (CBD’s) of major Australian cities. The author argues that 50% of new buildings in these

CBD's are in fact Green Star rated and he agrees that this is quite an achievement. However, the questions raised relate to the level of certification these buildings achieve. As shown in an earlier section of this proposal, Green Star awards three levels: *Best Practice* for 4-stars, *Australian Excellence* for 5-stars and *World Leadership* for 6-stars. Van Der Heijden unfortunately does not refer to the actual certification data published by the GBCA regarding how many buildings attained certification in each of the three levels. The author however poses the question: If the vast majority of buildings are not hitting the highest sustainability standards, then are we really witnessing a revolution? Is this an indication that buildings are just going through the motions to obtain these Green Star ratings and not engaging with the industry in ways to improve on the actual requirements of Green Star?

If not constantly increasing the level of difficulty in obtaining a Green Star rating, therefore raising the standards as the market adapts, does this tool still provide the benefits to the proponents of the rating systems it proposed? More importantly, is there any link between the environmental achievements of Green Star rated buildings and the actual environmental risks present in the areas of implementation?

2.3.3 Green Star: Developing the Business Case

Developing the business case for building green has been the focus of various publications released by the three GBCs included in the current research. The GBCA published its first Dollars and Sense in 2006. This publication was a response to the high volume of international studies indicated that a lack of access to real-time data on the benefits associated with green buildings negatively impact on industry adoption of such strategies (GBCA, 2006:8).

Dollars and Sense (GBCA, 2006) was the first report to provide insight into the green building industry, and specifically the situation in Australia. The aim of the report was to illustrate how the industry is changing, by highlighting projects that have had various successes based on the application of the Green Star principles. It also discusses specific benefits associated with creating more environmentally sensitive buildings.

One example included in the report refers to the "first well publicised green office building in Australia, called 60L which is located on 60-66 Leicester Street, Carlton

in Victoria. Although this building did not have a Green Star certification, it won the 2003 Banksia Award for Leadership in Sustainable Buildings" (GBCA, 2006:16). According to the GBCA, the owners of the project indicated that because of "rainwater collection and on site waste water treatment" the building only requires approximately "10% of its water demand from the main water supply" (GBCA, 2006:16). The building was an industry leader on impact minimisation and commercial viability (GBCA, 2006:16).

Various other case studies were included in that very first Australian Dollars and Sense, some of which are referred to in later sections of this dissertation for additional insight into the benefits of Green Star (GBCA, 2006). An important note contained in the 2008 Dollars and Sense highlights the dynamics behind the Green Star rating systems, showing the ability to adapt and grow: "A number of benchmarks were also increased to represent changing national concerns, including water and energy" and it states that "reuse of water is now essential to achieve full credits under the Water Category" (GBCSA, 2008:30).

The process of documenting the benefits and actual results from Green Star certified buildings have continued over the years. In 2012, the GBCA published A Decade of Green as part of the celebrations of the GBCA and Green Star AUS being operational for 10 years at that point. The report (GBCA, 2012(a):6-7) showcased the development of the GBCA itself from 3 staff members to 55. By 2012, 515 projects received certification and a total of 12 rating tools were released to the market. Clearly the market responded to the call to create better buildings and in turn the GBCA stepped up and shaped a functional system to support the growth of the green building industry in Australia.

Learning early on from the lessons of their Australian counterparts, the GBCSA knew that it would be crucial to provide the industry with actual data on building performance improvements that resulted from using the Green Star RSA Rating System, and in 2012 the first Rands and Sense was published (2014). International and more importantly local case studies are showcased to make a strong business case for building "green". To celebrate reaching fifty buildings certified in South Africa, the GBCSA published a report entitled 50 (GBCSA, 2014(a)). This publication details the growth of the GBCSA, the achievements in resource use

reductions because of the buildings' Green Star strategies and it provides insight into specific projects that facilitated market transformation where specific product development specifications are concerned. More details regarding market transformation are included in Chapter 6 of this dissertation.

For a significant amount of time there was no tool available to Green Star certified buildings to keep track of post-occupancy performance. This made it impossible to determine if the strategies included in the design of a building, because of Green Star, was in fact leading to a long-term change in operational performance. This was clearly an oversight in the operational structure of Green Star – if one is unable to measure ongoing performance, how then is it possible to declare that a green building has in fact been designed in a more resource efficient manner? The GBCs have realised the dichotomy of this approach and the addition of a *Performance* tool is changing the green building landscape even further.

The New Zealand Green Building Council (2014) believe that to drive the building and property sectors to even a greater level of performance and efficiency, a *Performance* tool is critical. The NZGBC went further by stating that such a tool “will play a key role in ensuring the initiatives implemented during design and construction of new buildings and refurbishments, are delivering actual savings” (NZGBC, 2014(b):1). The *Performance* tool looks beyond just the design of a building but assesses how the green interventions perform during day-to-day operations to determine the effectiveness of the design strategies. It also provides a tool that can reach a larger audience by focussing on building stock created before the advent of Green Star, making it possible to address the shortcomings of these older buildings in terms of environmental performance.

Working together with EECA Business⁵⁶, the New Zealand Green Building Council (NZGBC) introduced NABERSNZ™. This scheme is regarded as the first stage towards addressing existing building performance in NZ and it measures and rates the energy performance of office buildings in the operational stage. A Green Star Performance rating tool has been launched in both Australia and South Africa.

⁵⁶ This forms part of the Energy Efficiency and Conservation Authority (EECA) of New Zealand.

The Australian tool, Green Star – *Performance*, measures the operational aspects of a building in terms of the same nine categories as listed in the preceding table and certifications are valid for three years (GBCA, [n.d.]:5). The new Australian tool enables building owners to continuously monitor a building’s operational performance throughout the three-year period, to undertake re-assessment and enable re-certification once the three years has passed (GBCA, [n.d.]:5). Built on the Australian performance tool, the GBCSA launched Green Star RSA *Existing Building Performance* (GBCSA, 2014:v). These performance-focused tools provide projects with the necessary tools to target certification to “match the key phases in a building life cycle – Design > Built > Performance” (NZGBC, 2014(c):4).

Although the performance tools, and the existing building tools have been introduced to the market, assessment of how projects perform under these tools fall beyond the scope of the current research project. However, the implementation of these tools creates an opportunity for future research to determine the extent to which certified building performance stayed in line with *Design* and *As Built* expectations. The findings from such extensions of the current study will serve as further validation of the expected findings of the proposed research set out in this dissertation.

According to the GBCSA (2008:v), a panel of assessors’ review compliance and “applicants are required to demonstrate achievement of all relevant credits by the provision of relevant documentary evidence”. Since the first Green Star rating tool was launched in Australia in 2003, a significant number of buildings have gone through the certification process, thus providing a wealth of knowledge regarding how well Green Star fared in aiding project teams to achieve results through the pursuit of specific green building practices.

The database provided by the GBCA (Walters, 2016: Sheet 2) shows that by the 16th of January 2016 a total of 492 buildings were certified under Green Star AUS Office. By the same date, a total number of 122 buildings were certified in NZ, of which 80 were certified under the Green Star NZ Office specifically (Li, 2016: line 18). In South Africa, there were 95 buildings certified under the office tool by the GBCSA by the 16th of January 2016 (Rushin, 2016: line 2 and 3).

Much progress has been made through the evolution of the Green Star rating tools and green building rating systems in general, but one aspect that is not being addressed, and which has a significant impact on how buildings function, is the state of the infrastructure that it connects to. The BREEAM New Construction: Infrastructure (Pilot) guidelines, recently launched by the BRE, provides “a performance based assessment method and certification scheme for new infrastructure assets” (BRE, 2017(b): para. 7). This new tool “aims to mitigate the life cycle impacts of new infrastructure assets on the environment and enhance positive social and economic impacts” (BRE, 2017(b): para. 7). Connecting urban infrastructure has an important role to play in maximising the impact of green buildings.

Graham (2010:10) notes that almost 30% of potable urban water is lost due to leakages in the connecting infrastructure, which in turn affect the actual performance of a so-called sustainable building. Investigating the impact surrounding infrastructure conditions or strategies might have on Green Star certified projects fall outside the current scope of the research set out in this dissertation. One example where such a synergy exists to the benefit of a project can be found in Cape Town. Century City in Cape Town provides users with the option of using treated effluent as a non-potable water source (Aurecon, 2014).

This opportunity for the Century City development was identified resulting from the access it has “to treated effluent water from the Potsdam Municipal Sewer Treatment facility” (Aurecon, 2014:2). It is stated that the original intent was only to provide water for landscaping purposes and to maintain the water levels in the canals after receiving appropriate treatment. It was determined that, due to the canals’ connection to the high water-table and storm-water run-off contributing to the water levels as well, the top-up of the canals is no longer required (Aurecon, 2014:2). Unfortunately, the project ran into some challenges in getting people to consider using the treated effluent elsewhere on the project, which Aurecon has ascribed mostly due to “a lack of understanding and limit of example applications” (Aurecon, 2014:2). Documenting projects such as these and helping to create a greater awareness that the technology and know-how exists could further expand the role of green infrastructure and green buildings in the cities of the future.

Although the abovementioned issue regarding urban infrastructure and the role it plays in a green building system falls outside the ambit of the current research, it does identify an area of additional future research – understanding how design teams will approach sustainable building design if greater importance or even just an understanding of the surrounding infrastructure was essential to obtaining a favourable certification outcome.

Ultimately there is a range of ways in which to reduce water stress risk and vulnerability but it seems the answers lie in how we think about water, what we do to protect it from contaminants or pollutants, and what we do to change our attitudes and practices on water use (see Larsen, 2004; Web.worldbank.org, 2014; and Growing Blue, 2014). On an urban scale, the use of water sensitive urban design provides a way to manage water effectively to make a positive contribution to the overall water cycle. On a building-specific scale, green building rating tools are one way of guiding project teams to think strategically in how potable water use is approached.

2.4 Behavioural Psychology and Water Management

What drives the decision-making process when design teams get together to identify the suitable Green Star credits to be targeted? Some design teams use building information modelling software to assess the impact that key design choices might have on the sustainability performance of the building (Story, 2009). Bank, Thompson and McCarthy (2011:431) agrees, and state that “Pertinent information contained within a BIM model is extracted, and utilized in decision-making related to operations, maintenance, and upgrades, and the development of what-if scenarios”.

The literature investigations for the current research identified limited sources that specifically address the questions regarding how design teams decide which credits within Green Star to target, but one paper suggests that the “consultant plays an important role in influencing the developer's choice of selecting a desirable green building design alternative” (Pan, Dzeng and Yang, 2011:1). An article by Shaw, Kenny, Kumar and Hood (2012) proposes that the main driving

force behind these types of decisions might be overall sustainability⁵⁷ of a project and not necessarily specific design parameters related to one building component, for instance water use. What does however become clear is that “expertise from a range of different fields needs to be integrated” (Andresen, 2000:1).

The decision-making in the green building design process is complex and not reliant on only one driving force. According to Robert Olde (Newell et al., 2011:4) “Reports such as Building Better Returns which go into the detail of removing variable factors to determine the impact of green issues on rent and value determinants allow improved education in the industry and better informed decision making on investment and risk management for investors and financiers, directly in property and indirectly in energy and other resource efficiency sectors”. Bank et al. (2011) found that although there is an expectation that buildings using the LEED certification process will aim to achieve those credits with the highest environmental impact or benefit, the reality is that teams focus on securing the lowest-cost points first. The author does however state that “Decision tools developed using appropriate sustainability indicators will allow LEED points to be chosen on a basis other than lowest cost” (Bank et al., 2011:439).

Although not focussed on buildings, *per se*, research conducted in Australia by Brookes et al., (2011), provides valuable insight into the decision-making process involved when encouraging private developers to embrace water sensitive urban design (WSUD). The authors found the topic largely unexplored and therefore drew extensively on various economic and administrative studies, supported by several scholarships undertaken in corporate and environmental sustainability to formulate a framework for interpret the aspects that drive developers to implement WSUD on large scale (Brookes et al., 2011:2).

Because WSUD and Green Star both require the creation of green infrastructure to facilitate improvement of environmental performance, the researcher felt that it could be used to shine a light on potential shared factors that impact the Green Star certification decision-making process.

⁵⁷ Which they define as a combination of environmental, financial/economic and societal/community aspects (Shaw et al., 2012:1).

The framework created by Brookes et al., (2011:3) is set out in Figure 2-5 in which they refer to as the “Wheel of Organisational Behaviour”. The wheel is divided into four themes: Political, Economic, Social and Technological (also referred to in short as PEST⁵⁸) – with each theme further divided into contextual, organisational and individual levels (Brookes et al., 2011:3).

The researchers (Brookes et al., 2011), used this framework in the case study analysis to understand the potential factors influencing the adoption⁵⁹ of WSUD by the private land developer. Because WSUD and Green Star both require the creation of green infrastructure to facilitate improvement in environmental performance, the researcher felt that it could be used to shine a light on potential factors that impact the decision-making process in Green Star certifications.

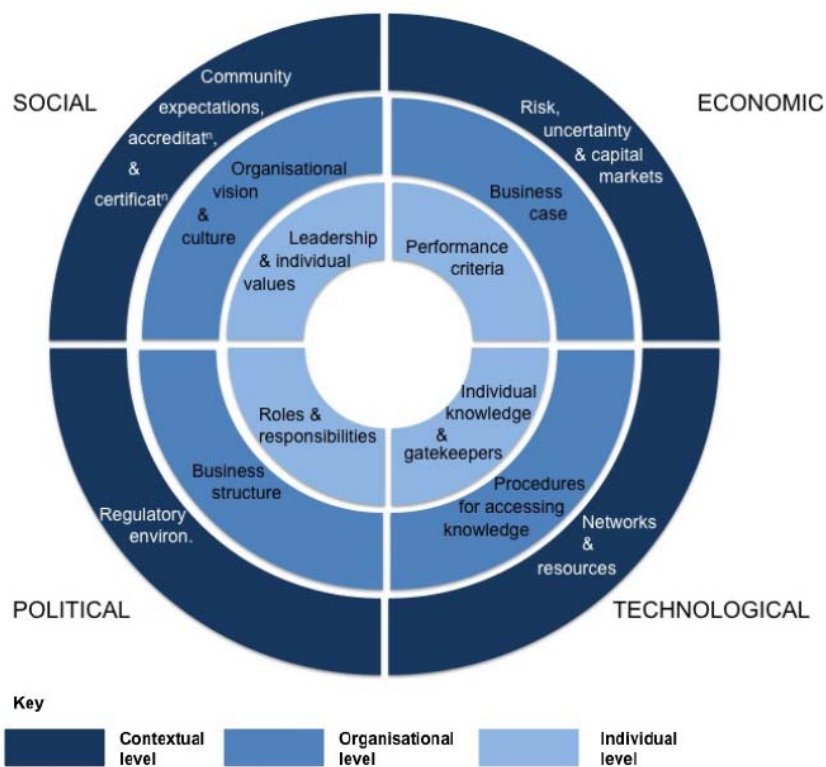


Figure 2-5: The Wheel of Organisational Behaviour

Source: Brookes et al., 2011:3.

⁵⁸ PEST refers to a widely used diagnostic tool to understand the effect of the macro-environment on organizational behavior (Brookes et al., 2011:2).

⁵⁹ In the context of the discussion included here regarding WSUD, the term *adoption* refers to implementation; while the term *adaptation* refers to changing certain elements.

More detail on each of these aspects is provided in Table 2.6 and the researchers (Brookes et al., 2011:5) applied this framework to two case studies – a greenfield industrial development and an infill commercial development - to determine whether the same factors motivated developers to consider WSUD. The outcome of the assessment is set out in Figure 2.6.

Table 2.6: Definitions of the Factors Included in the Wheel of Organisational Behaviour

	Contextual	Organisational	Individual
Political	Regulatory environment controls (or mandates) public behaviour through rule setting, monitoring and sanctioning activities. It broadly takes one of four forms: mandated policies and procedures, standards for performance and outcomes, reporting and information disclosure requirements, and incentives and disincentives (e.g. subsidies)	Business structure provides a framework for organising and coordinating business activities. It defines the roles and responsibilities of individuals and business units as well as the procedures (or rules) through which these roles and responsibilities can be achieved.	Roles and responsibilities permitted through the organisational structure define the rules governing individual behaviour.
Economic	Risk, uncertainty and capital markets relate to the likelihood of appropriating benefits, the realization of these benefits relative to business cycles, the age of traditional infrastructure and access to capital markets to ensure economic benefits.	Business case of project, policy or program that requires organisational commitment of human and financial resources. Many reasons influence it, including profit, efficiency, reputation, value and competitiveness.	Performance criteria gauge the behaviour and effectiveness of an employee or project. They are generally linked to the business case of the organisation and help ensure successful implementation.
Social	Community expectations, accreditation and certification represent society's expectations of organisational behaviour and have the effect of honouring or shaming their actions.	Organisational vision and culture articulates the goal and rationale behind a change initiative and is important in guiding cultural change in the organisation.	Leadership and individual values from management and employees is required in implementing the vision and culture espoused by the organisation.
Technological	Networks and resources facilitate the exchange of information, experiences and motivations between similar and associated organisations. Networks can help reduce uncertainty posed by externalities (such as markets) and provide confidence in new practices and	Procedures for accessing knowledge facilitate an organisation in recognising new external knowledge, assimilating it and applying it to commercial ends. The structure of the organisation is one method through which knowledge transfer is	Individual knowledge and gatekeepers are where knowledge is held an organisation. A gatekeeper is a particular individual that links the organisation to external pools of knowledge and translates the knowledge into a form that can be adopted. The success of this

	Contextual	Organisational	Individual
	technologies by linking organisations to examples and experiences of adoption that can answer questions of compatibility, certainty and complexity.	supported. Experience through implementation also provides background necessary to affirm the value of a technology /process and change organisational practices to support ongoing adoption.	translation is subject to the existing knowledge base of the other employees. This knowledge base is influenced by experience within the organisation, prior work experience, vocational training and network associations.

Source: Taken verbatim from Brookes et al., (2011:4) who based the table on work from Montalvo (2008), Benn et al., (2014), Doppelt (2007) and North (1990).

The findings of the research are set out in the following figure, and is said to reveal “the importance of economic factors at a contextual, organisational and individual level in stimulating adoption” (Brookes et al., 2011:1). From the diagram the importance of technological issues on the organisational level for both case studies are further highlighted.

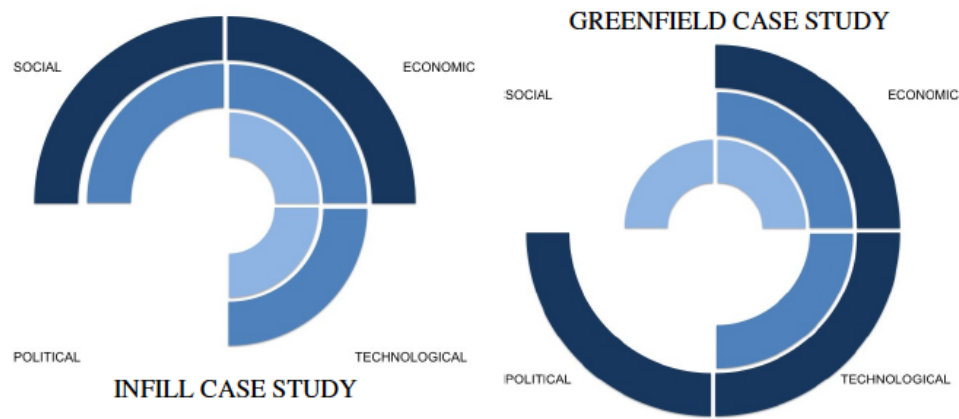


Figure 2-6: The Factors Identified as Influencing Adoption of WSUD in the Infill Commercial (left) and Greenfield Industrial (right) Case Study

Source: Brookes et al, 2011:7

Where the infill commercial development was concerned, the main driver behind adaptation was a strong community expectation specifically regarding sustainable design, whereas the greenfield industrial developments, where communities are not already present for the most part, the main driving force is “political will and the support of stakeholders in respect to leadership and knowledge” (Brookes et al, 2011:7).

It is clear that on the one hand, issues such as education, economic value and risk management are all driving forces behind design team decisions on sustainable building factors, but the need to build a strong business case for property owners and developers also show the importance of financial implications on the other hand - such as keeping the premium to create Green Star buildings at a minimum but also facilitating significant savings in operational costs associated with green buildings.

Similar to the assertions by Brookes et al., (2011:7), the importance of government buy-in and the associated momentum that can be created by introducing appropriate policy should not be discounted is noted by a range of other authors (see Wilson & Tagaza, [n.d.]; Warren, 2009; and Commonwealth of Australia, 2007).

Hoffman & Henn (2008:391) state that social and psychological issues are the biggest obstacles to adopting green building practices and using green building rating systems. This in turn necessitates raising stakeholder awareness and educating design teams and end users on green building concepts making it critical to their success (Zuo & Zhao, 2014:278).

The research into the adoption of the WSUD principles also illustrates that although it is unlikely that different development types will approach adoption of such principles in the same way, it “demonstrates how policy interventions can be more effectively targeted by assessing the PEST⁶⁰ factors in a private land developer adopting WSUD, and matching contextual and organisational drivers with policy levers” (Brookes et al, 2011:8).

The issue of policy is ongoing but it had an early start. Australian Ecologically Sustainable Development (ESD) legislation and policies provide very clear direction that Government buildings should use precautionary principles in all decision-making (Commonwealth of Australia, 2007). Cole (2005:1) states that the “precautionary principle in the context of environmental protection is essentially about the management of scientific risk”. Cole further declares that the

⁶⁰ Political, economical, social and technological.

precautionary principle is a fundamental component of the concept of ESD which is defined in Principle 15 of the Rio Declaration which he sets out in his article as: “Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation”. In this instance, a range of relevant pieces of Australian legislation drives decision-making.

Ashley & Cashman (2006:301) also argue that “the key drivers likely to impact on the long-term demand for infrastructure in the water sector” can be grouped into the headings like those used by the WSUD researchers: “socio-economic, technological, environmental and political”.

The researchers (Ashley & Cashman, 2006:303) state that the socio-economic issues, such as population growth, changing demand profiles and access to services could be expected to increase the costs of water service infrastructure.

Technological change could aid in keeping the increase in cost to a minimum through monitoring technology, or the use of green infrastructure. The author maintains that environmental/external stresses, like drought, will be the main change driver. Forcing the adoption of new approaches previously not considered due to increased abstraction, maladministration, and unsustainable actions, which are the biggest causes for water shortages, that could be further, complicated by climatic conditions (Leflaive, 2009:8).

In Australia, it is argued that droughts and water stress in the main cities have placed greater pressure on finding alternative or innovative ways of managing water (CSIRO, 2004). Lastly, the authors highlight political changes are likely to increase the relative cost of future water service delivery – and this is due to issues such as: “land use and urbanisation control processes; effectiveness of governance up and down the process, at national and/or local levels; the forms and needs of revenue collection (which may not improve due to political will); and increasing service levels driving infrastructure performance up” (Leflaive, 2009:8).

The issues set out above might provide more of an overview of the factors that could potentially drive decision-making in a broader context, not necessarily

building specific interventions, but there are also more design-focussed methods that guide project teams.

In some cases, design teams use Life-Cycle Assessments (LCA) to aid in decision-making. However, due to the high cost of such assessments (time and resource intensive); it is focused on decisions regarding different options for elements (wool carpet versus nylon carpet) rather than the entire building (Commonwealth of Australia, 2007). Green Star itself is also identified as a framework to assist with decision-making by providing a “coherent way to think through the design” (Commonwealth of Australia, 2007:13). It can however be argued that Green Star, with the various calculators it provides to design teams for use during the design and ultimate certification process sets itself apart from ordinary LCA’s, by giving teams the opportunity to see how different options will influence the performance results when compared to a notional base building⁶¹.

There are also a few authors that argue for the use of Building Eco-Assessment (BEA) tools⁶², which would facilitate strategic life cycle decision-making (see Cole et al., 2000; Barton et al., 2007; and Watson et al., 2004).

Learning from the experience related to the energy context in South Africa, decision-making can also be shaped by crises, or more accurately, how the building industry responds to crises. It seems that certain crisis times lead to action and change, indicating that decisions are not necessarily pro-active, but rather as a response to a specific context decision-makers are faced with. It has been said that: “The modern green building movement in South Africa started gaining momentum with the focus on energy efficiency brought about by the rolling blackouts in 2008” (GBCSA, 2012(a):30).

Zabel, as cited by Von Ketelhodt & Wöcke (2008:4) indicated “the basic approach by humans to natural resources result in their incorrect valuation”. They further provide examples of these approaches, where one states: “The scarcity of natural

⁶¹ This refers to a reference building created by the various calculators provided by the GBCSA to aid teams in calculating a benchmark to compare their improved building to. The notional or reference building complies “with various standards and schedules (including aspects of SANS 204: 2008) of the same size as the actual building and in the same location” (GBCSA, 2010: 1)

⁶² “Tools that facilitate strategic life cycle decision-making” (Watson et al., (2004:1)

resources is measured in quantity and prices”, and they also indicate that “natural resources are measured in terms of their extraction costs rather than in terms of their overall scarcity”. This makes it clear that unless severe fluctuations in the availability of water is experienced, obtaining water becomes more expensive, or the cost becomes higher, people might not be driven to change the way they think about this precious resource. This sentiment is further supported by an IMF staff discussion note (Kochhar et al, 2015:21), which states that “water pricing reforms are essential to rationalise demand, improve the delivery of services, and unlock additional water supply”.

Decisions regarding which credits to target will therefore be aided by the Green Star rating tools being used in specific building projects, and debated with the whole team during the Green Star project workshops that are undertaken together with the design team to ensure that all the members understand the client’s brief on sustainability. It would be crucial to engage with industry specialists to understand how the outcomes of these workshops are captured to determine if this could shed more light on specifically why credits in the Water Category were either chosen or discarded.

The aim of engaging with members of the Green Star certification project teams will be to assess whether there is a tendency among these professional teams to default to building design strategies that have previously assisted with obtaining points or whether decisions are linked to actual water stress trends or research.

2.5 Summative Remarks on the Literature Review

Water is a limited resource, and it experiences ever-increasing pressure due to climate change, urban development and population growth. There are competing water users, and uses and a balance is required to ensure a sustainable way of life. Various indices are available worldwide to measure the extent to which countries experience water stress. The findings of those assessments, as far as it relates to the three focus countries that form part of the current research, are clear: Australia and South Africa are both at a very high risk of water stress conditions. The water related challenges in New Zealand are less pronounced and linked more to pluvial flooding and nutrient pollution, but changing weather patterns might increase the associated risk in the long-term.

To ensure that water can keep sustaining life on earth in the most efficient way possible, alternatives are required in terms of how water is valued and ultimately managed and sourced. The importance of moving toward a green economy, places financial values on environmental resources making it possible to use market forces to protect resources.

Concepts such as green building and the related rating systems provide built environment professionals with the tools to design and construct more resource efficient buildings. Ultimately there are forces outside the control of such systems that guide how these rating systems are used. In related research, it was demonstrated that politics, society, economics and technology all play a role in what drives decision-makers to accept or reject recommendations related to development.

The following Chapter provides insight into the research design and method used in carrying out the research.

3 RESEARCH METHODS

This Chapter of the dissertation presents the research design and method used in carrying out the research. It provides an overview of the approach that was required for a study of this nature, methods of data collection and analysis. It also refers to all considerations that were made on ethical issues.

3.1 Green Star and Water Conservation Research Design

The overall purpose of the current research project is to determine whether Green Star is an effective mechanism for facilitating water conservation in the built environment. Being the first three countries to create, adopt and implement Green Star provided a strong argument for focussing on projects certified in Australia, New Zealand and South Africa. Securing and assessment datasets from all three countries provided significant data volumes. This allowed an analysis of projects certified over several years providing insight into potential trends toward the water credits, how the building industry might have changed its approach toward water conservation; and, allowed insight into the way in which the various Green Star Office rating system iterations have been moulded by industry response.

The intention of the research is to focus on commercial buildings certified under the Green Star Office rating tools in place in Australia, New Zealand and South Africa.

The specific data required, played an important role in determining the best method for data collection and sources of data utilised. The specific data required for the research included:

- a) Information on the development of the Green Star rating system;
- b) Data relating to the extent to which projects certified under the Green Star Office rating tool in the three countries under investigation have targeted specific credits in the Water Category; and
- c) Insight into the decision-making process that drives project teams to identify which credits or points to include in their respective Green Star strategies.

The research entailed a desktop study of relevant policies, legislation and research reports available to the researcher, with reference being made to academic works

of relevance. To reinforce the investigations, the exploratory, qualitative research process was further supported by comparative analysis, secondary data analyses, and a semi-structured questionnaire.

3.1.1 Qualitative Research

Brikci as referenced by Patton & Cochran (2007:2) states that “qualitative research is characterised by its aims, which relate to understanding some aspect of social life, and its methods which (in general) generate words, rather than numbers, as data for analysis”. LeCompte & Preissle (1994:141) believe “qualitative research is based on and grounded in descriptions of observations” and they go further in their assessment by stating that “these descriptions address the fundamental question, what is happening here?”.

The Green Star and Water Conservation research is based on qualitative research methods, and is regarded as an exploratory study which is defined as “a valuable means of finding out what is happening; to seek new insights; to ask questions and to assess phenomena in a new light” (Robson (2002:59) as cited by Saunders et al. (1997:133).

3.1.2 Comparative Analysis

Comparative analysis is used by researchers when a limited number of items are compared in “a focussed and systematic manner” to determine similarities or differences between the items (Hofstee, 2006:124). Tilly (1984) set out four types of comparative analysis: individualising, universalising, variation-finding and encompassing. The author states that individualising comparison contrasts a small number of cases to grasp the peculiarities of each case ((Tilly, 1984:82) as used by Pickvance, 2005:3).

Pickvance further holds that “Individualising comparison involves discovering how different two or more cases are”, and that “it is an essential pre-condition of comparative analysis since an accurate descriptive grasp of the specificities of cases is essential before comparison can begin” (2005:3).

Comparative analysis will be used by the current researcher to compare and assess the different versions of the Green Star Office rating tool. The intent of the comparison will be to create an in-depth understanding of the similarities and/or

differences between the various versions of the rating tool to determine whether a meaningful comparison of the available secondary data on projects certified through use of these different rating tool versions can be undertaken.

3.1.3 Secondary Data Analysis

This research method can be described as the “analysis of existing data collected by others” (Donnellan & Lucas, 2013:1). There are various advantages and disadvantages of using this research method, and selected examples based on the work of Pérez-Sindin López (2013) are listed below:

Advantages:

- Ability to save time during research, as no primary data collection is required, but rather the reliance of existing data.
- Accessibility of valid data not always possible, and reliance on secondary data could enable analysis of data previously inaccessible.

Disadvantages:

- Based on Hofstee (2006:129) and Pérez-Sindin López (2013: para. 5) referring to the work on Denscombe (2010) the first disadvantage of this research method is potential inappropriateness of the data. Data collected for a different purpose might not provide relevant data which can be used for a different study; and
- Referring to work by Saunders, Lewis & Thornhill (1997), Pérez-Sindin López (2013: para. 6) identifies the second disadvantage as the “lack of control over data quality”.

For the current research, secondary data refers to data obtained from the three GBCs relating to the projects that have undergone certification under the Green Star Office tools in each of the focus countries. This information was compiled on behalf of the researcher by each of the GBCs, using existing data collected as part of the certification process each project went through.

It was possible for each GBC to restructure the original datasets to extract information relating only to the number of points secured in the Water Category, as part of certification submissions. These repurposed datasets were deemed appropriate for the intended analysis as part of the current research.

Care was taken by the current researcher to identify any errors contained within the datasets that might impact negatively on the outcome of an assessment, and a clear record was kept of any changes made to the datasets before analysis commenced. An overview and the associated clean-up of these datasets are set out in more detail in Appendix E.

3.1.4 *Semi-Structured Questionnaire*

The intent behind using a semi-structured survey is “to elicit information from a limited number of individuals who are presumed to have the information you are seeking, who are able and willing to communicate, and who are (nearly always) intended to be representatives of a larger group” (Hofstee, 2006:122). Thus, the decision was made to use a purposeful sampling process to connect with relevant industry professionals to gain valuable insight.

Refer to Section 3.2.3 for more detail on the questionnaire design, sampling strategy, data collection and analysis method used.

3.2 Green Star and Water Conservation Research Method

3.2.1 *Green Star Office Rating Tools – Comparative Assessment*

To determine the validity of a comparison of Green Star Office certified buildings, it was essential to create a clear understanding of the similarities and differences between the various versions of the Green Star Office tool utilised by projects as contained in those datasets.

Data Collection:

Publicly available data was sourced with relative ease, but for the Australian and New Zealand specific data, the respective GBCs were approached. The final list of documents collected for review, included the following:

- Green Star RSA – Office v1 Technical Manual
- Green Star RSA – Office v1.1 Technical Manual
- Green Star AUS – Office *As Built* v2 – selected pages from the technical manual specifically referring to the compliance criteria for the Water Category and the related credits

- Green Star AUS – Office *Design* v2 – selected pages from the technical manual specifically referring to the compliance criteria for the Water Category and the related credits
- Green Star AUS – Office v3 (2008) – Technical Manual
- Green Star AUS – Office v3 (2008) Appendix A - selected pages on the environmental weightings used in the tool
- A report drafted by AECOM for the GBCA: Green Star Credit Development Water Category 31 March 2014
- Green Star NZ – Office *Design* and *As Built* v1 Water – selected pages from the Technical Manual December 2008. More specifically the section of the technical manual specifically referring to the Water Category and the related credits.
- Green Star NZ – Office 2009 Revision Feb 2014 - selected pages from the technical manual specifically referring to the Water Category and the related credits
- Green Star NZ – Office 2009 Revision Feb 2014 Appendix B – selected pages on the environmental weightings used in the tool
- Green Star NZ – Office 2009 Revision Feb 2014 Appendix D – Water Category Credit Allocation
- Green Star NZ –Water Credit Revision [n.d.] – selected pages

Where necessary, the information obtained from the GBCs was augmented from additional sources and other research papers that provided more insight into the origin of Green Star, the level of market buy-in into the certification process and the outcomes associated with Green Star certifications. Additional engagement with selected individuals at the NZGBC shed further light onto the tool development process and the extent to which external research was considered.

Data Analysis:

The technical manuals and related documentation were reviewed by:

- Examining the content of each manual, or Water Category section specifically;
- Noting the specific sections or content incorporated into the documents; and
- Reviewing, where possible, all supplementary documentation that could aid with creating an in-depth understand of separate credits or the workings of the Potable Water Calculator utilised by each GBC.

The review provided valuable insight into the Water Category in place in each country. This allowed for a comparison across the tools used to determine:

- a) Which credits were included in the Office rating systems used in the three focus countries – more specifically if all three countries included the same credits in the same manner.
- b) It was possible to compare the specific information provided for each credit in terms of its aim, the credit criteria, documentation requirements as part of the certification process, additional guidance provided, background information and references for further information.
- c) It was also possible to unpack the specific environmental weightings that were in place in the three focus countries to assess any differences in their approach.

3.2.2 Green Star Office Rating Tools – Secondary Data Analysis

In addition to the information set out above, all three GBCs provided datasets compiled internally. These datasets contain information on the projects that have achieved certification under the Green Star Office rating tool.

Data collection:

The datasets did not all include the same level of data, with the dataset provided by the GBCSA being the most comprehensive as it included data related to points obtained in the other environmental categories (i.e. energy, transport, innovation, etc.), along with the specific achievements in the Water Category.

Generally, the datasets had the following common data entries:

- Project identifier (in some instances this was just a project number, but in some cases, there was a clear link to the identity of specific buildings);
- The version of the rating tool used in the certification application;
- The specific rating achieved (in terms of the New Zealand data, the dataset included a reference to the total number of points a particular project obtained and the researcher therefore had to calculate the specific rating achieved);
- In the Australian tool the data differentiated between round 1 and round 2 certification submission outcomes;
- It referenced the specific credits by name and the number assigned to a specific credit by the relevant rating tools;
- The Australian dataset specified the specific number of points available under each credit and the number of points the project obtained at the end of the

assessment process. For the South African and New Zealand projects, the information on number of points available was augmented from the technical manuals obtained.

More detail regarding the origin of the datasets, information contained within the datasets and any data clean up required is set out for each of the countries in Appendix E.

Data analysis:

The intent behind the analysis was to gain insight into potential patterns, trends and overall performance of the Water Category and its related credits. Using an MS-Excel file, and applying relevant formulas to calculate averages, totals and percentages, the following findings were extracted from the datasets:

- Total number of projects included in the dataset;
- Total number of projects certified as 4 stars, 5 stars and 6 stars;
- Total number of projects per location;
- Location data set out in percentages;
- The average number of points achieved by all projects in each of the credits;
- An assessment of all projects in terms of the specific number of points achieved in each credit;
- An assessment of points achieved per credit in terms of percentage relating to total number of projects assessed;
- The number of projects that achieved all available points;
- Projects that achieved total number of points in terms of certification level reached;
- The number of projects that achieved the average number of points for the Water Category in total; and
- The number of projects that achieved the average number of points for the Water Category in total as a percentage of total number of certified projects included in the dataset.

More detail on the findings of these assessments is set out in Chapter 5 of this dissertation.

3.2.3 Green Star and Water Conservation Semi-Structured Questionnaire Questionnaire Design

From the extensive literature investigation, it was determined that data limitations relating to the behavioural psychology driving the decision-making process behind Green Star certification processes, existed. To overcome this obstacle, the use of a semi-structured survey to gain insight into the experience from Green Star professionals was chosen as a support research method.

The questionnaire consisted of 26 questions, both structured and unstructured, with the intent to obtain as much relevant information as possible. The question sequence was formulated in such a manner to provide a logical progression of information requests, starting with 12 initial questions aimed at getting to know more about the participant, and then turning to the Water Category. Asking questions on general aspects of the Water Category, and then moving into more specific questions on each of the credits contained within the category.

The final version of the Green Star and Water Conservation Semi-Structured Questionnaire utilised as part of the research process is included in Appendix J.

Sampling Strategy

Due to the nature of information needed to support the research process, a very specific respondent profile was created to help with identifying potential participants. The two key points in the respondent profile requirements driving the sampling profiling were:

- Respondents that have shown commitment to the green building industry required – the decision was made by the researcher to focus on individuals that have completed a one-day Green Star RSA Accredited Professional training course, has passed the associated examination and is registered with the Green Building Council of South Africa.
- It is also essential that the respondent has experience in the Green Star certification process.

The Green Star certification facilitation industry in South Africa is compact, and a select number of companies are most prevalent in playing the role of AP. It was due to the important and comprehensive role that AP's play that the decision was

made to focus on these individuals to understand the behavioural driving factors in the Green Star certification process. In consultation with Marloes Reinink, a Green Star industry specialist and research supervisor, a total number of 43 Green Star RSA AP's were identified to be approached for participation in the survey process.

Data Collection

Potential respondents were approached via e-mail with a short introduction on why they have been selected to participate; what the research focuses on; and then directing them to the more comprehensive introduction to the study contained in the survey document attached to the email.

The questionnaire was provided to respondents as a Word-based document, which could be filled in in electronic format and returned to the researcher; or could be printed out, filled in by hand and sent back to the researcher. After the initial request to participate in the survey process, the researcher followed-up with two reminder e-mails.

Of the 43 potential respondents approached, 12 people participated, representing 27% of the original purposeful sample. This was representative of eight firms currently active as Green Star certification facilitators.

Collectively, the respondents have participated in approximately 166 projects, of which approximately 100 were Green Star Office projects specifically. Considering that by the 16th of January 2016 a total number of 95 buildings were certified under the Green Star RSA Office v.1 rating tool, the outcome of the survey process seems adequate for providing insight into the certification and/or planning and design process. Extensive participation in such projects made the respondents ideal candidates to provide insight into the decision-making aspects associated with it.

Data Analysis

As stated in an earlier section, the questions contained within the semi-structured survey was varied, ranging from open-ended questions, rankings, scaled questions, multiple choice with a single answer, to dichotomous questions.

Since open-ended questions were also used, it was essential to review and code all answer sheets. This enabled the researcher to identify all responses, and to work toward finding any trends, patterns and similarities or differences in the answers.

An MS-Excel-based database was created to capture the responses received. This allowed assessment of the answers provided to the structured questions, as well as gain insight into the feedback provided through the open-ended sections of the survey. More detail on the findings of the survey is included in Chapter 5 of this dissertation, with a general overview included as Appendix K.

3.3 Ethical Considerations

Due to the use of a survey process as part of the research methodology, it was essential to obtain clearance from the University of the Witwatersrand School of Architecture and Planning Research Ethics Committee. During the survey process, potential respondents were provided with clear information on the nature of the research project, limitations or consequences of their participation, and a clear understanding that they can terminate participation in the process at any time. During the analysis of data obtained through the surveys, each completed questionnaire was assigned a letter from A to L as the only distinguishing feature, with all personal information of the respondent removed.

To secure certified project specific data, the relevant GBCs were required to approve access to sensitive information. Except for the South African dataset, the researcher was required to sign strict confidentiality agreements before the datasets were released. More information on the application process to obtain the datasets and the specific nature of the confidentiality agreements can be found in Appendices F, G, H and I.

These agreements uphold the researcher's intention to keep the datasets in the strictest of confidence, to use the data to create comparable information for consideration, and that none of the data will be published in its entirety or linked to specific project identifiers.

4 DEVELOPMENT OF THE GREEN STAR WATER CATEGORY

4.1 Introduction

The literature review clearly shows water stress is a key indicator of the state of the resource in a specific country. Australia and South Africa are expected to have a higher probability than New Zealand to experience severe water availability issues, but changing weather patterns and local context could lead to increased water challenges.

This section provides an overview of the issue that prompted the development of green building guidelines, the development of the Green Star rating system and it unpacks each credit contained within the Water Category in detail. The intent is to ensure that comparison of buildings certified with different versions of the Green Star Office rating tool is appropriate, flagging any concern that require further consideration to interpret the findings of such a comparison within the correct context.

4.2 Response to a Changing Environment

Through work done by the International Bank for Reconstruction and Development/The World Bank (2011), a guide for climate change adaptation in cities was compiled. The guide identifies the potential impacts of climate change on the different regions of the world were identified, it sets out a framework that cities could refer to for an understanding of the convergence of disaster risk management an adaptation strategies, and it also includes a range of sector-specific adaptive responses.

The following issues were relevant to the Green Star and Water Conservation research was raised:

Table 4.1: Potential Impacts of Climate Change on the Different Regions of the World

Region	Potential Impact
Africa	- Increased water stress for 75-250 million people by 2020. - Agricultural production and access to food is projected to be severely compromised in many countries and regions of Africa. - Threats to low-lying coastal areas posed by sea-level rise. - Further degradation of mangroves and coral reefs projected and additional consequences for fisheries and tourism. - Decreased fisheries resources in large lakes, which could be exacerbated by overfishing.

Region	Potential Impact
Australia and New Zealand	- Intensified water security problems in southern and eastern Australia and parts of New Zealand by 2030. - Significant loss of biodiversity in ecologically rich sites by 2020, including the Great Barrier Reef and Queensland Wet Tropics. - Increased risk from sea-level rise, more severe and more frequent storms, and coastal flooding in the Cairns region and southeast Queensland (AUS), Northland to the Bay of Plenty (NZ), and other coastal communities with ongoing development and population growth by 2050. - Some initial agricultural benefits in western and southern New Zealand, such as longer growing seasons, less frost, and increased rainfall. - Decreased yields from agriculture and forestry by 2030 because of increased drought and fire, in much of southern and eastern Australia and parts of eastern New Zealand.

Source: Taken verbatim from - The International Bank for Reconstruction and Development/The World Bank (2011:96)

But the guide further highlights the fact that “adaptation efforts in cities offer co-benefits for climate change mitigation and for local economic development” (The International Bank for Reconstruction and Development/The World Bank, 2011:5). One way for cities to create resilience is by investment in adaptation, specifically when those investments are focussed on increasing “the resilience and reliability of urban infrastructure”, which in turn “can improve broader economic performance by increasing city competitiveness and attractiveness for investors” (The International Bank for Reconstruction and Development/The World Bank, 2011:5).

The guide also identifies Green Building investment as another potential way of facilitating adaptation in cities. “The private sector and development agencies often drive a large part of a city’s economic and land use decisions, and can, thus, promote the city’s resilience by making investment decisions that take climate impacts into consideration (for example, appropriate building designs in flood-prone zones, improved standards of waste and wastewater treatment, and promotion of green building designs that can cool occupants naturally)” (The International Bank for Reconstruction and Development/The World Bank, 2011:27).

And it is exactly this commitment and drive by the private sector to improve the value of the assets created in the built environment, and the need to “provide industry with an objective measurement for green buildings” (GBCSA, 2008:ix) that led to the creation of the Green Star rating system in 2003. The following sections of this Chapter will provide insight into the development process, the factors that influenced the specific approach taken to water conservation.

4.3 Green Star: The Beginning

In an earlier section, it was stated that the GBCA developed Green Star in 2003, but a more accurate overview of the development history of the tool reveals that “the strategic consulting, engineering and project delivery company - Sinclair Knight Merz - through a Memorandum of Understanding with the Building Research Establishment, developed Australian BREEAM in 2000” (Cole, 2014:11). Cole further states that this tool was later sold to the GBCA in 2002 that subsequently developed it as the Green Star system we still use today (Cole, 2014:11).

Saunders (2008:43) intimates that the fact that Green Star was based on the BREEAM methodology makes these two systems very similar. However, he highlights that since the launch of Green Star, the assessment methodology has been adapted to make the delivery system more aligned with the LEED approach.

Saunders sets out a range of similarities and differences between these three related tools and he drew up the following comparison⁶³:

Table 4.2: Comparison of BREEAM, LEED and Green Star⁶⁴

	BREEAM	LEED	Green Star
Launch Date	1990	1998	2003
Ratings	Pass / Good / Very Good / Excellent / Outstanding	Certified / Silver / Gold / Platinum	One Star / Two Star / Three Star / Four Star / Five Star / Six Star
Weightings	Applied to each issue category (consensus based on scientific / open consultation)	All credits equally weighted, although the number of credits related to each issue is a de facto weighting	Applied to each issue category (industry survey based)
Categories ⁶⁵	1. Energy Use 2. Transport 3. Water 4. Ecology 5. Land use 6. Materials 7. Pollution 8. Health and Well-being 9. Management 10. Innovation	1. Energy and atmosphere 2. Water efficiency 3. Sustainable sites 4. Materials and resources 5. Indoor environmental quality (IEQ) 6. Innovation	1. Energy 2. Transport 3. Water 4. Land use and ecology 5. Emissions 6. Materials 7. IEQ 8. Management 9. Innovation

Sources: Saunders (2008: 9); Sebake (2009:3)

⁶³ It should be noted that the original table included reference to the Japanese CASBEE rating system but it was omitted due to non-relevance to the current research.

⁶⁴ The original table compiled by Saunders (2008:28) is not included due to relevance, and additional data from separate sources have been included for the purpose of this research.

⁶⁵ As set out by Sebake, (2009:3).

Clearly there are similarities between the systems, but Saunders (2008:42) also highlights the fact that “none of the schemes travel well if used in countries other than those which the system was initially designed to work in”⁶⁶, which could be regarded as an indication of the context relevant specificities of such tools. Saunders (2008:6) ascribes this context specific approach, “at least in part, from each system relying on local regulatory minima to achieve certain aspects of performance”. This, in turn, could lead to buildings securing much higher certification levels in comparison to those merely adhering to local legislation or standard practices (Saunders, 2008:6).

All three the rating systems set out in the preceding table include a category specifically aimed at water. Understanding how these categories were developed could therefore provide further insight into the specifics of how each system views water conservation.

4.3.1 Green Star Origins: BREEAM as the Starting Point

The primary aim of the BREEAM rating system is to “mitigate the life cycle impacts of new buildings on the environment in a robust and cost effective manner” (Waidyasekara et al., 2013:109). Saunders (2008:32) notes that BREEAM was originally launched in the 1990s and constant review and updating keeps it ahead of UK Building Regulations and allows it to stay in line with current best practice. Along with various sources referred to in earlier sections of this dissertation, Mitchell (2009:3) supports the idea that BREEAM is widely regarded as the world’s first green building rating system.

Investigations into the BREEAM Australia claim mentioned in the preceding section were hard to verify and no specific information relating to such a document was uncovered by the current research. The information obtained was however deemed sufficient for the researcher to create a basic understanding of BREEAM in general and how it informed the creation of the Green Star system.

⁶⁶ This inability of rating systems to “travel well” demonstrates the need to context specific tools to be developed and used in a way that address local issues. Green Star seems to have been able to provide just such a system for Australia, New Zealand and South Africa as demonstrated throughout this dissertation.

Although access to the original BREEAM documentation was restricted ⁶⁷, information obtained from the technical manual version SD5073 – Issue 3.0 (Date 18/10/2012) for New Construction, was considered sufficient for the purposes of the current research. BREEAM consists of 10 categories as set out in Table 4.3, but it is the Water Category that is of interest to the current research.

The function of the Water Category is to encourage “sustainable water use in the operation of buildings and its site” (BRE 2017(a): section 4, click on the water icon). Unfortunately, the website nor the TM provide any detailed insight into the reasoning behind the aim for the Water Category, or specifies which research (if any) informed the development of the water credits. It does however provide insight into the water credits, and the available number of points associated with each. These are set out in the following table.

Table 4.3: BREEAM Water Credits Overview

No.	Credit	Aim of the Credit	Points Available
WAT-01	Water Consumption	The aim of this credit is to reduce the consumption of potable water for sanitary use in new buildings from all sources through the use of water efficient components and water recycling systems. The points available under this credit is awarded through the use of a sliding scale of achievement – a 12.5% improvement will earn a project 1 point while a 55% improvement will secure all 5 points.	5
WAT-02	Water Monitoring	The aim of this credit is to ensure that water consumption can be monitored and managed and therefore encourages reductions in water consumption.	1
WAT-03	Water Leak Detection and Prevention	The aim is to reduce the impact of water leaks that may otherwise go undetected.	2
WAT-04	Water Efficient Equipment	To reduce unregulated water consumption by encouraging specification of water efficient equipment.	1
Total			9

Source: Based on information taken from BRE (2011:300-320).

As part of the annual revision process associated with the BREEAM tool in 2008, the innovation category credits, minimum standards and an introduction of mandatory post-construction reviews were implemented (Wikipedia, <https://en.wikipedia.org/wiki/BREEAM#History>). These revisions brought BREEAM closer to the Green Star rating tools projects used today. A briefing paper on the “New methodology for generating BREEAM scheme category weightings”

⁶⁷ According to electronic communication received from Tamsin McCabe, a BREEAM Technical consultant acting on behalf of BRE Global Limited, BREEAM documentation is exclusively available to trained assessors (McCabe, 2016: Electronic communications)

(Taylor & Ward, 2016:1), “weightings lie at the heart of any building sustainability assessment scheme that provides a single score or rating for overall performance”. Refer to Appendix C for more detail on the new methodology behind the BREEAM core weightings development process.

The process of defining category weightings is complex. This is attributed to the fact that the aim behind the categories within BREEAM focus on different impacts; some address environmental impacts (including global warming and resource depletion), other impacts relate to social or economic sustainability (Taylor & Ward, 2016:2).

In an ideal situation, weightings would be based on quantifiable evidence relating to the anticipated impact or benefit and cost associated with every issue addressed by the various categories (Taylor & Ward, 2016:2). Due to the complex nature of rating tools, the number of categories and issues being addressed are too wide with significant gaps in scientific knowledge (Taylor & Ward, 2016:2).

Taylor & Ward (2016:2) believes it is possible to use category weightings as a way of assigning importance – the higher the weighting, the more important a specific category is believed to be. The specific weightings are set out as follow:

Table 4.4: BREEAM Environmental Section Weightings⁶⁸

Environmental Section	Weighting
Management	12%
Health and Wellbeing	15%
Energy	19%
Transport	8%
Water	6%
Materials	12,5%
Waste	7,5%
Land Use and Ecology	10%
Pollution	10%
Total	100%
Innovation (additional)	10%

Source: BRE (2011:23)

⁶⁸ ‘BREEAM uses an explicit weighting system derived from a combination of consensus based weightings and ranking by a panel of experts. The outputs from this exercise are then used to determine the relative value of the environmental sections used in BREEAM and their contribution to the overall BREEAM score’ (BRE, 2011:23).

In terms of *environmental weighting* (only introduced after the creation of the Australian version of the Green Star tool) the Water Category is assigned the lowest importance. The relatively low weighting of the Water Category can be understood better taking into consideration the statements made by Brown et al. (2016:66) in a journal article detailing an assessment into flow regulators installed in washroom taps at a specific office building. In the article, these researchers state, “in the operation of a non-residential building the water supply costs are marginal, relative to the other utility costs”. They further argue that it is due to the low cost of water that leads to a reduction in “the level of priority that organisations place on water efficiency”. One does wonder how this might change in times of ongoing drought as currently being experienced in South Africa, which places a severe restriction on water availability – placing water at a premium regardless of the low price associated with the resource.

Brown et al. (2016:66), further hold that “government policy in the UK and EU (and elsewhere) supports reducing water consumption due to the environmental benefits of reduced consumption both in terms of energy savings and reduced impacts on water supply sources”.

In an article on Britain’s water crises, Davies (2015: para. 14) refers to a government white paper that ‘considered various possible scenarios for the future water supply across the whole country’. Davis indicated that the white paper concluded: “All of the scenarios predicted a future with less water available for people, businesses and the environment. Future pressures will not be limited to the south and east of England. Under many of the scenarios, the south-west and northern England will see significant unmet demand.” Which begs the question why BREEAM still places such low importance on water efficiency and usage reduction.

The BRE suggests that the use of environmental weightings is essential for the environmental assessment of buildings. This will provide a method for prioritising the potential impacts of such a building. McCabe (2016: Electronic communications) indicated that the weightings methodology of BREEAM UK was recently updated. Prior to the update, BREEAM weightings for non-domestic building assessments were all derived from a “core set of weightings”. McCabe

(2016: Electronic communications) states that these “core weightings were developed through a combination of expert consensus and life cycle assessment (LCA)”. The intent was that these core weightings should “reflect the environmental impacts resulting from the design, construction, operational, maintenance and end of life processes associated with non-domestic (sic) buildings”.

The more recent approach to calculating the weightings to be used by BREEAM tools going forward is somewhat different to the historical approach. Set out by Taylor & Ward (2016:3), the consensus-based category weightings were developed during a process involving two cycles of public participation. Additionally, the process has also been the subject of at least two peer review studies and it is stated that “the new BREEAM weighting methodology is intended to address the inherent difficulties with establishing category weighting for sustainability assessment schemes” (Taylor & Ward, 2016:4).

The following diagram provides a simplified overview of the two-stage process associated with defining the new weightings.

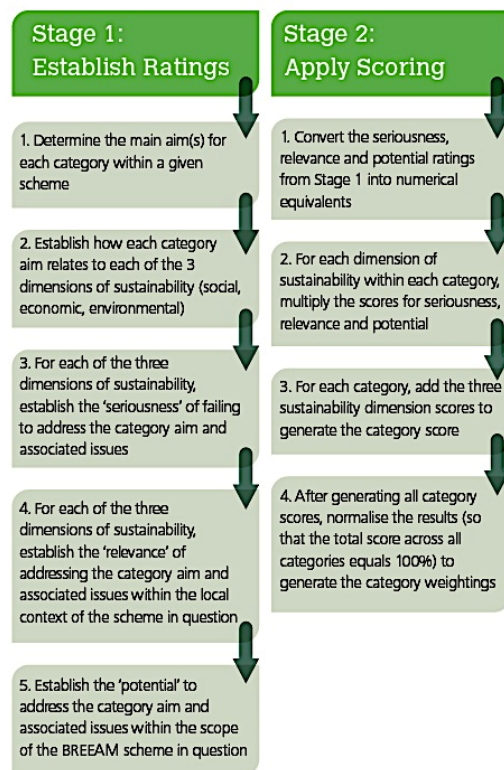


Figure 4-1: BREEAM Weightings Methodology Process Flowchart
Source: Taylor & Ward (2016:3)

Taylor & Ward (2016:4) indicate that the updated weightings generated through this new methodology will be reviewed at least every five years, as issues of importance might change over time. Requests for information from the BRE regarding the newly formulated weightings remain unanswered, but this was expected as the new methodology only announced during 2016.

4.3.2 Green Star Origins: LEED as an Important Contributor

Another tool that was instrumental in the creation of the Green Star rating system was the US-based Leadership in Energy and Environmental Design (LEED) – “a voluntary, consensus-based national standard for developing high-performance, sustainable buildings” (GBCSA, 2008:xxix).

The LEED Reference Guide for Green Building Design and Construction (USGBC, 2009:xii) notes that each “LEED rating system is organized into 5 environmental categories: Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, and Indoor Environmental Quality”.

It is when one delves further into the specifics of the Water Efficiency category that one notices more similarities but also the differences between LEED and Green Star. The introductory section of the Water Category in the LEED guide is more comprehensive than what is included in the Green Star technical manuals (more on this is included in a later section of this dissertation). It clearly spells out the water consumption patterns of the United States. It highlights issues around water availability and it touches on the fact that “efficiency measures can easily reduce water use in average commercial buildings by 30% or more” (USGBC, 2009:161).

There are no pre-requisites in the Water category of Green Star, while LEED projects are required to reduce potable water use by at least 20% when compared with a “water-use baseline calculated for the building (not including irrigation)”, although additional points are available if further water use reductions can be made (USGBC, 2009:165).

The specifics of the Water Efficiency category are set out in the following table:

Table 4.5: LEED Water Efficiency Credits and Prerequisites Overview

Credit	Title	Points Available in New Construction Projects
WE Prerequisite 1	Water Use Reduction	Required
WE Credit 1	Water Efficient Landscaping	2-4 points
WE Credit 2	Innovative Wastewater Technologies	2 points
WE Credit 3	Water Use Reduction	2-4 points

Source: USGBC, 2009:163

The LEED guides seem to provide the most comprehensive information as part of the motivation to project teams for pursuing specific credits. In terms of how the guide is set out, and the level of information included, there is no uncertainty regarding the extent of the problem a specific credit wishes to address, the research that backs up the thinking and it also provides clear links to other credits within the LEED system that is affected by one another. This also helps project teams constantly keep a larger context in mind, rather than focussing on the minutiae of specific credits and the possible points that can be obtained instead of holistic systems thinking.

LEED v4 is the latest version, which, per the USGBC (2017(a): para. 1) provides a streamlined, specialised tool with a better user experience. In the newest version of LEED, the Water Efficiency (WE) section “addresses water holistically, taking into account indoor use, outdoor use, specialized uses and metering. It measures all sources of water related to a building, including cooling towers, appliances, fixtures, fittings, process water, and irrigation” (USGBC, 2017(a): para. 7).

There is a drive toward whole-building-level water metering to allow for greater control over water use and the ability to identify additional areas of potential water savings (USGBC, 2017(a): para. 7). LEED v4 further encourages projects to reuse water, including “reclaimed wastewater, greywater, condensate, process water, and rainwater, for irrigation, toilet flushing and more” (USGBC, 2017(a): para. 7).

Introduced by LEED 2009, Regional Priority (RP) Credits provide incentives through existing credits as bonus points, linked to issues designated as particularly important. LEED v4 makes the RP Credits accessible to any project in the world, per the specific environmental issues for different regions (USGBC, 2017(b): para. 1), with international projects now being afforded the opportunity to access credits that address specific issues of that country (USGBC, 2017(c): para. 1).

For instance, projects located in water stressed countries will be able to secure additional RP or bonus points for additional water savings over and above the standard LEED requirements.

4.3.3 *Green Star: Summative Remarks*

Reviewing BREEAM and LEED creates clarity on the shared characteristics of these systems with Green Star. Similar strategies are included as part of the overall approach to facilitate a reduction in the use of potable water, all realising the importance of water use linked to irrigation.

Green Star AUS was extensively based on the BREEAM and LEED rating systems. Clear similarities between these tools are therefore expected. Early in the development process of Green Star, the decision was however made to use a more interactive approach to develop its first rating tool (GBCA, 2012:18). Green Star AUS originally started out as BREEAM Australia, and with the help of a technical team consisted of industry professionals, academics, public officials and large property industry organisations. The system we use today was created with a more focussed view on addressing the location specific issues faced by Australia.

4.4 Unpacking the Water Category and its Credits

Green Star, LEED and BREEAM are interwoven, with many similarities and borrowed intent. However, the focus of the current research falls on Green Star specifically, and the remainder of this section will be used to delve into it in more detail.

4.4.1 *Green Star: Environmental Weighting*

Green Star consists of nine environmental categories, each with its own credits, all with a focus on addressing very specific aspects related to building design and operational performance. Each Green Star tool that is put to the market has its own technical manual (TM) specifically created to provide design teams with information that will enable them to determine the environmental attributes of the buildings being created and allow for improvement (GBCSA, 2008:v).

Each manual begins with an introduction, which provides the reader with an overview of the Green Star RSA rating process, its credits, how the certification process works and it provides an extensive glossary. It then offers a short guide

on how the technical manual will present information for each credit, how the guide should be used and then delves into each category and its associated credits in more detail. For each of the nine categories, the manual includes a short introduction into the category, usually one or two pages. This is followed by a more detailed overview of each of the credits within the relevant category.

Early in the Green Star Technical Manuals, the issue of environmental weighting is raised, mainly to educate the reader that such a factor will be applied to the percentage score of each category, to arrive at a single score (GBCSA, 2008:x). During in-person and electronic communication, Reinink⁶⁹ over the course of 2016, indicated that when the GBCA conceptualised the Green Star rating system, the use of an environmental weighting factor was envisioned as a way in which to make geographical differentiation possible. Reinink (2016: Personal communication) also indicated that the original intent for South Africa was to allow the weightings to be adapted over time to highlight specific provincial priorities.

Green Star is a voluntary, national rating system, and all three countries using Green Star have geographical differences and environmental factors that impact on how specific resources are viewed. Zuo & Zhao (2014:273) state that “It is worth noting that green buildings in different countries are designed and built according to local climatic conditions and to suit the requirements of the locals”. It is for this reason, that they believe that the assessment criteria in different green building rating tools approach the concept of water conservation differently. In their research, Zuo & Zhao found that different states within Australia, although all using the same rating tool, apply weightings differently⁷⁰: “For instance, Water Category receives a weighting of as low as 10% in Northern Territory and Queensland; and as high as 15% in South Australia, Tasmania and Victoria in GBCA Green Star Healthcare V1 tool” (2014:273). Although the authors do not elaborate on their position, Zuo & Zhao argue that the different applications⁷¹ of the weighting factor are most likely due to the ‘more significant issue associated with water resources in these three states’. This thinking is also supported by the documentation created

⁶⁹ Marloes Reinink formed part of the Technical Working Group responsible for the “technical development of the Green Star RSA – Office v1 rating tool” (GBCSA, 2008:vii).

⁷⁰ Although Zuo & Zhao (2014:273) indicate the weightings are applied differently, a more accurate statement would be that weightings are set per state priorities but still *applied* in the same manner.

⁷¹ Refer to Footnote 58.

by the GBCA. What drove this formulation of the specific environmental weightings?

Australia

Access to the original documentation created for the first Green Star AUS Office rating system was limited, but through extracts of the 2008 v3 TM (GBCA, 2008), the approach to developing a weighting system is set out. More specifically, the technical manual (TM) states: “A rating tool that provides a single score must include some assumptions regarding the relative importance or environmental impact of different building features” (GBCA, 2008:419).

Using the “framework adopted by the United Kingdom’s BREEAM (Building Research Establishment’s Environmental Assessment Method) system to provide more flexibility in the approach to weightings, the Green Star AUS tool also used the same “two-tiered weighting structure” (GBCA, 2008:419):

- 1) “Each credit category (e.g. Energy, Indoor Environment Quality etc.) has an environmental weighting; and
- 2) The number of points allocated to each issue (e.g. Daylight and Noise in Indoor Environment Quality Category) is effectively a weighting between issues within a credit category”.

Furthermore, it is stated that the category weightings used by Green Star AUS were formulated after engaging scientific and stakeholder opinions, with the following documents also consulted:

- “Environmentally Sustainable Buildings: Challenges and Policies – a 2003 report by the OECD (Organisation for Economic Co-operation and Development);
- Australia State of the Environment – a 2001 report by the Commonwealth Department of Environment and Heritage;
- Comparison with overseas rating tools BREEAM (UK) and LEED (USA and Canada); and
- A national survey undertaken by the Green Building Council of Australia (GBCA) in 2003. The survey was adapted from the survey process used by the Building Research Establishment to assist in the allocation of appropriate environmental weightings for each of the categories” (GBCA, 2008:419).

The following table provides some insight into the findings of those assessments:

Table 4.6: LEED and BREEAM Weightings (%) and the Results from the 2003 National GBCA Survey

Category	LEED	BREEAM	GBCA Survey Results
Management	7	15	10
Indoor Environment Quality	22	15	17
Energy	24	12.5	20
Transport	6	12.5	9
Water	7	5	9
Materials	16	10	16
Ecology	13	15	12
Emissions	4	15	7
TOTAL	99⁷²	100	100

Source: GBCA (2008:419)

From the same extract of the 2008 technical manual (GBCA, 2008:420) it is determined that the GBCA felt that “the relative weighting of environmental issues provides regional sensitivity to the various Green Star rating tools”. It also states that “the regional weightings used in the various Green Star rating tools apply variations to average weightings to reflect issues of importance in each state or territory” but when considering the table below, the only two categories that implemented different weighting factors were Water and Ecology.

Table 4.7 sets out the specific weightings applied in the six states: New South Wales, Queensland, South Australia, Tasmania, Victoria and Western Australia; and it also shows how the weightings are applied in the two mainland territories, the Australian Capital Territory (ACT) and the Northern Territory (NT) which fall outside the borders of the state.

Each state has its own state constitution, which divides the state's government into the same divisions of legislature, executive, and judiciary as the federal government (Australian Government, [n.d.]:1). Additionally, it is noted the two mainland territories and one offshore territory, Norfolk Island, have been granted a limited right of self-governance by the federal government. In these territories, ranges of governmental matters are now handled by a locally elected parliament (IBID).

⁷² The current researchers believe some error has occurred in how data is reflected in this table taken from the Green Star AUS – Office Design and As Built v3 TM (2008:419) as the LEED score should also add up to 100 as illustrated in Table 15 of this dissertation.

Table 4.7: State Variations in the Green Star - Office v3 Weightings

	No. of points	NSW %	ACT %	NT %	QLD %	SA %	TAS %	VIC %	WA %
Man	12	9	9	9	9	9	9	9	9
IEQ	27	20	20	20	20	20	20	20	20
Ene	24	25	25	25	25	25	25	25	25
Tra	11	8	8	8	8	8	8	8	8
Wat	13	12	12	10	14	15	10	15	14
Mat	23	14	14	14	14	14	14	14	14
Eco	8	6	6	8	4	4	8	4	5
Emi	14	6	6	6	6	5	6	5	5
TOTAL	132	100%	100%	100%	100%	100%	100%	100%	100%

Source: GBCA (2008:420)

The states that assign the highest weight to the Water Category are South Australia (SA) and Victoria (VIC) both with 15%, followed by Queensland (QLD) and Western Australia (WA) with 14%. From the information provided in the technical manuals it is unclear how these weightings were derived, a sentiment that is shared by AECOM (2014:11) in a report that was compiled as part of the process of a complete shake-up of the Green Star AUS rating tools. In their report, AECOM states that “it appears that the overall Water Category is weighted appropriately and reflects the relative importance or impact this category has within the Australian environment” but further states that “it is unclear from where the weightings for the Water Category originated” (2014:11).

Although historically the Green Star AUS tools have allowed for state differentiation of weights assigned to the Water Category, this is coming to an end. The AECOM report (2014:1) provides insight into how the Water Category and its related credits could be affected by the fact that “the Green Building Council of Australia (GBCA) is condensing the *Design* and *As Built* suite of tools into one tool that is flexible enough to cover all building types”. The most important issue relates to the advocacy for the removal of the use of state-based weightings. AECOM (2014:11) advises that in order “to ensure consistency with how environmental issues are dealt with at a national level the state-based weighting system should be removed”. AECOM feels that the two key issues in the Water Category, rainfall and evaporation, is dealt with adequately in the latest version of the Potable Water Calculator to be introduced by the newly condensed tool, which they argue, provides sufficient local consideration.

So, does a national system provide significant opportunity to capture these geographically defining factors, and does it need to? The specific environmental conditions in different parts of a country could be diverse and that is also supported by the original approach of the GBCA to allow for different weightings to be used in different states. The latest thinking (AECOM, 2014:2) is that the locality specific information contained in the Potable Water Calculator provides for sufficient differentiation and using one weighting across the country is the better approach.

New Zealand

Davison (2016: Electronic communications, line 2) provided insight into how the weightings were devised in New Zealand. She indicated that when the Green Star system was adapted from the original Australian version, “the weightings were changed slightly regarding the Water Category”. She highlights the fact that water issues in NZ are different from those being faced in Australia, which she links to the “abundance of rain” that in turn led to the reason behind the lowering of the weighting associated with the Water Category. For NZ, the bigger concern is around “peak rain events and the potential for pollution & (sic) stream damage during storm events (though this is covered in the storm water (sic) credit in the emissions category, not in the Water Category)” (Davison, 2016: line 6). More specifically, the weightings adopted by Green Star NZ is set out in the table below:

Table 4.8: Green Star NZ Office - Weightings

Category	% Weighting as per Green Star NZ Office
Management	10%
Indoor Environment Quality	16%
Energy	25%
Transport	10%
Water	10%
Materials	14%
Ecology	10%
Emissions	5% ⁷³
TOTAL	100

Source: Davison (2016: Electronic communications)

The low weighting assigned to the Emissions category is surprising given the importance assigned to storm water and pluvial flooding in the NZ context.

⁷³ The low weighting assigned to the Emissions category is surprising given the important assigned to storm water and pluvial flooding in the NZ context.

The Green Star NZ – Office 2009 technical manual notes that the process of establishing the weightings were similar to the process followed by the GBCA. The outcome for the Water Category was also reminiscent of the GBCA weightings but significantly higher than the weightings contained in both BREEAM and LEED.

Table 4.9: Comparison of Effective Weightings for Commercial Buildings

Category	LEED (%)	BREEAM (%)	GBCA (%)	NZGBC (%)
Management	7	15	10	10
Indoor Environment Quality	22	15	17	20
Energy	24	12.5	20	25
Transport	6	12.5	9	10
Water	7	5	9	10
Materials	16	10	16	10
Ecology	13	15	12	10
Emissions	4	15	7	5
TOTAL	100	100	100	100

Source: GBCA (2008:419), NZGBC (2014(a):257)

South Africa

In terms of devising the weightings where the South African tools are concerned, it is stated that “the weightings were derived through consultation with industry experts considering the Australian weightings and deliberating on the relative importance of issues in the South African context” (GBCSA, 2008:365). It is essentially the same system as the Australian tool, with the only difference being that South Africa assigned a weighting factor of 14 while Australia only assigned a 12.

4.4.2 Water Category – the Introduction Section

As previously noted, each Green Star rating tool is presented to the market through a Technical Manual (TM). A TM is a comprehensive guideline that project teams use to go through the various design elements associated with a project. All the TMs reviewed as part of the current research project introduces each of the environmental categories, followed by the specifics that make up each of the credits incorporated into that specific category.

Australia

In the Australian tool, there are five paragraphs in the introduction. Each TM reviewed had the same opening line: “Within the Water Category, credits address the reduction of potable water use through efficient design of building systems, rainwater collection and reuse” (GBCSA, 2008:191).

The second paragraph refers to the importance of water, factors that affect fresh water supplies and it highlights the fact that Australia is the driest inhabited continent and the third largest per capita water consumer where demand for water is outstripping supply rapidly (GBCA, 2008:203).

The third paragraph links improved design with the potential to reduce operational costs (GBCA, 2008:203). It identifies recycling from rainwater, greywater and black water as possible ways to reduce the use of potable water and it also provides a reference to the 10% of sewerage, which is currently being recycled in Australia. This system is referred to as "*the third pipe*".

The fourth paragraph provides insight into average water use of an average sized office building – determined to be over 20,000 litres per day for an office sized 10,000m², or more than 7 million litres per annum (Australian Government Department of Environment and Heritage as referenced by GBCA, 2008:203).

The fifth and final paragraph is shared by the AUS and RSA TMs; reiterating the need to reduce potable water consumption in buildings (GBCSA, 2008:191; GBCA, 2008:203). Similar statements are then used in each TM to highlight that "such reductions will ease the pressure on the relevant countries water resources as well as continue to contribute to the most cost efficient operation of buildings" (GBCSA, 2009:191; and GBCA, 2008:203).

New Zealand

The introduction section in the NZ tool is three paragraphs. The first paragraph is the same as the AUS TM. The second paragraph starts off with stressing the importance of water to all living things and then in similar wording to the Australian tool refers to factors that impact fresh water availability, including: catchment location, contaminated sources, drought and mismanagement (NZGBC, 2014(b):[n.p]).

There are slight differences in wording and facts referred to in the two NZ TMs assessed. In the one document (NZGBC, 2014(a)) the second paragraph states that NZ uses two to three times as much water as other OECD countries; and the other TM further states that water in NZ is relatively clean by international

standards but that there are increasing problems associated with nutrient levels due to urban storm water pollution, animal effluent and fertiliser run-off.

The second TM (NZGBC, 2014(b)) states that NZ has clean and abundant water sources, mentions the importance of water to fauna and flora, and it highlights the significance of water to recreational activities. It refers to degradation in water quality experienced in some areas but not to the specific factors that contributed to this as it does in the Office 2009 TM. The impact of this degradation on aspects such as aquatic life, drinking water supplies, cultural values, water-based recreation and the economy is however highlighted. It notes seasonal water shortages and the doubling of “the national water allocation for irrigation, households, manufacturing and other uses between 1999 and 2010” (NZGBC, 2014(a):139, 2014(b):[n.p.]).

The third and final paragraph shares similarities with the final paragraphs of the AUS and RSA introductions. The two NZ documents have the exact same final paragraph and it specifically mentions how “water efficient appliances and fixtures, behavioural changes, and changes in irrigation methods can reduce consumption by 30 percent or more” (NZGBC, 2014(a):139, 2014(b):[n.p.]). The paragraph ends with the exact same statement as the AUS and RSA TMs.

South Africa

The introductory section in the RSA Office v1 technical manual is by far the most comprehensive compared with similar sections in the Australian and New Zealand documentation, and consists of eight paragraphs. Paragraphs 1 and 8 have already been addressed under the Australian section above. Paragraph 7 is also a word-for-word replica of the fourth paragraph in the AUS TM. The remainder of the introduction show the extent to which the technical team behind the Green Star Office adaptation process took RSA specific data into consideration.

The second paragraph starts with a reference to the climbing global water consumption patterns and then, like the AUS and NZ introductions, it underlines the importance of water to all living things. This paragraph also refers to the factors that affect fresh water supplies, by referencing RSA specific data sources. The TM

also mentions that the RSA government provided safe drinking water to 16 million people since 1994.

The third paragraph talks about water availability and the challenges of low and unreliable rainfall with regard to the replenishment of potable water sources through rainwater. It highlights the fact that there is limited capacity to support any additional development in most areas throughout the country, especially areas where rainfall is erratic. It concludes by saying that “sustainable use of potable water in South Africa would not only protect the already stressed sources but also ensure future availability of this precious resource” (GBCSA, 2008:191).

The fourth paragraph addresses the issue of leakage, which the tools from the other two countries do not refer to at all in the introduction section. The challenges around leakages in South Africa are not on a building scale but on a municipal infrastructure level.

The impact of cooling towers in terms of heat rejection in air conditioners is highlighted in paragraph 5, an issue that is addressed by credit 4.

Similar to paragraph 3 in the Australian tool, paragraph 6 refers to the potential operational savings that are possible using the Green Star design system. Like the AUS and NZ tools it refers to the recycling of water and mentions that only a small number of existing buildings have such systems in place.

Summative Remarks

The technical teams behind the development and adaptation of the Green Star office tools seems to have considered the local context within which these tools were to function.

Although there is a varying degree of detailed information captured in the Introduction Section of the Water Category as set out by each of the relevant technical manuals, the intent remains consistent and clear across all versions under consideration. Whether that intent translated into similar credit content is the focus of the following sub-sections.

4.4.3 Water Category: The Credits at First Glance

To guide the reader, the following figure provides an overview of the information set out for each credit within the Water Category. Each credit discussion provides insight into the specific number of points assigned, and it is followed by a short summary of the major differences and similarities that have been noted in each of the TMs reviewed.

In summary, the differences that will be highlighted and considered during the analysis in Chapter 5, include:

- In WAT-01, the 2009 version of the NZ rating tool gives seven points, while in the other two countries, only five points are available;
- WAT-02 only has one point under v3 of the AUS tool, but two NZ and RSA;
- RSA assigned three points to WAT-03, and AUS and NZ only one;
- The 2009 New Zealand version only assigned 2 points to WAT-04, but as described in earlier sub-sections, moved these two points into WAT-01;
- There is no WAT-05 credit in any of the NZ versions; and
- In total AUS have 13 points available, NZ 12 points and RSA 15 points.

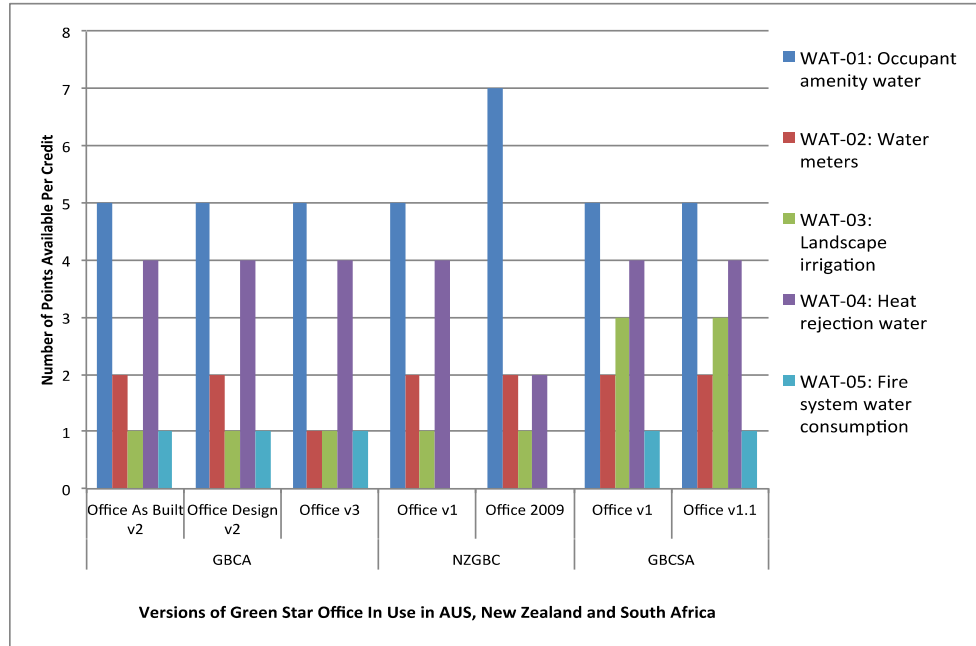


Figure 4-2: Overview of Green Star Water Category Credits⁷⁴

Sources: Information extracted from the various technical manuals (GBCSA, 2009:3; GBCA, 2008:3 and NZGBC, 2014(a):139-156)

⁷⁴ It should be noted that the different rating tools used slight variances of the credit titles but this was not regarded as a differentiating factor in the comparison.

4.4.4 Understanding the Credit Content

Each TM presents each credit according to the same structure:

Table 4.10: Guide to the Technical Manual

Component	Overview
Aim of credit	Asserts which environmental issue this credit is targeting, what the guiding principles behind the credit are, and what the desired environmental outcomes are.
Credit criteria	Explains clearly how the Aim of Credit section is to be met. It outlines measures that which must be undertaken to achieve the aim. This section also outlines how points are either awarded or <i>Not Applicable</i> within the Green Star RSA rating tool.
Documentation requirements	Describes the requirements that a project needs to meet for its submission to be successful when assessed by the Assessor(s). This section is divided in two areas: project performance requirements and submission guidelines. All projects must meet the performance and documentation requirements to be awarded the credit points. Each credit has a submission checklist that lists the requirements for the assessment of a <i>Design</i> and an <i>As Built</i> rating. All evidence collated must meet requirements set out in the Design Rating or As Built Rating documentation section of each credit in the Technical Manual as well as the general guidelines outlined in the Submission Requirements section on the GBCSA website. Note that each project should submit documentation relevant to Design or As Built, not both, depending upon which certification is being pursued.
Additional guidance	This section contains additional information, which is applicable to some projects. Where applicable, all information in Additional Guidance is mandatory. The Assessor(s) reserve the right to determine whether or not the project needs to meet the requirements of this section.
Background	Explains why the issue in the credit is important, with relevant information and statistics; it also explains how the issue is pertinent to the type of project addressed by the tool.
References and further information	All credits within the Green Star RSA rating tools are based on science and research; some of this research is provided as reference material in this section. The GBCSA recommends reading more about the issues in the credits; several interesting suggestions for further reading are provided in this section.

Source: GBCSA, (2014:32)

The intent of the discussion sections on each credit below, is not to provide voluminous duplication of the specific content contained in the TMs, but rather to determine whether the extent to which the likeliness or difference between the various TMs impact on comparison of projects certified under different versions of the Green Star Office tool.

4.4.5 WAT-1: Occupant Amenity Water (Points Available: 5-7)

Superficial differences are noted in terms of the name and aim of this credit, but the intent remains consistent: “To encourage and recognise systems, which have the potential to reduce the potable water consumption of building occupants” (GBCA, 2008:[n.p.]).

The most obvious difference is the number of points available. AUS and RSA have 5 points available while the NZ Office 2009 tool made an additional two points available if:

- a) no water based heat rejection system is used; or
- b) the water based heat rejection system uses 90% non-potable water.

From the information set out in the relevant TM, it seems that the NZ 2009 version simply shifted two points away from WAT-04: Heat Rejection Water to WAT-01.

Table 4.11: Overview of WAT-01 - Occupant Amenity Water

Credit	GBCA		NZGBC			GBCSA	
	Office As Built v2	Office Design v2	Office V3	Office v1	Office 2009	Office V1	Office v1.1
Occupant amenity water	5	5	5	5	7	5	5

Sources: Information extracted from the various technical manuals (GBCSA, 2008:3; GBCSA, 2014:34; GBCA, 2008:3 and NZGBC, 2008:[n.p.]; NZGBC, 2008:140; NZGBC, 2014(b):[n.p.]

To keep the discussion on each credit simplified, reference to the second part of the credit contained in the NZ Office 2009 revision is excluded, and only referred to again in the section dealing with WAT-04.

Compliance Requirements

In all the TMs reviewed, the compliance requirements require:

- A completed Potable Water Calculator;
- Some form of proof detailing the specific fixtures and fittings used; and
- Any calculations that were done relating to water re-use.

The credit rewards projects based on the outcome of the potable water calculator, firstly taking into consideration the reduction because of the fixtures and fittings incorporated into the design; and secondly be assessing the additional impact in reduction achieved if projects use alternative sources for water, i.e. rainwater harvesting, grey water- and black water recycling.

The potable water calculators provide projects with the opportunities to compare the design approaches identified to reduce potable water use to a reference case, using industry appropriate benchmarks. These benchmarks for the different TMs

are similar, and all range from worst to best case scenario water usage, depending on the efficiency measures associated with such fittings.

The following three tables provide some insight into the benchmarks in place for AUS, NZ and RSA respectively. These benchmarks were derived from AUS specifications and assessment methodologies, informed by assumptions on frequency and duration of each fitting type (GBCA, 2008:[n.p.]).

Table 4.12: Point Benchmarks for Water Consumption per Person per Day

Points	Water Conservation Ratings ⁷⁵	L/day/person benchmark			
		No Showers installed	Low Usage (5%)	Medium Usage (10%)	High Usage (15%)
1	2A	15	18	21	24
2	3A	11	13	15.5	17.5
3	4A	8.5	10	12	14
4	5A	7	8.5	10	11.5
5	5A + 20% improvement	5.5	7	8	9.5

Source: GBCE, 2008:[n.p.] – noted under heading How Potable Water Calculator Works

The NZ TMs use slightly different benchmarks based on the WELS Star ratings instead of the Water Conservation Ratings set out in the preceding table (NZGBC, 2014(a):142).

As mentioned in Chapter 1, there is currently a process underway to develop a RSA specific WELS system, and according to Braune (2016: Electronic communications), benchmarks used during the development of the local system were based on existing SANS standards for standard bathroom and building population design requirements. Further augmented by what was considered standard industry practice at the time Braune (2016: Electronic communications).

Table 4.13: Point Benchmarks for Water Consumption per Person per Day as used in Green Star NZ - Office 2009 (Revised February 2014)

Points	WELS Ratings	Star	L/day/person benchmark			
			No. Showers installed	Low Demand (5%)	Medium Demand (10%)	High Demand (15%)
1	3 star		11	13	15	17
2	4 star		9	11	13	16
3	5 star		7	9	12	14

⁷⁵ In the GBCE Office Design & As Built v3 technical manual, reference is made to the National Water Conservation Rating and Labelling Scheme. This is said to be a mandatory scheme administered by the Water Association of Australia on behalf of its members (GBCE, 2008:248).

Points	WELS Ratings	Star	L/day/person benchmark		
			No. Showers installed	Low Demand (5%)	Medium Demand (10%) High Demand (15%)
4	6 star		6	8	10
5	6 star + 20% improvement		5	7	8

Source: NZGBC (2014(a):142)

The various TMs indicate that a standard occupancy for office buildings is derived based on the assumption of 15m² per person of the total usable area⁷⁶. In the Australian and New Zealand tools, there is a further explanation of the office hours' calculations used to determine occupancy – the calculators use a standard approach of 10 hours per day, 5 days per week, which could be adjusted if there are higher occupied hours. The South Africa calculator is however said to assess "base building features, so hours of operation within the occupancy are not considered and no adjustment is made where the hours of occupancy may exceed normal hours of operation" (GBCA, 2008:1). Consumption is calculated on the number of building occupants. The calculator facilitates comparison of the proposed design/as built structure with an appropriate reference case, both using the same occupancy data. It seems that this approach could provide sufficient data on usage, but more detail regarding the potential impact of hours of operation on consumption patterns is required to determine if this is a gap in the calculator. Such investigations fall outside the scope of the current research.

Additional Guidance

As explained in Table 4.10, this section of the technical manual contains additional information and requirements that might be mandatory for projects, dependent on guidance from the Green Star assessor(s) (GBCSA, 2008:1). Information is presented differently but the content is similar. This section explains:

- How the potable water calculator functions;
- Which additional benchmark or water consumption data is used to populate the backend of the potable water calculator; and
- That some form of water re-use would be required, including grey- or black water recycling and/or rainwater harvesting systems, if projects are to target all available points.

⁷⁶ The AUS TM refers to Net Lettable Area (NLA), NZ to assessable area and RSA tools use usable area.

Access to information on the portable water calculator specifics in each country was confined to the limited references made in the AUS and NZ TMs, supported by the RSA potable water and sewage calculator guide GBCSA (2010(a):2). From this guide, it seems that the calculator rewards water savings through fittings and fixtures more than it rewards potential recycling efforts. Due to the significant risk and cost associated with the last component, this creates reluctance by project principals to pursue such strategies.

Another difference between the AUS, NZ and RSA tools, are the assumptions on percentage of building occupants that will use the shower facilities. In AUS and NZ this is estimated as high as 10% while RSA used a conservative 3%. This assumption is linked to the TRA-03: Cyclist Facilities credit, and the South African assumption will increase to 6% for users of the shower facilities if two points are targeted under the TRA-03 credit (GBCSA, 2008:173).

The AUS and NZ TMs then provide similar sections on how the calculators must be used if there are grey water, black water or rainwater systems installed. Projects are required to work through a set of questions and depending on the answers given, the calculator guidelines provide additional feedback to the project. Questions relate to:

- Whether a grey water, black water or rainwater system is installed;
- If the harvested/recycled water is treated to potable water standard for use throughout the building; and
- Whether the harvested/recycled water is used for toilet flushing only (not including irrigation related use as that forms part of WAT-03).

If projects include rainwater harvesting as a potential alternative source, the calculations imbedded in the potable water calculator makes simplified assessments based on:

- Annual rainfall;
- Collection area;
- Run-off coefficient;
- Storage capacity;
- Volume of rainwater collected used for irrigation or other purposes; and
- Percentage of urinals with WCs using rainwater for toilet flushing.

These calculations do not entail detailed water storage efficiency calculations, but all TMs require storage tanks with a minimum 20-day storage capacity, which is linked to the irrigation and toilet flushing demand entered into the calculator. Some of the TMs provide additional insight into the formulas available for projects to determine appropriate storage capacity of these tanks (NZGBC, 2008:145).

The South African tool also “assumes a 20 litre/100m² first flush volume of water is lost for each rain day” GBCSA (2010(a):5). This methodology has received some critique due to the high volume of water that is lost, especially because 97% of all rainfall events worldwide are regarded as *light events*⁷⁷ (Brom, 2016:103).

The final issue addressed in this section of the credit is the simple greywater calculator, and the methodology to be used to calculate the level of greywater harvesting which is possible, is similar across all the technical manuals. The RSA Potable Water Calculator guideline also includes a section on black water harvesting.

Background

This section seems focussed on localising the need for a specific credit. Similar data references are made, i.e. average consumption data for office buildings by referring to local information. The RSA TMs did not include the same level of detail, and no reference is made to water use data. The section on Rainwater, Greywater and Black water used similar wording to the AUS and NZ TMs, but it also includes a statement on black water systems, further demonstrating contextualisation of the rating tool for the need of the local market it serves.

References and Further Information

The final section of the credit description in the TMs includes country specific links or references. The intent behind these documents, websites, codes or regulations is to provide projects with additional information for clarity on issues or benchmarks referred to in the credit description.

⁷⁷ The article by Brom (2016) does not provide any further clarification of the term *light event*, but in the work of Dyson (2009:627) “a significant rainfall event is defined when the average rainfall exceeds 10 mm, a heavy rainfall event when the average rainfall exceeds 15 mm and a very heavy rainfall event when the average rainfall exceeds 25 mm”; thus leaving the current researcher with the understanding that a light event might refer to an event of less than 10 mm.

Technical Clarifications (TC) and Erratum

In the Green Star RSA Office v1.1 technical guideline there is an additional section included dealing specifically with all technical clarifications that have previously been submitted by projects for consideration. This type of information provides insight into feedback from the market on credit content, and is indicative of progressive development of the credit over time.

The two relevant TCs to note include:

- A request that the use of reticulated off-site reclaimed water as an acceptable way to reduce potable water consumption was approved but only if the building and water source is connected in a meaningful way.
- Exemption from obtaining approval from the relevant local authority for the use of a black water treatment facility in time for submitting the Green Star certification application but with the understanding that such a system is designed to all applicable SABS, SANS and DWAF standards, and will only be constructed once the relevant local authority approval is obtained.

Summative Remarks on WAT-01

The information provided in the TMs are similar and except for the extra two points incorporated into the 2009 NZ version, a comparison of projects certified under the different tools are possible. Caution will be required to ensure that those additional points do not skew the results of the analysis and that like-for-like is indeed being considered.

4.4.6 WAT-2: Water Meters (Points available: 1-2)

The name is the same across all tools, and the credit aim is sufficiently similar: “To encourage and recognise the design of systems that monitor and manage water consumption” (GBCSA, 2008:1).

Table 4.14: Overview of WAT-02 - Water Meters⁷⁸

Credit	GBCA			NZGBC		GBCSA	
	As Built v2	Design v2	V3	v1	2009	V1	v1.1
Water meters	2	2	1	2	2	2	2

Sources: Information extracted from the various technical manuals (GBCSA, 2009:3; GBCA, 2008:3 and NZGBC, 2008:[n.p.])

⁷⁸ It should be noted that the different rating tools used slight variances of the credit titles but this was not regarded as a differentiating factor in the comparison.

Apart from the Green Star AUS v3 TM, the credit criterion is similar across the various tools: “One point is awarded where it can be demonstrated that water meters are installed for all major water uses (refer to Additional Guidance) in the project” (GBCA 2008:1). “A further point is awarded if all the meters are linked to a building management system to provide a leak detection system” (GBCA, 2008:1⁷⁹).

In AUS v3, projects still must achieve the same credit criteria, but the reward associated with that achievement is now capped at 1 point. Although no explanation is provided for this move, in a document introducing v3, it is stated that “v3 has been revised to award industry leadership through raised benchmarks, new credits and updated references to standards as well as more relevant and clearer Compliance Requirements” (GBCA 2008(b):1) might be some indication that industry has moved to a situation where the approach to water meters have been accepted as industry practice, freeing up that extra point for another credit within the category, or another category altogether. This can possibly be regarded as an indication of industry transformation and growth.

Compliance Requirements

There are slight variances in the compliance requirements or documentation to be submitted to demonstrate how the credit criteria are satisfied. The AUS and NZ TMs also identify the interconnectedness with other water credits as a consideration by the assessors⁸⁰ as a point to keep in mind.

Additional Guidance

The information provided is similar across all TMs, including a section on water meter requirements. This provides project teams with guidance on where sub-metering might be required, and in the RSA tool it also clarifies when the use of a simple formula would be appropriate to provide water consumption information.

⁷⁹ It should be noted that the Australian technical manuals seem to number the pages of each credit section starting from 1), therefore it becomes seemingly impossible to provide accurate reference to page numbers that could guide a reader.

⁸⁰ In the Australian technical manual reference is made to “(where installed): irrigation systems; cooling towers; rainwater or recycled water systems; hot water systems” and in the New Zealand 2008 tool it is stated that “The Certified Assessor(s) will be looking for consistency with information provided for other water credits (e.g. WAT-1, WAT-3, WAT-4), where applicable”.

All rating systems include the following as major water uses:

- Bathrooms;
- Showers (the Australian and New Zealand tools state that this should be included if provided for at least 5% of staff, where this number is 3% of staff in the South Africa system);
- Evaporative heat rejection systems;
- Irrigation systems;
- Wash-down systems;
- Recycled water supply;
- Rainwater supply; and
- Humidifiers.

Background

Once again, these sections are similar across all TMs, with select references to local context. The 2014 Revision of the Green Star NZ Office 2009 TM also addressed this by including country specific data on where responsibility lies in terms of water resource management and average daily water use data.

The RSA TM refers to local projects and the water savings achieved because of using water meters, with the most important sentence being: “when water users know how much water they use, and the cost associated with that particular use, behaviour and usage pattern changes accordingly” (GBCSA, 2008:199), succinctly summing up the intent behind the credit.

References and Further Information

Each technical manual provides a list of locally relevant reference documents or sources that project teams can consult for further information.

Summative Remarks on WAT-02

The biggest difference is the reduction of points by AUS v3, while all other tools still provide 2 available points. Reorganisation of a rating system is a regular occurrence, and allows for the inclusion of more recent industry feedback and implementation practicalities, ensuring that industry movement is always considered and adjusted for to allow further growth and development of the industry.

4.4.7 WAT-3: Landscape Irrigation (Points available: 1-3)

The credit name is applied consistently apart from the 2014 Revision of the NZGBC Office 2009 TM that changed the title to Landscape Irrigation Water Efficiency.

The credit aim is also consistently applied: “To encourage and recognise the design of systems that aim to reduce the consumption of potable water for landscape irrigation” (GBCA, 2008:1).

The number of points is the most notable difference. With RSA awarding 3 points while the other countries only have one point available.

Table 4.15: Overview of WAT-03 - Landscape Irrigation⁸¹

Credit	GBCA		NZGBC			GBCSA	
	Office As Built v2	Office Design v2	Office V3	Office v1	Office 2009	Office V1	Office v1.1
Landscape irrigation	1	1	1	1	1	3	3

Sources: Information extracted from the various technical manuals (GBCSA, 2009:3; GBCA, 2008:3 and NZGBC, 2008:[n.p.]

Two routes were available in the AUS v2 tools, allowing projects to obtain the point by reducing water for landscape irrigation by 90% by sourcing on site through rainwater harvesting or recycled site water. The alternative was to have a water efficient irrigation system installed, and reference is made to things like “subsoil drip system”, “automatic timers” and “soil moisture sensor control overrides” (GBCA, 2008:1). If no landscaping is present, or it covers less than 1% of the site, the point is regarded as *Not Applicable* and is excluded from the points available used to calculate the Water Category score (GBCA, 2008:1).

The AUS v3 TM changed these requirements slightly, with the options being a 90% reduction in water consumption, without the specific reference to rainwater harvesting or water recycling; or the alternative is to install a xeriscape garden. There is also the option of choosing *Not Applicable* (GBCA, 2008: 225).

The New Zealand tools (NZGBC, 2008; and 2014(a):151) provides three possible routes to obtain the one available point:

⁸¹ It should be noted that the different rating tools used slight variances of the credit titles but this was not regarded as a differentiating factor in the comparison.

- 90% of the water requirement for landscape irrigation is sourced from on-site rainwater collection or recycled site water; or
- Where a water efficient irrigation system comprising subsoil drip systems and automatic timers with rainwater or soil moisture sensor control override is installed for servicing at least half of the landscaped area; or
- Where plants chosen are all drought-tolerant and require no additional watering once established (i.e. xeriscaping is used)".

In the 2008 version of the tool, it is stated that "if there is no landscaping or irrigation systems installed then the credit is Not Applicable" (NZGBC, 2008:[n.p.]). In the 2014 revision on the other hand it states that "if there is no landscaping, or landscaping (including roof, vertical and planter gardens) represents less than 1% of the site area or 100m² (whichever is the larger), this point is Not Applicable and is excluded from the points available used to calculate the Water Category score" (NZGBC, 2014(a):151)

The South African tool (GBCSA, 2008:201) has three points available and these can be achieved as follows:

- One point for projects that reduce potable water consumption for landscape irrigation 50%; and
- Two points are awarded where a) potable water use for irrigation is reduced by 90%; or b) xeriscaping is used.

No landscaping or landscaping of less than 1% of the site area or 100m² makes these last two points Not Applicable.

- The third point will be awarded if 30% or more of the site is landscaped and the above criteria for 90% reductions have been met. If the landscaped area is less than 30% the third credit is regarded as Not Applicable and excluded from the points calculations.

Each TM stipulates its own compliance requirements, with comprehensive instructions provided to guide teams.

Additional Guidance

The Australian v2 tool; the NZ 2008, v1; and the 2014 revision of the NZGBC 2009 tool all create a direct link between this credit and WAT-01. More specifically it

instructs teams on how to deal with irrigation water usage in the Potable Water Calculator to avoid double counting. The RSA tool also creates a link to the ECO-4: Change in Ecological Value credit, which does not form part of the current research.

Background

All the TMs state that “irrigation demand is not included in the Potable Water Calculator due to the technical difficulties in setting a benchmark for use in commercial buildings” (GBCSA, 2008:204), but the AUS and NZ TMs further state that the research conducted by Sydney Water indicates that this use is typically 5%. The RSA TM on the other hand states that in South Africa that figure could be as high as 50%, which could also be the reason why the RSA tool provides more points here than the other two countries.

The NZ tools provide more in-depth information on the local situation regarding water allocation and guides projects on the role of specific plants, removal of the human error component and that appropriate watering times can be most beneficial in reducing irrigation water demand (NZGBC, 2014(a):152-153).

References and Further Information

Each of the technical manuals includes a list of locally appropriate sources that project teams can consult for additional insight or information.

Technical Clarifications and Erratum

The technical clarifications included with this credit also refer to one of the TCs listed under WAT-1:

- Using reticulated off-site reclaimed water can be used to reduce potable water consumption if connected to the building in a meaningful way;
- Non-permanent landscape, such as potted plants, planter boxes, or other non-insitu⁸² landscape features, internally or externally, which can be removed, not within the scope of the Wat-3 credit;

⁸² Terminology copied directly from the GBCSA Office v1.1. TM manual (2014:6).

- Also, possible to use combined initiatives (i.e. xeriscape, water-efficient irrigation system and non-potable water for landscape irrigation), but will require a similar reference for comparison; and
- “Groundwater seeping into building basements may be included as non-potable water” (GBCSA, 2014:6), but this route will require projects to submit a Credit Interpretation Request (CIR).

Summative Remarks on WAT-03

The various tools are similar in the approach to and intent of this credit. The RSA tool places a higher reward on this credit, and this could be since irrigation water use is much higher here than the other two countries. During the initial development of the GBCSA tool, the discussions centred around the level low land prices in South Africa and higher prevalence of landscaping around office building than its Australian counterparts (Reinink, 2016: Personal communications). Furthermore, it was determined that irrigation water use can easily *out-consume* normal toilet flushing in a South African office building (Reinink, 2016: Personal communications).

The link created with other credits also provides insight to the tool aims of addressing water in a bigger urban, environmental systems context.

In an earlier section, the impact of development on the urban water cycle has been noted. Increased development leads to greater run-off due to less opportunity for drainage, which in turn leads to less transpiration. There is a direct impact on the natural eco-system.

The intent behind the credit is clear, and it is understandable that there is a need to ensure that new developments don’t create large landscaped areas purely for aesthetic reasons, and in doing so draining potable water resources. Landscaped areas can however be created using appropriately endemic plants and limiting the use of lawns as the major landscaping component (Reinink, 2016: Personal communications).

Does this approach not miss a critical point? Instead of just rewarding xeriscaping, would the broader urban water cycle not gain more from a landscaping approach

that seeks to retain water on site using natural systems, such as bioswales⁸³? Such an approach could help make water available on site for landscaping requirements while also creating a microclimate – to support biodiversity and support the local ecosystem. Is Green Star missing an important opportunity – missing the chance of taking a building scale approach but always keeping in mind the larger urban system within which the building will ultimately function?

4.4.8 WAT-4: Heat Rejection Water (Points Available: 2-4)

In the AUS v2 version, and the NZ 2008 v1, the name for this credit is WAT-4: Cooling Tower Water Consumption. The RSA tools, the 2009 NZ version, and the AUS v3 TMs all use the term *Heat Rejection Water*. The change in terminology could be linked to a growing understanding by the building industry to understand the reference behind these terms.

According to Grundfos ([n.d.]:1), “Heat rejection is the excess heat from a cooling system which is removed by the condenser/cooling tower”. A cooling tower can be described “as a heat rejection device, which extracts waste heat to the atmosphere through the cooling of a water stream to a lower temperature” (Cooling Technology Institute (2012-2015⁸⁴:1)).

Clearly these terms refer to the same aspects of a buildings’ operational system, and the intent is clear. Cooling towers can represent an approximate 30% of water use in typical office buildings, so any reduction can facilitate significant water savings.

Credit Aim

In the same manner that the title of this credit changed over time, the specific wording of the credit aim was also adjusted, moving to the more general description: “To encourage and recognise design that reduces potable water consumption from heat rejection systems” (GBCSA, 2008:207).

⁸³ “Bioswales are storm water runoff conveyance systems that provide an alternative to storm sewers” (Natural Resource Conservation Services, 2005:1).

⁸⁴ This is the copyright date exactly as it is displayed on the relevant website.

Credit Criteria

The NZ 2009 version shifted two points previously linked to WAT-04 to WAT-01. Still rewarding project teams for the efforts associated with reducing water use associated with heat rejection, but displacing where those points can be earned within the Water Category.

Table 4.16: Overview of WAT-04 - Heat Rejection Water

Credit	GBCA			NZGBC		GBCSA	
	As Built v2	Design v2	V3	v1	2009	V1	v1.1
Heat rejection water	4	4	4	4	2	4	4

Sources: Information extracted from the various technical manuals (GBCSA, 2009:3; GBCA, 2008:3 and NZGBC, 2008:[n.p.])

This shift in the allocation of points will need to be considered in the comparison of certified building data set out in Chapter 5 of this dissertation, and to provide a realistic understanding of how projects achieve points associated with reducing the water use associated with heat rejection, reference to the performance of NZ projects certified by the 2009 version, with specific reference to achievement under WAT-01, will be required.

The 2008 AUS (Design and As Built) v2, 2008 NZ (Design and As Built) v1 assign four points to this credit. Projects can achieve this in two ways:

- Two points are awarded if the cooling tower water treatment is designed to achieve six or better cycles⁸⁵ of concentration for water based cooling systems; or
- The natural ventilation mode of a mixed mode system reduces the HVAC⁸⁶ cooling water consumption by at least 50%.

Four points are awarded where it is demonstrated that:

- No cooling towers or evaporative cooling is specified in the design; or
- Cooling systems use 90% non-potable water.

The only difference with the wording used in the AUS v3, and RSA v1 and v1.1 TMs, relates to the removal of the term “cycles of concentration” from the credit

⁸⁵ Refer to the article on Cooling Towers in Appendix D, which provides insight into the concept of cycles of concentration being referred to in this credit.

⁸⁶ Refers to heating, ventilation and air conditioning (HVAC), which “is the technology of indoor and vehicular environmental comfort” (<https://en.wikipedia.org/wiki/HVAC>). In the context of the current research it specifically refers to the HVAC system of an office building.

criteria, although this aspect is still addressed in the Compliance Requirements and Additional Guidance sections (GBCSA, 2008:207).

Compliance Requirements

These sections of the various TMs vary significantly, which is mainly due to the different pathways specified by the various tools. Each pathway is explained in depth as is the proof documentation required, indicating which member of the professional team will be the appropriate person to write the required reports.

Additional Guidance

This section is very brief and addresses how the water consumption savings due to the use of a mixed-mode system could be calculated. The RSA tools, along with the 2008 AUS v3, links achievement of points in this credit to other credits within the rating system, and more specifically reference is made to ENE-1: Greenhouse Gas Emissions.

Background

The different Background sections of the various TMs are all very short and except for the RSA tools all refer to data extracted from the Sydney Water research mentioned earlier in this dissertation. All the technical manuals mention that “the use of non-chemical dosing (such as ionisation, UV⁸⁷ Treatment, etc.) can save water by avoiding more frequent flushing of cooling tower water systems” (GBCSA, 2008:209).

References and Further Information

Different standards and additional reading material links are provided in this section in each of the TMs – the references included in the AUS and NZ tools are similar while the RSA tool provides unique source material.

Technical Clarifications and Erratum

A TC not yet mentioned is listed in this section, and relate to the identification of evaporative cooling as a water consuming heat rejection system, for this credit (GBCSA, 2014:4-5).

⁸⁷ “Ultraviolet (UV) sanitizing units are used in many water purification systems to control bacteria and have certain applications in animal drinking water systems” (Edstrom Industries Inc., [n.d.]:1).

Summative Remarks on WAT-04

The biggest difference between the different versions of this credit is the NZ 2009 version that has reduced the points for this credit, but not completely removing them from the rating tool, rather allocating it to WAT-01 credit.

There is a greater tendency, demonstrated by evidence throughout this dissertation that GBCs are considering collapsing the entire Water Category into one credit. Moving points from one credit might have implications when comparing projects certified across different rating tool versions, but the important aspect is that projects are appropriately rewarded for achieving the required potable water use reduction targets set. More importantly Water should be treated in an integrated manner instead of fragmenting the approach purely in the interest of achieving points.

4.4.9 WAT-5: Fire System Water Consumption (Points Available: 1)

The name for this credit is consistently applied across all the TMs from RSA and AUS; with no such credit included in the versions of the NZ tools reviewed.

The original wording of the credit aim, as included in the 2008 Green Star AUS Office (Design and As Built) v2 reads: “To encourage and recognise building design that reduces potable water consumption of the building’s fire protection and essential water storage systems” (GBCA, 2008:1). The other TMs have slight wording variances, but the intent of the credit remains the same.

Credit Criteria

In the AUS (Design and As Built) v2 the credit criteria were set out as follow:

“One point is awarded where there is sufficient temporary storage for fire protection system test water and maintenance drain-downs for re-use on-site or where a facility exists for the pump out and recovery of water for use off-site” (GBCA, 2008:1).

Table 4.17: Overview of WAT-05 - Fire System Water Consumption

Credit	GBCA			NZGBC		GBCSA	
	As Built v2	Design v2	V3	v1	2009	V1	v1.1
Fire system water consumption	1	1	1	-	-	1	1

Sources: Information extracted from the various technical manuals (GBCSA, 2009:3; GBCA, 2008:3 and NZGBC, 2008:[n.p.])

More detailed wording is used in the 2008 AUS v3, and the RSA v1 and v1.1 TMs: One point is awarded where:

- Sufficient temporary storage is provided for a minimum of 80% of routine fire protection system test water and maintenance drain-downs, for reuse on-site;
- Each floor is fitted with a sprinkler system with isolation valves or shut-off points for floor-by-floor testing; or
- The fire protection system does not expel water for testing.

If no sprinkler system is in place, this credit is Not Applicable and is excluded from the Points Available (GBCSA, 2014:1).

Compliance Requirements

Locally relevant requirements are set out in the different tools, and the RSA TMs even refer to the local SANS 10400:1990 safety standards.

Additional Guidance

The AUS v3 and the RSA TMs include a more comprehensive section under this heading but generally the wording remains the same.

Background

Once again, the wording of this section in the various relevant TMs are similar; addressing issues related to statutory Health and Safety requirements, the potential of leaks to the storage tank, and how the use of isolation valves can enable sectional maintenance to the sprinkler system.

References and Further Information

Country specific references are provided in the different TMs.

Summative Remarks on WAT-05

The most important aspect to take note of is the absence of a WAT-05 credit in the NZ tools, although this credit is now included in the latest version. No projects have been certified under the new version yet. Davison (2016: Electronic communications, line 2) indicated that the NZGBC “reward projects for looking at fire protection water – it is one of many options for achieving points in WAT-1”. Davison further stated that during the development of the new credit, consideration was given to differences in the “fire codes and the way that sprinkler systems are

operated are quite different from Australia (and probably SA)" (2016: Electronic communications, line 5).

Reinink (2016: Personal communications) indicate that recent changes in South African insurance requirements also require projects that install sprinklers to obtain ASIB⁸⁸ approval, which requires that water is re-circulated back into tanks after testing.

4.5 Conclusion

The Green Star system is rooted in BREEAM and LEED, and through extensive engagement with relevant industry professionals, the Green Star system was created for the Australian market. Faced with similar conditions, the tool was adapted for the New Zealand and South African markets. Each adaptation process engrained location specific research and industry knowledge to ensure that the tools created as part of the adaption process, recognises the subtle differences between the three markets.

The power of green building is not to be underestimated. In preparing for changing conditions considering climate change and pressures on resources, Green Star provides a possible way to respond to the changing environment.

This Chapter was focussed on creating a shared understanding of the similarities between the different rating systems used in the three countries under review to provide sufficient certainty that a comparison between buildings certified under various versions is indeed possible and useful. Although locality specific information is contained within the various versions of the Green Star Office tool used in each country, the intent remains consistent enough to allow for a comparison of data related to buildings certified under each.

However, the select differences, which might impact on such an analysis, are:

- In WAT-01: Occupant Amenity Water: in the 2009 version of the NZ rating tool, this credit has seven available points, while in the other two countries, project teams can achieve five points at most;

⁸⁸ Refers to the Automatic Sprinkler Inspection Bureau (ASIB), originally established in 1970 to regulate the requirements for fixed fire protection (ASIB, [n.d.]: para 1).

- WAT-02: Water Meters: only has one available point under version 3 of the Australian tool, but two points in all the rest;
- South Africa assigned three points in total to the WAT-03: Landscape Irrigation credit, and the other countries only one point;
- The 2009 New Zealand version only assigned 2 points to WAT-04: Heat Rejection Water, but as described in earlier sub-sections, this is due to the movement of these two points into WAT-01;
- There is also no WAT-05: Fire System Water Consumption credit in any of the New Zealand versions under consideration; and
- The total points available in the Water credit is also not consistent across the three countries, with Australia assigning a total of 13 points, New Zealand 12 points and South Africa 15 points.

The following Chapter sets out the detailed analysis that was undertaken to understand the extent to which projects in each of the focus countries targeted and achieved the available number of points in each of the credits. The points system used by the Green Star rating tool can be regarded as the main internal mechanism through which projects are rewarded for a changed in approach to building design, Chapter 5 deals into understanding how effective this method is for facilitating water conservation in the built environment.

5 MEASURING THE EFFECTIVENESS OF GREEN STAR IN WATER CONSERVATION IN THE BUILT ENVIRONMENT: THE FINDINGS

This Chapter of the dissertation provides an overview of the findings of an assessment of country specific datasets of projects certified under the various versions of the Green Star Office rating tool. The preceding chapter demonstrated how water conservation is captured within the Green Star system, and it also sets out how the use of a reward-based points system is the main internal mechanism that can facilitate an industry change. The main intent of this chapter is to confirm whether Green Star does provide an effective mechanism to facilitate water conservation in the built environment by examining how projects performed in each of the credits related to water use, providing selected examples of buildings certified in each of the focus countries, and further supporting the findings through feedback obtained from industry professionals active in the Green Star and green building industry.

5.1 Green Star Credits: A Summary

There are various environmental, economic and social benefits associated with green building. This includes reduced operational costs, conserving resources or adhering to legislation or policy requirements (see Castro-Lacouture et al. 2009; Wedding and Crawford-Brown, 2007; and Kneifel, 2010).

There are also certain aspects that could limit a project's intention to target specific credits, and this is mostly linked to the anticipated cost associated with the anticipated benefit that will be achieved as a result. Brom (2016:110) indicates that "simple, cost effective solutions exist that will reduce the water impact and can be implemented on all projects regardless of scale or green mandate". The aim of the following sub-sections is to delve deeper into the specific credits that projects targeted during certification, and the analysis endeavours to identify the driving forces behind the choices made.

To guide the reader through the following sub-sections it is imperative to highlight again the small differences between the versions of the Green Star Office rating system in use in the three focus countries, and reviewed as part of this research.

For easy reference, a summary of the differences between the different versions in the discussions below will ensure greater clarity and insight into the specific achievements of projects, and are highlighted here:

- The shifting of 2 points in the 2009 NZ tool, to WAT-01 from WAT-04;
- Only 1 available point for WAT-02 in the AUS v3 tool;
- Three points in WAT-03 in RSA, while the other countries only have 1 point;
- The absence of a WAT-05 in any of the NZ versions; and
- AUS has a total of 13 points, NZ 12 points and RSA 15 points.

5.2 Green Star Certification Levels Achieved

To gain an understanding of the magnitude of projects that have been certified under the Green Star Office tools, the different GBCs were asked to provide information on the total number of projects certified by the 16th of January 2016. This information is set out in the following table⁸⁹:

Table 5.1: Number of Green Star Office Certified Buildings - 16 January 2016

Country	Total No. Certified	Projects by Rating Achieved					
		Four Star		Five Star		Six Star	
		Design	As Built	Design	As Built	Design	As Built
AUS	492	112	29	181	82	52	36
NZ	80	29	8	27	12	2	2
RSA	95	48	15	17	8	5	2
Total	667	189	52	225	102	59	40

Source: Rushin, 2016: Electronic communications; Li, 2016: Electronic communications; and Walters, 2016: Electronic communications

AUS has the highest number of certified projects, with 492 certified by the 16th of January 2016. NZ and RSA achieved 80 and 95 certifications respectively. More specifically, the information in the preceding table provides the following insight:

- In AUS, most the total number of certified projects achieved 5-stars under Design (37%) and 17% of the total projects achieved 5-stars As Built;
- In NZ, most total projects certified were 4-star Design projects (36%), with 15% of total projects certified achieving 5-stars under the As Built rating; and
- In RSA, most all projects certified were for 4-star Design (51%) and 4-star As Built (16%) projects.

⁸⁹ For the information contained in this table, no differentiation is made regarding the specific version of the Green Star – Office tool used during the certification process. The intent was to provide insight into the overall performance of the Green Star system.

The AUS Green Star system has been operational longer than in the other two countries, so a higher level of certification is to be expected. The total population of NZ, and therefore the anticipated levels of development are much lower than RSA, yet there is only a slight variance between certification levels reached in these two countries; potentially indicative of a slightly slower uptake of Green Star in NZ.

Firstly, focussing on 6-star certified projects the following is noted:

- AUS achieved a total of 17% **6-star certifications**, of which 59% were Design projects, and the remainder being As Built projects;
- NZ has 5% 6-star certified projects, divided equally between Design and As Built projects; and
- RSA has 7% of the total certified projects achieving 6-star certification level, with significantly more Design (71%) than As Built (29%) reaching this level.

Secondly in terms of **5-star certifications**:

- In total, the highest number of projects certified, approximately 50%, obtained 5-stars;
- AUS led the charge with 54%. Approximately 37% were Design stage projects and only 17% As Built, although these As Built projects represented the highest percentage of all AUS As Built projects;
- Almost 49% of all NZ certified projects achieved 5-stars; with 34% being Design projects; and
- Just over 26% of all RSA certified projects reached 5-stars; approximately 17% represented by Design projects and the remainder As Built.

Thirdly, the focus falls on **4-star certifications**:

- 28% of all projects certified across the three countries achieved 4-star Design certification;
- In AUS, approximately 29% of projects achieved 4-star Design certification;
- Followed by 50% of RSA Design; and
- 36% NZ Design stage projects.

Although the preceding information relate to the **total number of projects certified** by the 16th of January 2016, the remainder of the Chapter will refer to the datasets provided by each of the GBCs, which only focus on Office certified projects.

5.3 Green Star Certification: The Datasets

The analysis on certified projects relied on datasets provided by each GBC. The specific details of the datasets, data clean up required and assessment framework used, is set out in more detail in Chapter 2.

Due to the slight variances between the different versions of the Office tool, data was also separated into more manageable and uniform datasets to provide accurate insight into the specifics.

Table 5.2: Green Star Office Certified Projects – Dataset Overview

Building Phase Rating Tool Version		GBCA				NZGBC				GBCSA	
		Design		As Built		Design		As Built		Design	As Built
		V1 and V2	V3	V1 and V2	V3	V1	2009	V1	2009	V1	V1
No. of Projects	4 Stars	85	26	19	10	16	10	5	0	44	8
	5 Stars	98	80	47	31	18	7	5	4	10	6
	6 Stars	34	17	23	10	1	0	2	0	3	2
	Sub-Total	217	123	89	51	35	17	12	4	57	16
Total		480				68				73	

Source: Adrie Fourie - Calculations based on GBC datasets provided, 2016

In total, 480 AUS projects were assessed, which represented 97% of all AUS projects certified by the 16th of January 2016. The NZ office dataset included 85% of all certified projects; and the RSA dataset looked at 73 projects, representing approximately 77% of all certified projects.

The rest of the Chapter will unpack these datasets in detail, looking at issues such as: location, Water Category performance and credit specific achievement.

5.4 Green Star Certifications: The Location

The need for geographically robust green building rating systems was flagged in earlier discussions. Different climatic conditions imply different water use needs.

For instance, in a warmer, drier climate, HVAC and irrigation related water use might be higher than in a wet, cool climate.

5.4.1 Australia

Australia allows for the application of different weightings for the Water Category across different states. Is there any one location that sees the pursuit of Green Star projects over that of others?

From the dataset, it was determined that most AUS certified projects (Design and As Built) are in Victoria, New South Wales, Queensland and Western Australia.

Table 5.3: Location of Australian Green Star Office Certified Buildings

Location	Design	As Built
New South Wales	21%	29%
Victoria	27%	23%
Queensland	21%	21%
Southern Australia	7%	12%
Western Australia	13%	7%
Tasmania	1%	0%
Northern Territory	1%	1%
Australian Capital Territory	9%	6%

Source: Adrie Fourie - Calculations based on GBCA datasets provided, 2016

When comparing Green Star locations with national population projections from 2012 to 2016, set out by the table below (Kusher, 2013: below para. 3), a location trend is noted.

Table 5.4: State-by-State Population Statistics and Projections

State	2012	% of National	2016	% of National	Average annual growth
NSW	7,305,882	32.2%	11,475,527	27.6%	0.9%
VIC	5,630,855	24.8%	10,305,516	24.8%	1.2%
QLD	4,568,414	20.1%	9,259,341	22.3%	1.5%
SA	1,656,454	7.3%	2,308,149	5.6%	0.7%
WA	2,434,738	10.7%	6,402,253	15.4%	2.0%
TAS	512,199	2.3%	565,710	1.4%	0.2%
NT	235,233	1.0%	453,024	1.1%	1.3%
ACT	375,076	1.7%	740,903	1.8%	1.4%

Source: ABS, RP Data as used by Kusher (2013: below para. 3).

The role of population growth in urban development was discussed in an earlier section, and the fact that Green Star is being used in these growing urban nodes of AUS could be regarded as an indication of the building industries' commitment to improving the quality and operational performance potential of newly created building stock.

The data also enabled reviewing data on location, in terms of the certification levels achieved in the different development stages projects can be certified under.

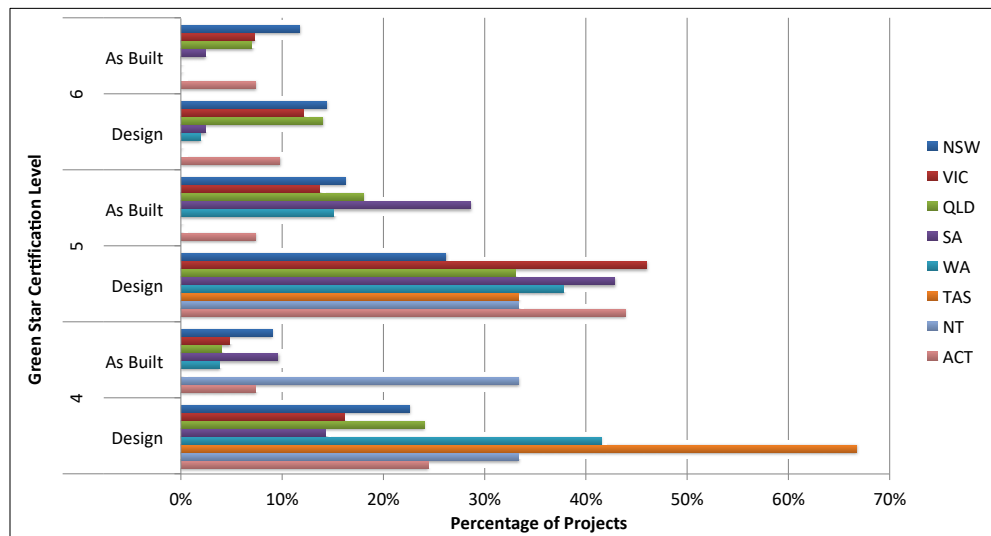


Figure 5-1: Australian Certification Levels Reached per Location

Source: Adrie Fourie - Calculations based on GBC datasets provided, 2016

From the preceding figure, it can be noted that:

- The majority (26%) of NSW projects achieved 5-stars under As Built, with the lowest number (9%) reaching 4-stars at As Built stage;
- In VIC, most projects (46%) were 5-star Design projects;
- QLD, had 33% 5-star Design projects;
- In SA, the majority were 5-star Design (43%);
- In WA, the majority reached 4-star Design (42%);
- TAS saw 67% of projects reaching 4-stars under Design;
- The majority in NT is 4-stars under Design; and
- In ACT an equal number of projects (33% each) certified 4-stars under As Built and 5-stars under Design.

Although not specifically focussed on Green Star, the Green Building Market Report (BCI Economics, 2014:21) indicates that almost 90% of industry players in AUS have indicated involvement in the green building industry in some way since 2008. This is described by BCI as an indication that “at least as far as the sheer affiliation with green building is concerned, the Australian construction market has reached a decisive penetration rate” (BCI Economics, 2014:21). BCI concurs that green building “has gone mainstream” (BCI Economics, 2014:21).

5.4.2 New Zealand

There is also a strong correlation between the location of Green Star projects and what is regarded as growth nodes in NZ.

Table 5.5: Location of Green Star NZ Office Certified Buildings

Location	Design	As Built
Auckland	62%	75%
Bay of Plenty	2%	0%
Christchurch	6%	6%
Manawatu-Wanganui	0%	6%
Northland	2%	0%
Taranaki	2%	0%
Wellington	19%	12%
Waikato	8%	0%

Source: Adrie Fourie - Calculations based on the NZGBC dataset, 2016

Most *Design* certifications are in Auckland (62%), Wellington (19%), Waikato (8%) and Christchurch (6%). With *As Built* certifications distributed slightly differently, where the top spot still goes to Auckland (75%), followed by Wellington (12%) and the third place shared between Christchurch and Manawatu-Wanganui (both with 6%).

The following figure provides an overview of the assessment of Green Star certification levels per location:

- The majority (39%) of NSW projects achieved 6-stars under As Built;
- 100% of Bay of Plenty projects were certified 4-stars Design;
- In Christchurch 50% of projects reached 5-stars at Design stage;
- For Manawatu-Wanganui, 50% of projects were certified 5-stars As Built and 50% 6-stars As Built;
- 100% of Northland projects reached 4-stars Design;
- 100% of Taranaki projects were certified 5-stars under Design;
- 67% of Wellington projects were awarded 5-stars under Design; and
- In Waikato, all the projects were 4-star certified Design.

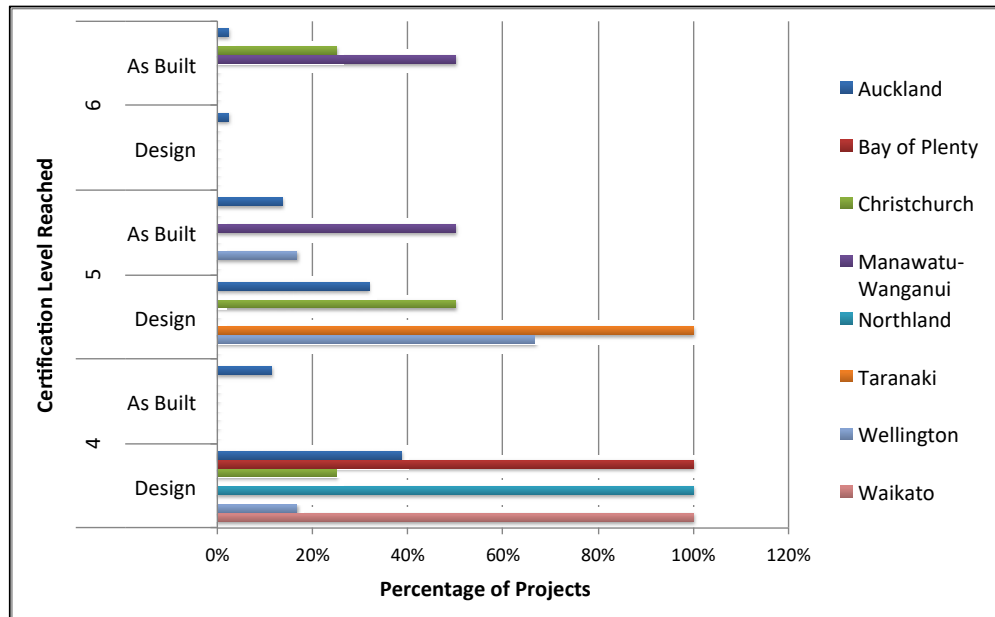


Figure 5-2: New Zealand Certification Levels Reached per Location

Source: Adrie Fourie - Calculations based on GBC datasets, 2016

Wellington is the capital of NZ, while Auckland is considered the largest city in the country (Statistics NZ, 2013(a): line 3). With a population of just over 1,4 million Auckland (Statistics NZ, 2013(b): para. 1) is one of the biggest draw cards for international migrants, adding approximately 43,000 new residents annually (Auckland Council, 2015: line 1). This influx requires significant development and expansion to accommodate a growing number of people and the demand for infrastructure.

Significant redevelopment efforts have been underway since the February 2011 earthquake tragedy that struck Christchurch (Mercer, 2015: para. 1). Many of the redevelopment efforts include projects achieving high Green Star certification levels, showing a commitment by government and the private sector to green building practices and Green Star certification specifically.

The Waikato region is described as “a dynamic region with increasing and changing demands on its natural and physical resources” (Waikato Regional Council, 2016: para. 1) with some of the “key growth and development pressures” defined as:

- “Rapidly increasing population in parts of the region;

- Urban areas and rural residential development;
- Increasing demand (including from the Auckland region) for services such as landfills, water supply, prisons and quarries;
- Land use change such as conversions of forests to dairy farms;
- Increasing freight and passenger transport on roads;
- Increasing demand for the region's energy resources and infrastructure; and
- Increasing coastal development" (Waikato Regional Council, 2016: para. 2).

The final region highlighted, is Manawatu-Wanganui. This region is located "in the lower half of the North Island", with Palmerston North and Wanganui as its main population centres (<https://en.wikipedia.org/wiki/Manawatu-Wanganui>). Significant population increases (through growth and migration trends) is expected to further drive development within this region, with a major focus falling on the regions' agri-tech industries (Manawatu Standard, 2015: para. 16).

Although the number of Office certified projects in NZ seem to be on the low side, according to NZ-based respondents to the BCI survey, this is mainly because educational, publicly funded/community/legal- and single residential building types seem to offer the most growth opportunities for Green Building (BCI Economics, 2014:55). The report also highlights that the "future development of the NZ green building sector is still highly dependent on upon governmentally supported areas" (BCI Economics, 2014:55).

5.4.3 South Africa

Although South Africa has nine provinces, and it appears that the location of Green Star certified projects is confined to Gauteng, the Western Cape and KwaZulu-Natal, and one project located in Limpopo.

Table 5.6: Location of Green Star South Africa Office Certified Buildings

Location	Design	As Built
Gauteng	71%	56%
Limpopo	2%	0%
KwaZulu-Natal	7%	25%
Western Cape	21%	19%

Source: Adrie Fourie - Calculations based on the GBCSA dataset, 2016

In Gauteng, most projects are in Johannesburg (with a total of 96% of projects which consists of 46% Design and 50% As Built). Projects in the Western Cape are mostly located in Cape Town (21% - Design and 19% - As Built). There are

25% As Built projects located in KwaZulu Natal, and these projects are mostly located in the town of Umhlanga. There is one Design stage project located in Limpopo that achieved a 4-star certification.

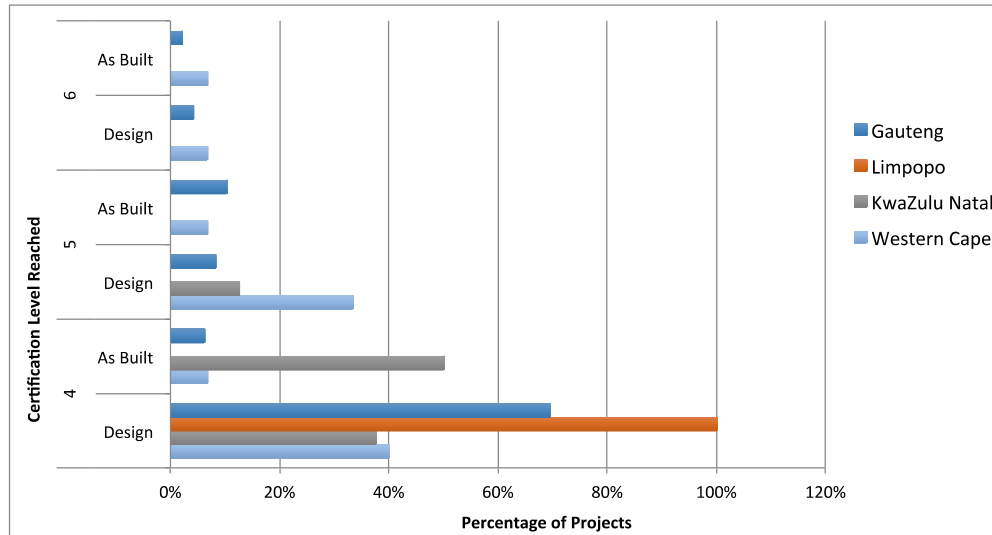


Figure 5-3: South African Certification Levels Reached per Location

Source: Adrie Fourie - Calculations based on GBC datasets, 2016

The following can be said for certification levels reached per location:

- Of the Gauteng certified projects, the majority (69%) are 4-star Design projects;
- 100% of Limpopo projects are 4-star Design;
- 50% of projects in KZN are 4-star As Built; and
- In the Western Cape, most projects reached 4-stars under Design stage.

The location trends of Green Star certified buildings also echo the importance of these three provinces in the RSA context, as identified through investigations undertaken by the Human Science Research Council (2014). The findings of their study indicate that “In terms of provincial contributions to the South African GDP, Gauteng Province dominates with more than 33%, followed by KwaZulu-Natal (KZN) with more than 15% and the Western Cape with over 14% contributions” (HSRC, 2014:1).

Gauteng Province is regarded as the “smallest, most densely populated of South Africa’s nine provinces” but it is “also the province that contributes most sizeably to the nation’s GDP” (COJ, 2011:38). Johannesburg is the capital city of Gauteng province and is regarded as the largest economy in RSA in terms of metropolitan

area contributions to economic growth and employment, followed closely by the City of Cape Town (HSRC, 2014:17).

Dentlinger (2016:1) identified the Cape Town CBD as a node that is “outpacing other metros across RSA in terms of infrastructure and business growth, and highlights that there is construction worth almost R8 billion due to take place in the city over the next five years”.

Umhlanga, located in KwaZulu-Natal, is also an area where significant investment and growth has been noted. Described as “one of Durban’s most upmarket suburbs”, which according to Mark White⁹⁰ “brought an influx of professionals into the area” (Botha, 2013:1). It is encouraging to note that building industry professionals and developers alike have realised the significant benefit of creating green buildings and the locational spread of Green Star certified buildings across the three nodes seemingly experiencing the most growth and development in RSA is regarded as an indication of the expected trends behind the growth of the green building industry in its entirety.

It is expected that the first Green Star project for Limpopo will be the first of more to come. The project is in the Limpopo Eco Industrial park, and according to the company website, a firm of architects were appointed to ensure that all administrative and industrial buildings within the park pursue at least 6-star Green Star certifications (LEIP, 2016: para. 1).

Previously known as the Northern Province, Limpopo is regarded as a favourite holiday destination in South Africa (Limpopo Tourism Agency, 2017: para. 1). Green building has been identified by the Limpopo Government (Letsoala, 2013:2) as one of the key focus areas that form part of the Limpopo Green Economy plan. As part of the Green Economy Plan (2013:4) the need for a strong awareness campaign around reasonable resource consumption was identified. Although not a Green Star certified project, the Vele Secondary School in Limpopo – which was funded in part by US television dynamo Oprah Winfrey, was awarded the Afrisam SAIA award for sustainable architecture in 2012 (Leading Architecture and Design,

⁹⁰ A real estate broker with Tyson Properties uMhlanga Rocks.

2012: para. 1-2). Any project that promotes green building practices serves as a further indication that the green building movement is gaining momentum and it seems that Limpopo role-players are starting to realise the importance of creating environmentally sensitive projects to take development into the future.

5.5 General Performance of the Water Category

The following subsections look in closer detail at the general performance of the Water Category. Firstly, it touches on the Water Category in relation to all categories; it investigates whether any projects managed to secure all available points within the Water Category; and general remarks on the Green Star strategy process and decision drivers are made.

5.5.1 The Water Category in Relation to All Categories

The GBCSA provided the most comprehensive dataset, not only including information on points achieved in the Water Category, but also providing information into all the points achieved by projects across the nine categories.

To allow for differentiation of achievement between Design and As Built certifications, the dataset was divided accordingly, and information is presented in two separate tables below.

Both tables present the following information:

- Column 1 shows the Green Star environmental categories,
- Column 2 provides an overview of the total number of points available for each of the nine categories;
- Column 3 set out the **average number** of points available in each category. Within certain categories, there are points associated with credits that could be regarded as Not Applicable, with those points being excluded from the Points Available. For instance, in the WAT-05: Fire System Water Consumption Credit, if a building does not have a sprinkler system, the one point linked to this credit is regarded as Not Available and excluded from the overall points calculation.
- Column 4 shows an overview of the average number of points achieved by Design certified projects;

- It was then also possible to calculate how representative the average number of points per category were of the total number of points available, and this is set out in column 5;
- With column number 6 providing the percentage of projects that scored either the average number of points (as set out in column 3) or higher.

The following table provides an overview of the information described above, as it relates specifically to Design certified buildings.

Table 5.7: Green Star South Africa Design Certifications Total and Average Points Overview (Design)

1 Green Star Category	2 Total No. Of Points Available	3 Average No. of Points Available	4 Average No. of Points Achieved	5 Column 4 as a % of Column 3	6 No. of Projects Securing Average No. of Points Available or Higher
Management	14	14	9	66%	60%
IEQ	28	27	14	50%	47%
Energy	30	30	16	54%	54%
Transport	14	14	8	55%	54%
Water	15	14	11	81%	65%
Materials	22	19	9	46%	49%
Land Use and Ecology	9	9	2	22%	61%
Emissions	17	16	7	44%	51%
Innovation	5	5	1	14%	30%
Total	154	147	76	Not Relevant	

Source: Adrie Fourie - Calculations based on the GBCSA dataset, 2016

The following findings are set out in the table:

- Before identifying any credits or points deemed Not Applicable, as column 2 shows, there are a total of 154 possible available to projects;
- Column 3 shows that on average, only 147 of those points are available – indicating that generally, at least 7 points are discarded or regarded as Not Applicable and therefore not included in the final points calculations during certification;
- The average number of points Design projects are likely to achieve, is set out in Column 4. Generally, projects seem to secure at least 76 of the points available. Projects seem to score the highest number of points in the IEQ (14 points), Energy (16) and Water (11) categories;
- It seems that for the Water (81%), Management (66%), and Transport (55%) categories, the average number of points achieved are the closest to the

average number of points available. Projects are more likely to target points in these categories;

- The Land Use and Ecology (22%) category, along with Innovation (14%) are the categories least likely to be targeted for all available points;
- Most projects (65%) seem to achieve at least the average number of points or higher in the Water Category, followed closely by Management (60%) and the Land Use and Ecology (61%) categories. It should however be noted that for the Land Use and Ecology category the average number of points are very low.

The following table provides similar information, but this time the focus is on As Built certified projects.

Table 5.8: Green Star South Africa Design Certifications Total and Average Points Overview (As Built)

1 Green Star Category	2 Total No. Of Points Available	3 Average No. of Points Available	4 Average No. of Points Achieved	5 Column 4 as a % of Column 3	6 No. of Projects Securing Average No. of Points Available or Higher
Management	14	13	9	67%	56%
IEQ	28	27	15	55%	50%
Energy	30	30	16	55%	44%
Transport	14	14	9	62%	50%
Water	15	14	11	82%	63%
Materials	22	19	8	42%	56%
Land Use and Ecology	9	8	2	28%	63%
Emissions	17	16	7	43%	44%
Innovation	5	5	2	43%	56%
Total	154	146	80	Not Relevant	

Source: Adrie Fourie - Calculations based on the GBCSA dataset, 2016

The findings that can be highlighted are:

- Although the average number of points available for As Built projects is slightly lower (146) than for Design (147) projects, it seems that the average number of points achieved by As Built projects (80) is higher than is the case for Design projects (76).
- As Built projects also seem to score the highest number of points in the IEQ (15 points), Energy (16) and Water (11) categories;
- It seems that 63% of projects target the average or higher number of points available in the Water and Land Use and Ecology categories. This is followed

by the Management-, Materials- and Innovation categories where 56% of projects managed to secure the average or higher number of available points.

5.5.2 Water: Who got the Top Marks?

The datasets from AUS and NZ did not include data on performance across all nine categories, but all three datasets did make it possible to compare to what extent projects achieved the total number of points available in the Water Category specifically. Taking into consideration that the total number of points available in the three countries vary (see Table 2.4 for more detail), the following table provides an overview of the percentage of projects included in the dataset achieved the total number of points relevant in that country, and further divides the achievement per the certification level achieved.

Table 5.9: Percentage of Green Star Certified Projects Achieving All Available Water Category Points

Dataset	Design			As Built		
	4 stars	5 stars	6 stars	4 stars	5 stars	6 stars
GBCA	1.2%	4.4%	3.5%	0%	4.3%	5%
NZGBC	0%	7.7%	2%	0%	12.5%	6%
GBCSA	1.8%	1.8%	0%	0%	0%	0%

Source: Adrie Fourie - Calculations based on GBC datasets, 2016

From the table, it is noted that:

- 44 GBCA projects scored all available points: 31 Design (four 4-star, fifteen 5-star and twelve 6-star), and 13 As Built (six 5-star and seven 6-star buildings). This represents 9% of all projects assessed.
- 8 of the 68 NZGBC buildings assessed, achieved the total number of points: consisting of 5 Design (four 5-star and one 6-star) and 3 As Built projects (two 5-star and one 6-star). Representing 12% of all projects assessed.
- Only 2 GBCSA projects scored the full 15 available points during Design certification (one 4-star and one 5-star), representing 3% of all projects assessed; with no As Built projects securing all points.

Clearly New Zealand seems to be outperforming its two counterparts with the highest number of projects achieving all available points in the Water Category. There are two identified main drivers for sustainable development in New Zealand; on the one hand the government sector “has been specifying increasing requirements for sustainability in the office buildings it owns or leases”; and on the

other hand, there is significant interest by “private sector at the prime development end of the office market” to develop more sustainable office buildings (Building Research, the Ministry for the Environment and the NZ Green Building Council, [n.d.]:6-7). Recently, the NZGBC also investigated the introduction of mandatory green building standards by considering several international examples (NZGBC, 2011). Clearly the importance placed on water issues by the NZ government has already trickled down to the building industry.

5.5.3 Green Star Strategy

Project teams are guided in their pursuit of points by what is referred to in the industry as a Green Star Strategy. This strategy represents the plan used by project teams to determine which credits across the Green Star system to target.

As part of the Green Star and Water Conservation survey undertaken as part of the current research, respondents were asked to indicate how these Green Star Strategies were developed. The overall majority, 92%, indicated that a specific Green Star certification target is set by project teams in consultation with clients at the very beginning of the planning process. The respondents indicated that in most instances, clients have a clear vision of which certification level to target and minimum requirements are set for the design teams. These targets might be augmented as the planning and design process unfolds if it becomes clear that additional points could be achieved with slight adjustments. If additional costs involved with securing these points do not destabilise the financial viability of the project, teams adjust targets accordingly.

One respondent indicated that as part of the services provided to clients during the initial stages of the certification level targeting strategy formulation, clients are provided with the necessary tools to undertake cost/benefit assessments. These assessments, related to the different interventions and strategies that could be targeted, aids with robust and informed decision-making. It is imperative that the specifics of interventions are included in the building development process upfront to ensure that these solutions are integrated into the building design. If not included into the actual design, this requires technology solutions to be added at a later stage, which will add unnecessary additional costs. Only 8% of respondents indicated that the choice regarding which level of certification to target is purely motivated by financial considerations.

Mason (2010) put together a report on the Psychology 3: William James Building Green Star Education Design Pilot project. Although this was a Green Star Education Design pilot, the report still provides valuable insight into decision-making process involved in a Green Star certification. Mason (2010:11) identified some credits that could potentially have been achieved in hindsight without significant additional capital costs or changes in the design were identified in hindsight. The biggest reason for this specific project team missing out on these extra points were ascribed to the fact that the specific Green Star rating tool used in the certification process was still in the development stage. Although not obtaining all the points that should have been targeted, the project team realised that “using the Green Star tool is more comprehensive than going it alone” (Mason, 2010:15). Where completed tools are presented to market, those tools provide clear methods for assessing building projects to address all relevant aspects relating to improving building performance, facilitating professional team interaction, collaboration and debate in a robust but helpful manner.

5.5.4 Decision Drivers

As part of the Green Star and Water Conservation survey undertaken with respondents from the South African Green Star industry, some insight was obtained in the approach to Green Star certifications, and the extent to which local government policies are considered when formulating the overall Green Star strategy.

Likelihood of Targeting Specific Credits - The following table was used to elicit information from the Green Star and Water Conservation Survey respondents as an overall indication of the likelihood of projects targeting each of the credits within the Water Category.

Table 5.10: Likelihood of Targeting Specific Water Category Credit

Water Credit	Least Likely	Unlikely	Neutral	Likely	Most Likely
WAT-01: Occupant Amenity Water	0%	0%	8%	8%	83%
WAT-02: Water Waters	0%	0%	0%	33%	67%
WAT-03: Landscape Irrigation	8%	0%	0%	33%	50%
WAT-04: Heat Rejection Water	0%	0%	42%	33%	17%
WAT-05: Fire System Water Consumption	0%	25%	0%	25%	50%

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

Except for WAT-04, it seems that project teams regard targeting all credits within the Water Category as most likely. More insight into the choices is provided in the following sub-sections.

Consideration of Local Policies/By-Laws - In an earlier section of this dissertation, the existence of local policy and bylaws, created to manage water use in the building environment, specifically in the RSA context, was discussed. One group of authors (Still et al., 2008:iv) assessed various RSA municipalities to determine whether they have created and implemented by-laws focussed on water efficiency. Although not extensive, some municipalities have created such by-laws, but enforcement challenges keep these from being implemented. More specifically, the researchers (Still et al., 2008:vi-vii) highlight that enforcing behaviour changes, such as restricting the use of a hosepipe for washing paved surfaces might be easier than bylaws directed at stipulating types of showers or toilets to be installed in new developments. Even this will require enough building inspectors with adequate training, to undertake this work, and it would be easier to control products at source (Still et al., 2008:vii). The most important step is to extend the building code to include appropriate sections focussed on water efficiency good practice, enabling suppliers and specifiers to implement the new code with certainty that they are in “line with standard practice” (Still et al., 2008:vii).

Asked whether project teams consider local policies and by-laws in the Green Star process, 75% of respondents indicated that such policies were taken into consideration, 17% indicated that they did not and one respondent abstained from answering the question. Delving deeper into the type of local policies and by-laws that were considered, the challenges became clear.

Legislation, By-laws and Other Policies Considered – None of the respondents indicated that they were aware of any by-laws specifically focussed on water efficiency within buildings. Although 8% indicated that reference to policies were necessary to obtain a building permit - which might indicate some link to by-laws focussed on water efficiency in buildings - but, without more data, it remains uncertain. Most respondents (50%) indicated reference to policies were mostly for storm water management, 25% indicated it was related to the use of alternative

sources of water and 17% linked it to sewer discharge and storage requirements respectively.

Responsible Party – 42% of respondents indicated that the responsibility of reviewing local policies and by-laws lie with the civil engineer, 33% indicated it is the responsibility of the wet services engineer; while 8% indicated that the responsibility lies with the Town Planner, the Hydraulic Engineer or the Green Star Consultant respectively. Another 8% indicated that the responsibility should be shared.

As shown in Figure 1-3 in Chapter 1, the intent behind Green Star is to reward the top 25% of industry role-players in terms of Green Building practices. This is regarded as projects that outperform existing building regulations, which according to the researcher should include reference to regulations, policies and by-laws focussed on water efficiency. It seems that Green Star currently has no requirement for projects to identify if any such policies exist, or how these policies were incorporated into the overall design. This might indicate that Green Star rewards projects that are in line with current regulations and not driving projects to outperform existing requirements.

One respondent indicated that reference to any policies, legislation or by-laws are unlikely as the team is only focussed on creating a design that meets the requirements of Green Star. This is regarded as a further indication that Green Star has a new gap to fill when any redevelopment of the tools is undertaken. If the intent of the tool is to drive projects to outperform existing building regulations, ideally there must be a cross-referencing system in place to ensure projects achieve at least what is required by local, provincial or national government as a minimum.

5.6 Green Star Water Credit Specific Performance

The focus of the analysis now turns to the specific achievements noted in each of the credits within the Water Category. Information obtained from the dataset assessment is augmented with insight gathered through a semi-structured survey (described in more detail in Chapter 2), and industry references where needed.

5.6.1 Overall Credit Performance

The following table provides a high-level overview of the extent to which projects managed to secure all the available points associated with each credit. The table used version specific information to determine the total number of points available for a specific credit.

Originally set out in Table 2.4, an overview is reiterated below for easy reference. The following table sets out the findings of an assessment of all certified projects contained within the various GBC datasets to determine the number of projects that could secure all available points associated with each of the credits.

Table 5.11: Overview of Green Star Water Category Credits⁹¹

Credit	GBCA		NZGBC			GBCSA	
	Office As Built v2	Office Design v2	Office V3	Office v1	Office 2009	Office V1	Office v1.1
Occupant amenity water	5	5	5	5	7	5	5
Water meters	2	2	1	2	2	2	2
Landscape irrigation	1	1	1	1	1	3	3
Heat rejection water	4	4	4	4	2	4	4
Fire system water consumption	1	1	1	*92	*93	1	1
Category Total Points Available	13	13	12	12	12	15	15

Sources: Information extracted from the various technical manuals (GBCSA, 2009:3; GBCA, 2008:3 and NZGBC, 2008:[n.p.])

The percentages in bold highlights were most projects could secure all available points, while the red text indicates where the lowest number of projects could secure all the available points.

⁹¹ It should be noted that the different rating tools used slight variances of the credit titles but this was not regarded as a differentiating factor in the comparison.

⁹² Based on information provided by the NZGBC, no corresponding WAT-5 credit is included in any of the Green Star NZ Office rating tools. (NZGBC, 2008:[n.p.]).

⁹³ Based on information provided by the NZGBC, no corresponding WAT-5 credit is included in any of the Green Star NZ Office rating tools but points for water based heat rejection, or more specifically the absence of water based heat rejection is included in the WAT-1 credit of the 2009 revision of the Office NZ rating tool. (NZGBC, 2014(a):144).

Table 5.12: Overall Performance Credit Overview

Building Phase	Tool	GBCA				NZGBC				GBCSA	
		Design		As Built		Design		As Built		Design	As Built
		V1 and V2	V3	V1 and V2	V3	V1	2009	V1	2009	V1	V1
WAT-01		59%	37%	66%	31%	34%	29%	50%	25%	54%	56%
WAT-02		80%	2%	79%	2%	60%	65%	58%	75%	88%	100%
WAT-03		58%	59%	61%	63%	43%	53%	42%	25%	12%	19%
WAT-04		46%	50%	31%	51%	77%	100%	67%	100%	88%	81%
WAT-05		54%	62%	63%	65%	Not Available				51%	50%

Source: Adrie Fourie - Calculations based on GBC provided datasets, 2016

In terms of the extent to which projects could secure all available points available per credit, we note the following:

- In Australia, the WAT-02: Water Meters credit is both the best and worst performing credit with projects certified under the v3 rating tool being least likely to obtain all available points, with only 2% of Design and As Built projects managing to do so; while projects certified under v1 and v2 outperformed other categories with 80% and 79% of Design and As Built projects securing all available points.
- For New Zealand, the WAT-01: Occupant Amenity Water seems to be the worst performing credit under the 2009 version for Design and As Built with only 29% and 25% of projects securing all available points; followed closely by WAT-03: Landscape Irrigation with only 25% of As Built projects securing all points. The best performing credit seems to be WAT-04: Heat Rejection Water, with 100% of Design and As Built projects under the 2009 version securing all available points, following by 77% Design and 67% As Built projects securing all available points under v1.
- In South Africa, WAT-03 fares badly with only 12% of Design and 19% of As Built projects managing to secure all available points; with WAT-02 and WAT-04 being identified as the credits in which projects are most likely to obtain all available points with over 80% of all projects being able to secure all available points.

The remaining sub-sections delve into more detail on each credit, referring to additional information sources and findings from the survey when and as relevant.

5.6.2 WAT-01: Occupant Amenity Water

The aim of the WAT-1 credit is to reduce the amount of potable water used in a building. Water reduction is accomplished by identifying the largest water uses, metering to reduce waste through undetected leaks and installing appropriate water efficient fittings and fixtures. Additional reductions can be facilitated by incorporating elements into a building design to course water from sources other than municipal water supply. Metering falls beyond the scope of this credit and is addressed in more detail in the WAT-02 discussion section below.

The higher the volume of potable water reduction achieved, or the higher the level of alternative water sources secured; the higher the number of points a project could secure. The following table sets out a comparison between projects certified in the different countries, under the rating tool versions specified, and the specific number of points achieved for the WAT-01 credit.

At first glance, there seems to be a consistent performance trend across all certified projects, with a very high number of projects securing all 5 available points. Projects certified under the 2009 NZ version seem to perform markedly better than the rest, with 100% of As Built projects securing all the points available for this credit.

Table 5.13: Occupant Amenity Water – Credit Overview

		GBCA				NZGBC				GBCSA	
Building Phase		Design		As Built		Design		As Built		Design	As Built
Rating Version	Tool	V1 and V2	V3	V1 and V2	V3	V1	2009	V1	2009	V1	V1
No of points available	N/A	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	0	1%	5%	2%	6%	3%	0%	0%	0%	2%	0%
	1	0%	0%	0%	2%	0%	0%	0%	0%	2%	0%
	2	4%	6%	6%	6%	26%	12%	33%	0%	12%	13%
	3	21%	34%	16%	31%	17%	0%	8%	0%	21%	19%
	4	14%	19%	10%	24%	20%	29%	8%	0%	9%	13%
	5	59%	37%	66%	31%	34%	59% ⁹⁴	50%	100% ⁹⁵	54%	56%
Total % of Projects		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Source: Adrie Fourie - Calculations based on GBC datasets, 2016

⁹⁴ Of the projects assessed, a further 41% achieved either six or seven points in this category, which also indicates the base five points have been achieved, and therefore reflected in this table as such.

⁹⁵ The remaining 50% of projects also achieved the additional two points available under this credit, and therefore all projects have achieved at least these five available points for this analysis.

What should also be kept in mind is the rule of thumb which the Potable Water Calculators use, rewards projects between 1 and 3 points for simply choosing appropriate fittings and fixtures and a further 2 points where alternative sources or water is present.

For the AUS projects the following is noted:

- Under v1 and v2, 59% of Design and 66% As Built secured all 5 points;
- Projects certified under v3 are markedly different; 34% of Design projects achieved 3 points, and another 37% achieved all 5. For As Built projects it is an equal split with 31% of projects securing either 3 or 5 points respectively.

This could be because the new version of the tool made changes to the Water Category, which included (GBCA, 2008:2-3):

- WELS ratings being used consistently throughout;
- The weighting for the Water Category was increased for QLD and WA to reflect this issue's change in priority on the state and national agendas; and
- The concept of Best Practice has also been redefined by raising benchmarks and updated references to standards. There is an increased need for projects to reuse water to obtain a higher score. Clearly the increased difficulty in obtaining points in this credit is reflected by the data.

For the NZ projects the following is noted:

- Under v1, Design projects 26% of projects only secured 2 points, with 34% managing to secure all 5. There is also a significant number of projects (20%) that managed to secure 4 points.
- As Built v1 projects fared much better with 50% of projects securing all 5 points, with 33% only achieving 2.
- The outcome for projects rating under the 2009 version is more complex:
 - o 59% of Design, and 100% of As Built projects seemingly secured all 5 available points.
 - o This figure requires some clarification. As indicated previously, the 2009 NZ tool has 7 points available under WAT-01. As part of the analysis process, projects were not only assessed on the ability to achieve 5 points, the data also indicated the number of projects that achieved the additional two points available.

o So, projects that could score 6 or 7 points, would already have attained the initial 5 points. Reflected by the 59% projects listed under Design 2009 or the 100% of As Built projects rated under the 2009 version therefore refer to the number of projects that achieved 5, 6 or 7 points. The impact of the additional 2 points is however not relevant to this credit and will be discussed in detail under the WAT-04 credit discussion below.

In terms of South Africa:

- 21% of Design certified projects achieved 3 points, and 54% obtained all 5; and
- 19% of As Built certifications obtained 3 points and 56% got all 5.

Although there seems to be a high overall number of projects that secure all 5 available points, it seems that there is a significant gap in projects that include interventions that reduce water by using sources other than municipal supply.

The following table was put to survey respondents⁹⁶ to identify the biggest driving forces behind the decision to target specific credits during certification. Respondents were provided with the option to choose as many or as few of the driving factors as they deemed relevant.

Table 5.14: Decision Drivers during Green Star Strategy Formulation (WAT-01)

Decision Driving Factor	WAT-01: Occupant Amenity Water
Ease of achieving available points	75%
Client instruction	25%
Prohibitive cost	25%
Higher benefit over cost	17%
Anticipated financial savings	8%
Duplication of previous certification outcomes	0%
Informed through research	0%
Pressure from team members	17%
Design	33%
Availability of appropriate technology	25%
Unsure	0%
Location based policy	0%

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

⁹⁶ Refers to the Green Star and Water Conservation survey conducted as part of the research. Reference to this survey is made throughout and will be referred to as simply, the survey.

In terms of WAT:01, the largest driving factor, with 75% of all respondents, identifying it as such is *Ease of achieving available points*; followed by *Design* with 33% of the respondents' votes.

Brom (2016:103) highlights that “efficiency is the first principle of all sustainable building interventions and is often the simplest to implement”. Specifying low-flow taps, dual flush systems and even waterless urinals, which are all said to form part of most green certified buildings is regarded as the most financially shrewd manner to secure points, and can translate into a water saving of up to 20% (Brom, 2016:103).

Specifying water efficient fixtures and fitting is regarded as the most likely approach by 66% of survey respondents to achieve the entry-level points associated with this credit. The respondents indicated that the responsibility for choosing appropriate fitting and fixtures is mostly shared with the Architect taking the lead (91%) followed by the Wet Services Engineers (66%).

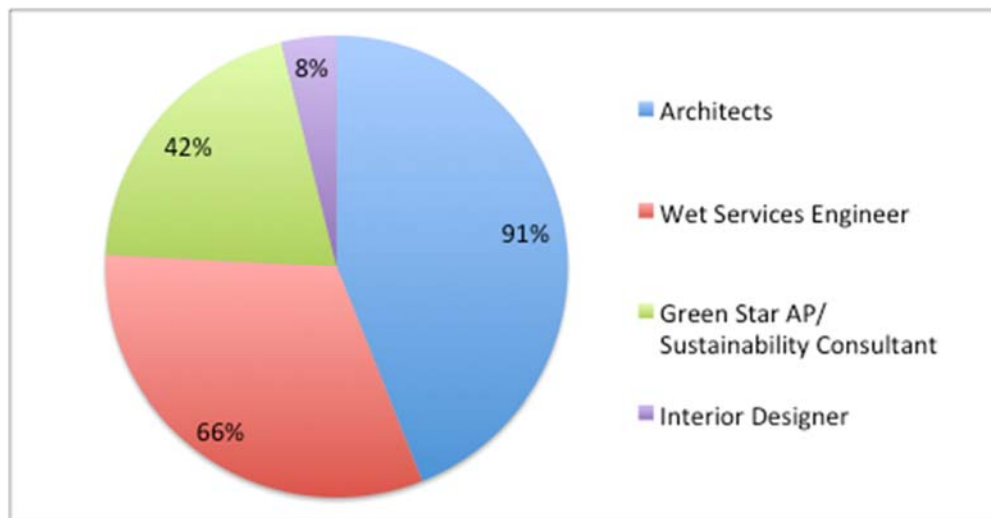


Figure 5-4: Share of Responsibility in Choosing/Specifying Appropriate Fittings and Fixtures

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

Asked whether the respondents felt if benchmarks used by Green Star were stringent enough, 75% agreed and only 25% indicated that there was significant room for improvement. Fitting and fixtures might be the easiest and in most instances the cheapest way to obtain points, but this is only possible because most products available in the market already adhere to the benchmarks used by Green

Star. However, as one respondent indicated, there are a high number of projects that use inefficient products, indicating that there is a need for further advocacy within the industry, both under professionals and the manufacturing side to ensure a move away from these inefficient products. Something that could be achieved only if appropriate guidelines and standards were in place, and hopefully the future SANS 10400 XB standards would help with that.

It seems that the GBCA understands the need to constantly improve the way in which the rating tools work, and with the raised benchmarks included in version 3 of their tool, the level of difficulty by which projects can secure points is demonstrated by the data reflecting less projects targeting all available points. The GBCSA (Momborg, 2016) have indicated their commitment to revising the current benchmarks captured by the Office tool, but one respondent has cautioned against a broad-brush approach to lowering benchmarks, as this could also lead to ineffective products, which in turn could lead to an overall negative perception toward Green Buildings.

Green Star rewards three alternative systems: rainwater harvesting, grey- and black water systems. This portion of the credit and how it is approached by projects seem more complex. Unfortunately, the datasets used in the analysis did not specify which of these alternative systems were used by projects to secure additional points. However, 92% of respondents indicated that they have previously participated in projects that used rainwater harvesting as an alternative source, 67% have experience with grey water treatment systems, and 42% were involved with projects that used black water treatment as an alternative source of water.

Reclaimed water is also regarded as a potential alternative source, one example being the Century City development that can buy second grade water from the Potsdam treatment plant, which require no additional recycling required within specific buildings. More detail on this project is provided in Section 5.7.3.3.

Rainwater Harvesting - Brom (2016) indicates that since rainwater is relatively clean, a simple filtration system is sufficient to treat the captured water for non-potable uses. The Potable Water Calculator uses a First Flush average to calculate

the volume of water lost, and Brom highlights that many systems include such a diverter as the first rain usually cleans large debris off roofs. Parker (as referenced by Brom, 2016:103) notes that this is a wasteful approach, especially in a water-stressed country such as South Africa where the first flush could mean as much as 50% of total collection. Parker (Brom, 2016:103) further holds that “about 97% of all rainfall events worldwide are classed as light events”, and therefore it is critical to find an appropriate approach to capture the maximum amount of water.

Brom (2016:103) indicates that Sotiralis Consulting advocate for the use of a pluvial system, which will allow all rainfall to be captured within a system that allow debris to settle out and clean water removed for storage. The added benefit of such a system also links to storm water management. Denner (as referenced by Brom, 2016:103) indicates that “the client can benefit if the roof can be utilised as an attenuation pond that captures rainwater and reduces the flow rate, which is a cost benefit to the client due to reduced pipe sizes. The storm water can then be collected in a rainwater harvesting tank for later use”.

The other consideration related to rainwater harvesting is the use thereof. This is dependent on location and rainfall patterns. Rainwater harvesting for use in irrigation is preferred over harvesting for use in the building as there is a significant cost perception (and in some instances reality) for storage and the required double piping; and lastly there is also spatial implications for placement of the required tanks with most projects not willing to sacrifice space for rainwater tanks. There are also financial implications related to the required pumps to move water back onto the roof to feed into the building, which might be regarded as prohibitive.

New Zealand might be slightly less affected by widespread drought, but the issues that projects are facing seem similar to that of Cape Town based projects, with the seasonal availability of water, requiring water storage during the rainfall season for use in the drier months. The space requirements and costs associated with such systems have already been flagged as a deterrent.

Grey Water - Brom (2016:105) states that in terms of cost and maintenance issues, the collection and filtration of grey water might be more beneficial in low rainfall areas. However, the respondents in the survey indicated that greywater

systems rarely provide the volume of water required in an office building, which often makes it unviable. Projects that generate significant volumes of greywater, through for instance a gym located within the building, are more likely to pursue greywater as a possible alternative water source.

Black Water Treatment – Andrew McDonald (Brom, 2016:106) indicates that this type of system can easily recover 99% of water used in a building, but Brom indicates that until recently there has been significant industry resistance to using this as an alternative water source. Survey respondents indicate that in most instances, clients feel the risk with this type of system is too high to warrant serious consideration.

The issues around black water systems relate to capital costs, complexity and ongoing maintenance implications and the presence of pathogens; but some projects are approaching black water treatment innovatively (Brom, 2016:106).

Australia implements water recycling on an urban scale – a practice that is referred to as the third pipe – the third pipe carries recycled water not for potable use into homes across Australia, for use in toilet flushing or for irrigation purposes. In South Africa, these systems are receiving more attention, but respondents to the survey identified the cost of this piping system is a big deterrent to pursuing water recycling systems on a building scale.

One such an example, which has a 5-Star Green Star RSA rating, is the Karl Bremer Hospital. In this project, “unused treated black water overflows to irrigate the grounds and the run-off goes into the storm water retention system” which “includes three attenuation gardens and one attenuation pond” (Brom, 2016:106).

Another innovative project is the Potsdam Water Treatment Facility, which supplies the Estuaries Plaza in Century City, Cape Town with an alternative water source. Refer to Section 5.7.1 for more detail on the project.

5.6.3 WAT-02: Water Meters

To achieve the 2 points available under this credit, projects must install water meters at major water usage points as predetermined by the Green Star system, and the meters must be linked to some sort of monitoring system. Installing water

meters is regarded as “second on the list of basic interventions”⁹⁷ to facilitate sustainable building (Brom, 2016:103). These systems can be installed at a relatively small cost and identify leaks or water waste. Fabio Venturi (as quoted by Brom, 2016:103) stated that “a Building Management System (BMS) with leak detection is essential for providing quick and accurate feedback, which the project team can respond to and mitigate potential flooding damage and water losses”.

One survey respondent referred to a project where they had been involved where, through some oversight of the project team, the borehole on site was not fitted with a water meter. In that project, a leak at the borehole then went undetected, which meant the project’s total annual water budget was lost within one month of having an untreated leak on site. Significant waste, but the anticipated impact this might have had on the professional team involved is immense. The likelihood of having something similar happen in other projects they become involved with seem insignificant, as this is all a part of growth and transformation of the industry at work.

The following table sets out the major driving forces behind the choice to pursue this credit:

Table 5.15: Decision Drivers during Green Star Strategy Formulation (WAT-02)

Decision Driving Factor	WAT-02: Water Meters
Ease of achieving available points	42%
Client instruction	25%
Prohibitive cost	0%
Higher benefit over cost	17%
Anticipated financial savings	17%
Duplication of previous certification outcome	0%
Informed through research	17%
Pressure from team members	25%
Design	25%
Availability of appropriate technology	17%
Unsure	0%
Location based policy	0%

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

The biggest driver seems, once again to be *Ease of achieving available points* chosen by 42% of the respondents, with *Client instruction*, *Pressure from team members* and *Design* all coming in with 25% of the votes each.

⁹⁷ Number one being the installation of water efficient fittings and fixtures.

Table 5.16 below provides an overview of how certified projects performed in terms of the range of points available in this credit.

Table 5.16: Water Meters – Credit Overview

		GBCA				NZGBC				GBCSA	
Building Phase		Design		As Built		Design		As Built		Design	As Built
Rating Version	Tool	V1 and V2	V3	V1 and V2	V3	V1	2009	V1	2009	V1	V1
No. of Points Available	N/A	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	0	9%	12%	11%	16%	11%	12%	8%	0%	2%	0%
	1	12%	85%	10%	82%	29%	24%	33%	25%	11%	0%
	2	80%	2% ⁹⁸	79%	2%	60%	65%	58%	75%	88%	100%
Total % of projects		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Source: Adrie Fourie - Calculations based on GBC provided datasets, 2016

Under AUS v1 and v2, 80% of Design and 79% of As Built phases, could secure both available points. Version 3 only has one point available and 85% of Design and 82% of As Built projects secure the point.

In NZ, 60% of Design certified under v1 managed to secure both points, a figure that increased to 65% under the 2009 version; 58% of As Built projects secured both points under the v1 and 75% of projects felt that there was significant value in linking water meters to a BMS or a less costly automated metering system.

Although water is still regarded as a relatively cheap resource, it seems that RSA projects are not averse to installing water meters and linking these to an appropriate automated metering system, with 88% of Design certified projects and 100% of As Built projects managing to secure both points.

When asked if respondents felt that projects would still pursue the installation of water meters and linking such meters to an automated metering system if Green Star no longer rewarded the effort, 67% of respondents indicated that this was highly likely, while 25% indicated that although meters might still be used to assign water use to specific tenants, linking to a BMS system was unlikely due to the costs

⁹⁸ Per the information in the relevant TM, v3 only has one point available. This additional 2% noted here could either be a data capturing error in creating the dataset, or the project in question was certified under a different version that listed in the dataset. The decision was made by the researcher to keep the dataset as is.

involved. It seems that market perception is fixated on the misconception that only the use of a BMS system specifically will allow projects to secure the second available point, but there are various alternative, less costly examples of monitoring systems available in the market that would still secure the point (Reinink, 2016: Personal communications).

In a report compiled by AECOM (2014) on the proposed collapse of the AUS water credits into one integrated credit, it is proposed that the WAT-02: Water Meter credit should be moved to the Management Category in its entirety, aptly names *Metering and Monitoring*, which in the RSA Green Star Existing Building rating tool also includes energy. To date, no NZ based projects have implemented the new credit configuration for certification purposes, but the reorganisation of credits in this manner could provide projects with greater control over managing resource use.

In addition to improving the way in which data relating to resource usage is collected and managed, the researcher also feels that projects should also be provided with greater motivation to pursue all water and water related credits not currently forming part of the Water Category, i.e. EMI-5: Watercourse pollution, and EMI-6: Discharge to Sewer. This should not only relate to potential operational costs savings (which to be fair is relatively low given the current low cost of water); but also, to acknowledge the important role appropriate water management (building scale or larger urban area) could play in creating improved microclimates that could help address issues relating to the heat island effect, and improve human health and resilience.

Increasing the cost of water is also something that should be considered, and it seems that many countries are already improving this valuation mechanism. Such discussions and investigation falls outside the scope of the current research, but for such discussions to take place, Government commitment is required to drive water savings forward. With the current ongoing drought in South Africa, water shedding⁹⁹ has been placed on the agenda in 2015 for the first time ever when

⁹⁹ During the energy crises in South Africa in 2008, there was insufficient electricity supply to satisfy demand, and the concept of load shedding was introduced. This is a scheduled system of sharing available electricity among users, which might lead to certain areas being without electricity for periods of time, with a schedule moving this *shutdown* across the country. Water shedding will entail a similar rotational process (Pillay, 2016:

various provinces within the country responded to the ongoing growth by using innovative water supply management practices (see Chabalala, 2015(a); Chabalala, 2015(b); and Bendile, 2016), while there was some scepticism by some government officials that such measure was indeed necessary (eNCA, 2015: para. 5) while some people feel that appropriate measures should have been implemented much sooner (Muller, 2015: below picture 2).

5.6.4 WAT-03: Landscape Irrigation

Along with HVAC systems, irrigation is said to use up the lion's share of water in commercial buildings (Brom, 2016:105). It has also already been highlighted that in South Africa irrigation accounts for as much as 50% of the total water consumed by office premises (GBCSA, 2008:204). This could explain why RSA decided to increase the number of points available to 3, in comparison with the one point used by its counterparts.

Table 5.17: Landscape Irrigation – Credit Overview

		GBCA				NZGBC				GBCSA	
Building Phase		Design		As Built		Design		As Built		Design	As Built
Rating Version	Tool	V1 and V2	V3	V1 and V2	V3	V1	2009	V1	2009	V1	V1
No. of Points Available	N/A	0%	0%	0%	0%	0%	0%	0%	0%	7%	13%
	0	42%	41%	39%	35%	57%	47%	58%	75%	14%	19%
	1	58%	59%	61%	63% ¹⁰⁰	43%	53%	42%	25%	35%	25%
	2	Not Available								32%	25%
	3									12%	19%

Source: Adrie Fourie - Calculations based on GBC provided datasets, 2016

From the preceding table, it seems that a slight majority of AUS v1 and v2 Design certified projects (58%) targeted and achieved the one available point, and 61% of project secured it under the v3 tool. Slightly more As Built projects secured the one point with 61% v1 and v2 projects and 63% under v3.

In NZ, Design rated buildings have an almost 50% split with 57% of v1 and v2 certified buildings securing the point while 43% of projects did not. Under the 2009

para. 2). This process entails a shutting down of reservoirs, allowing water to travel using only gravity, which means that low lying areas could still receive some water before being affected (Pillay, 2016: para. 10).

¹⁰⁰ There seems to be a data capturing error, as 2% of projects seem to have secured a second point, which is not available in the Australian credit. The researcher made the decision not to discount the entire project but rather just make the reader aware of potential data anomalies.

version slightly more (53%) projects managed to secure the point and 47% did not. Looking at As Built projects, it seems the divide increases. Under v1 and v2, the majority (57%) of projects did not secure the point, and under the 2009 version that figure increased to a staggering 75%.

Andrea Davison from the NZGBC, indicated that this significant increase in projects not securing this point, could be ascribed to the fact that many of the certified buildings are in CBD areas, which translate into a minimum landscape component (2016: Electronic communications). Unfortunately, this seems to be an incorrect assumption, as projects with landscaped areas of less than 1% of the site area or 100m², can claim this point as Not Applicable and it would not have been used to calculate the Water Category score; and a reflection as such would have been noted in the relevant database. None of the projects in the dataset lists this point as Not Applicable and one would need to speculate as to why this credit is doing so badly.

The extent to which RSA projects achieve the available number of points also vary significantly. To achieve 1 point, a project would have to reduce potable water consumption for landscape irrigation by 50%. Of the project assessed, 35% of Design and 25% of As Built rated projects seem to have obtained this one point.

A further 32% Design and 25% As Built projects could reduce potable water use by 90%, or these projects could have opted for a xeriscaping approach. Only 12% of Design and 19% of As Built projects could secure the third point, indicating that 30% or more of the site is landscaped and projects demonstrate a 90% reduction in potable water use.

The biggest hurdle for landscape irrigation point targeting is the fact that most clients are still inclined to prioritise a lush garden so xeriscaping is not regarded as an option. Rainwater harvesting for irrigation purposes are sometimes turned down due to the perceived cost involved and like NZ, several RSA projects are in urban areas and have little or no landscaped areas. Rainfall patterns also have an impact on the decision-making process. For instance, both Cape Town and Johannesburg have 6-month periods of no rain, while precipitation during the rainy season is

sufficient for irrigation purposes. The effectiveness of rainwater harvesting for irrigation could therefore be limited.

The ease with which points can be achieved and Design is the biggest driving factors behind this credit. However, 25% also indicated that they will consider certain strategies if the benefit outweighed the costs.

Table 5.18: Decision Drivers during Green Star Strategy Formulation (WAT-03)

Decision Driving Factor	WAT-03: Landscape Irrigation
Ease of achieving available points	33%
Client instruction	8%
Prohibitive cost	0%
Higher benefit over cost	25%
Anticipated financial savings	8%
Duplication of previous certification outcome	8%
Informed through research	8%
Pressure from team members	17%
Design	33%
Availability of appropriate technology	17%
Unsure	0%
Location based policy	0%

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

When asked about the likelihood of using specific interventions to secure points, most respondents indicated water-wise planting (67%) and water efficient irrigation systems (67%). Although 42% indicated that xeriscaping is a likely measure, 34% indicated that this is not a popular approach. Moisture sensors were considered likely by 50% of respondents, and some other strategies including mulch, rain sensors and timers, and the use of weather stations were also identified as possible methods to secure points.

Table 5.19: Likelihood of Targeting Specific Routes to Obtain Available Points

Water Credit	Least Likely	Unlikely	Neutral	Likely	Most Likely
Water-wise planting	0%	0%	8%	17%	67%
Water efficient irrigation system	0%	0%	0%	33%	67%
Xeriscaping planting	17%	8%	17%	42%	0%
Moisture sensors	0%	17%	17%	50%	17%
Other	0%	8%	0%	8%	17%

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

Local conditions can clearly provide the competitive edge for projects gaining maximum benefit from water initiatives. It is the recognition of these localised strategies and interventions that require additional attention in Green Star.

One RSA project that has seen significant savings because of landscaping interventions is the V&A Waterfront. The following table provides an overview of the initiatives that were implemented and the monthly and annual savings it has led to.

Table 5.20: V&A Waterfront Water Initiatives

Initiative	Monthly Saving	Annual Saving
Converted part of the irrigation system from spray to drop irrigation for less water usage, reduced weed growth and pest problems (25 litres/10m ² for spray irrigation vs. 10 litres/10m ² for drip irrigation)	R20 000	R240 000
Reduced watering times, especially during the rainy Cape Town winter and watering times adjusted according to the weather and location e.g. shade vs. sun.	No cost	R320 000 (2008) R330 618 (2009) R295 770 (2010)

Source: GBCSA, 2012(a):25

Survey respondents indicated that there is a need for more research to be done in terms of use of groundwater and boreholes as an alternative source of water for irrigation purposes. One respondent highlighted the fact that there is not sufficient research data available relating to the claims being made by the irrigation industry and the performance of irrigation related technology. There was a request for the provision of irrigation industry appropriate standards, which might ensure that this credit is “taken a bit more seriously” (Respondent G, 2016:6).

Although there certainly is a case to be made for projects pursuing different strategies under the innovation category – it seems that the Water Category credits should be constantly driving industry transformation. Securing appropriate research on product performance is essential, as is the realisation from the market that water issues will most likely only get worse, and gone are the times of elaborate, thirsty gardens.

5.6.5 WAT-04: Heat Rejection Water

The aim of this credit is to reward projects that reduce the use of potable water for heat rejection systems. The GBCSA (2014:3) indicates that the “use of water based heat rejection systems that consume huge amounts of water through cooling towers is wide spread because of the high energy-efficiency of such systems”. The goal is to drive projects to minimise or to remove “the use of potable water in heat rejection systems or completely eliminating the need for mechanical cooling in buildings”, which in turn could lead to “significant savings in both energy and water” (GBCSA, 2014:3).

Respondents from the survey indicated that Design was the biggest decision factor with 58% of the votes.

Table 5.21: Decision Drivers during Green Star Strategy Formulation (WAT-04)

Decision Driving Factor	WAT-04: Heat Rejection Water
Ease of achieving available points	25%
Client instruction	0%
Prohibitive cost	8%
Higher benefit over cost	25%
Anticipated financial savings	0%
Duplication of previous certification outcome	8%
Informed through research	0%
Pressure from team members	0%
Design	58%
Availability of appropriate technology	0%
Unsure	0%
Location based policy	0%

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

Kustura (2016: para. 5) believes that there isn't an easy answer when it comes to choosing between water-cooled chillers and air-cooled chillers. The author indicated that although water-cooled chillers are regarded as the most effective way to process heat, these systems require a significant amount of water and only makes sense where water is readily available and cheap (Kustura, 2016: para. 6). On a positive note, air-cooled chillers do not consume water, but are also much less efficient than the water-based system and require a significant amount of energy to run (Kustura, 2016: para. 7). However, as pointed out by Cameron (2011: para. 9) air-cooled chillers are modular systems with the potential of adding an extra unit if additional cooling capacity is required.

Due to the efficiency issues, the amount of space required for air-cooled systems are much higher than for water-based systems, air coolers still have a lower initial financial outlay than water cooled systems (AHI Carriers, 2015: para. 3). Maintenance and upkeep also seem to be lower for air-cooled system, and without regular maintenance, water cooled systems can be compromised in the longer-term (AHI Carriers, 2015: para. 3). Projects located in areas where high temperatures and humidity is an issue, air cooled chillers might be the better option, and this type of system might also be a better option for buildings with a cooling load of 300 tons or less (AHI Carriers, 2015: para. 5-6).

Asked which strategies projects are most likely used to achieve this point, respondents indicated that:

- 33% chose installing no water based heat rejection;
- Using a more efficient system had 8% of the votes;
- Installing air cooled chillers instead, with 41% of the votes; and
- Using alternative water sources or water reuse received 25% of the votes.

From the table, the AUS Design projects certified under v1 and v2 seem to be almost equally spread between projects obtaining two points (48%) and projects obtaining all 4 points (46%). To achieve at least two points, projects were required to reduce the use of potable water use for heat based rejection systems by 50%, and for the full four points, the consumption should have been reduced by 90% or no water-based heat rejection system must be provided in the building.

Table 5.22 provides insight into the extent to which projects targeted the available points. It should be noted that points are awarded as follow:

- 0 points are awarded where projects have water cooled systems but do not use alternative water sources for such cooling towers;
- 2 points are awarded where projects have cooling towers AND alternative water sources are used;
- 4 points are mostly likely awarded when projects have included air-cooled systems into their design.

The table therefore reflects only the points available to projects.

From the table, AUS Design projects certified under v1 and v2 seem to be almost equally spread between projects obtaining two points (48%) and projects obtaining all 4 points (46%). To achieve at least two points, projects were required to reduce the use of potable water use for heat based rejection systems by 50%, and for the full four points, the consumption should have been reduced by 90% or no water-based heat rejection system must be provided in the building.

Table 5.22: Heat Rejection Water – Credit Overview

Building Phase	Tool	GBCA				NZGBC				GBCSA	
		Design		As Built		Design		As Built		Design	As Built
		V1 and V2	V3	V1 and V2	V3	V1	2009	V1	2009	V1	V1
No. of Points Available	0	6%	46%	7%	41%	0%	0%	0%	0%	9%	19%
	2	48%	4%	62%	6%	23%	100%	33%	100%	4%	0%
	4	46%	50%	31%	51%	77%	41% ¹⁰¹	67%	50% ¹⁰²	88%	81%
Total % of projects		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Source: Adrie Fourie - Calculations based on GBC provided datasets, 2016

Under the AUS Design v3 tool, extreme opposites seem to be in play regarding points achieved with 46% of projects scoring no points, and 50% scoring all four points. For As Built rated projects there is a similar trend noted. Under v1 and v2, 62% of projects secured two points, and 31% achieved all four. Achieving all four available points is quite challenges, and in most instances an alternative water source is required to achieve four points. Unfortunately, the data available to the researcher does not provide any detail regarding the type of systems installed and it is therefore impossible to make any deductions on which system is most popular with certified projects¹⁰³. Under the v3 tool, the gap between projects seem wider with 41% of projects not obtaining any points while 51% could secure all four.

Most NZ Design rated projects using tool v1 and v2, 77% managed to secure all four available points, with 67% of As Built projects securing all points. In terms of projects rated under the 2009 version, it is imperative to refer to the fact that this version of the tool shifted some points from the WAT-04 credit to WAT-01. Therefore, understanding the information provided in the preceding table, requires some insight.

Under the 2009 version, 100% of all projects (both Design and As Built) secured the two points. The information provided however also indicates that 41% of

¹⁰¹ Under the 2009 version of the NZ Office tool, this credit only has two points available. Those two points relate to heat rejection water, which moved to this credit in the NZ version. This additional 41% reflected here refers to projects that obtained the additional two points provided for in WAT-01.

¹⁰² When this credit is assessed in isolation, the data indicates that 100% of projects secured the two available points. When one considers the number of projects that secured the additional two points related to heat rejection water systems in WAT-01, an additional 50% of projects achieved those two points.

¹⁰³ An assessment of the specific interventions introduced in building design was never the focus of this research, the absence of such details does not detract from the research findings in any significant manner.

Design projects and 50% of As Built projects also secured four points. Although this is technically incorrect as this version of the tool does not have a total of four points available, it does provide insight into the number of projects that managed to secure the points associated with Heat Rejection Water now included in WAT-01.

In South Africa 88% of Design projects and 81% of As Built projects managed to secure all four available points, only 4% of Design projects secured 2 points, with the rest of the certified projects not securing any of the available points.

5.6.6 WAT-05: Fire system water consumption

As explained in the previous chapter, this credit was only available in the AUS and RSA rating systems. For RSA projects, and projects rated under AUS v3 the option was also available to Not Applicable when a building does not have a sprinkler system.

The table shows that the number of AUS Design projects rated under v1 and v2, which obtained the one available point, is virtually equal to the number of projects that did not achieve the point with 54% and 46% respectively. Under v3, 62% of projects included an appropriately designed fire system, and this trend is also noted for As Built certifications. Under v1 and v2, 63% of projects achieved the available point and 65% of v3 certified projects.

Table 5.23: Fire System Water Consumption – Credit Overview

Building Phase Rating Tool Version		GBCA			GBCSA		
		Design V1 and V2	V3	As Built V1 and V2	V3	Design V1	As Built V1
No. of points available	N/A	Not Available	0%	Not Available	0%	25%	50%
	0	46%	38%	37%	35%	25%	0%
	1	54%	62%	63%	65%	51%	50%

Source: Adrie Fourie - Calculations based on GBC provided datasets, 2016

In RSA, the situation is slightly different. It seems that in terms of projects with a Design certification, at least one quarter of projects marked this credit as Not Applicable, which means that these projects do not have a sprinkler system. Another quarter of the Design projects did not obtain the 1 available point, which leaves 50% able to secure the available point. For As Built projects it was equally

split with 50% marking the point Not Applicable and 50% securing the available point.

Table 5.24: Decision Drivers during Green Star Strategy Formulation (WAT-05)

Decision Driving Factor	WAT-05: Fire System Water Consumption
Ease of achieving available points	33%
Client instruction	0%
Prohibitive cost	0%
Higher benefit over cost	17%
Anticipated financial savings	0%
Duplication of previous certification outcome	8%
Informed through research	0%
Pressure from team members	8%
Design	50%
Availability of appropriate technology	8%
Unsure	0%
Location based policy	0%

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

As per the outcome of the survey process, *Design* is deemed the biggest driving factor behind projects targeting this credit, with 50% of respondents indicating as such, followed by 33% that identified Ease of achieving available points as the second largest decision driver. One respondent indicated that this credit is extremely onerous to prove, and most projects just do not incorporate sprinkler systems into their design. The same respondent indicated that if there is a water reuse strategy in place, it is easy to add additional tanks required for re-capturing the fire system test water (Respondent I, 2016:6). This could add a substantial additional storage tank requirement to a project.

Another respondent (Respondent B, 2016:7) explained that projects are not required to put a water reuse strategy in place to secure the four available points. Once a building is of a certain size, the installation of sprinklers is a legal issue, and there are two possible scenarios projects can use to secure points:

- Option one: The sprinkler system of a building is linked to tanks on the roof in case of fire. When a fire does occur, pumps are used to provide the necessary water pressure for the sprinklers to work. These pumps need to be tested each month. Instead of buildings disposing of the test water into the storm water system, the more recent approach is to recirculate test water back into the storage tanks – effectively using a closed loop system (Respondent B, 2016:7);
- Option two: Instead of storage tanks linked to the sprinklers, some buildings rely on municipal pressure which only requires pressure testing to obtain

approval for the system up front – therefore no monthly testing requirement or water re-capturing aspect to consider; credit can be claimed (Respondent B, 2016:7).

Another respondent indicated that this credit is least likely to be targeted due to the low reward in number of points available, and it is further hampered by the fact that it is not regarded pragmatic to incorporate into the design (Respondent K, 2016:5). The credit is “most frequently achieved through rational fire design” (Respondent K, 2016:5).

Although this credit was not included as part of the NZ Green Star Office tools considered as part of the current research, the newest version of the Green Star NZ rating tools now also includes a credit specifically targeted to fire system consumption water savings – indicating that the market has noticed a gap and the NZGBC worked to fill it.

5.7 Selected Green Star Certified Projects: Water Category Achievement

5.7.1 Australian Examples

One aspect that sets the Green Star AUS Office Design and Office As Built v3 (GBCA, 2008) technical manual apart from the other manuals under consideration as part of this research process is the fact that buildings with exceptional achievements are specifically referred to. These examples provide projects with insight into the strategies implemented to achieve high scores in each of the environmental categories¹⁰⁴ that Green Star consists of.

Trevor Pearcey House, AEI Premises, Bruce, ACT

According to the GBCE, the “Trevor Pearcey House is a 19-year-old building in Fern Hill Technology Park” which was a refurbishment project which achieved a “6 Star Green Star – Office Design v2 rating in October 2007” (GBCE, 2008:xxxvi). This project achieved a total of 79 points, where 75 points is the minimum score to achieve 6 Stars. Furthermore, this project was awarded the maximum category score for Water and Transport (GBCE, 2008:xxxvi).

¹⁰⁴ Refer to Figure 2-3 for more detail on the nine categories.

The following water efficient features have been incorporated into the building:

- Single flush toilet cisterns upgraded to dual flush (9/4.5 litre) cisterns;
- Existing urinals upgraded with a low water use system;
- Taps upgraded to 4 litres/minute;
- Upgrade of shower head to 6 litres/minute; and
- Rainwater in 2 x 3,000l tanks used for flushing toilets (GBCA, 2008:xxxvii).

Additionally, water metering was installed to measure major areas of water consumption, which includes:

- "Potable back-up to the rainwater tanks which are feeding toilets;
- Mains water supply; and
- Hot water" (GBCA, 2008:xxxvii).

Shown in the image below is the refurbished building.



Source: Wrigley (2013: as used on the Australian Institute of Architects website: http://dynamic.architecture.com.au/awards_search?option=showaward&entryno=2008014450)

Other aspects of the project that contributed to the overall water performance potential included:

- The installation of a water consumption tracking system which assesses use at 15 minute intervals and which immediately shuts off the water supply if a leak is detected;

- Although irrigation is said to fall within the scope of work of the body corporate, the project also upgraded irrigation systems for the areas immediately surrounding the building as part of the project;
- The building does not “have a sprinkler system and does not contain a fire services tank”, and “the water based fire protection system is based on an existing fire hose reel located on the ground floor at the rear” (GBCA, 2008:xxxvii). This existing system also diverts water consumed as part of the testing of the system “to be captured in the rainwater tanks”; and
- The building also does not have cooling towers installed, a further water saving initiative of the project (which according to the researcher is only technically true if there were cooling towers in the building before the refurbishment).

The operational performance of the building confirms that water use is 85% less than the Canberra average, and it also delivers a combined saving of \$22,500 per year (GBCA, 2012(b)). Another interesting note is that this project was delivered on what is regarded a conventional budget (of \$1700/m²) thereby demonstrating to the market that significant environmental improvements to existing building stock are possible.

Metropolitan Fire Brigade, 450 Burnley Street, Burnley, VIC

This project received a 5 Star Green Star – Office Design v2 rating in August 2006, and is regarded as “an excellent example of how buildings can achieve high credits in the Water Category” (GBCA, 2008:271). The building achieved 12 of the available 13 points, and in addition to the elements set out below, the “project team has developed water conservation measures for the overall site that include an integrated storm water harvesting and reuse system to reduce water demand” (GBCA, 2008:271). The image below provides a glimpse of what this project created.



Source: [n.d]. No specific photo credit for the image is provide. Image obtained from the MFB Kidzone
 Page: <http://www.mfbkidzone.com.au/gallery/4-fire-stations>

The following is taken verbatim from the Green Star AUS Office Design and Office
 As Built v3 (GBCA, 2008:271-272) technical manual:

WAT-1 Occupant Amenity Potable Water Efficiency 4/5

Points awarded for water-efficient toilets, wash hand basins, showerheads and waterless urinals. No points claimed for water reuse.

WAT-2 Water Meters 2/2

These credits were awarded because water meters connected to the Building Management System (BMS) were specified. The water meters measure all the major water uses in the building and the BMS provides an adequate leak detection system.

WAT-3 Landscape Irrigation Water Efficiency 1/1

This credit was awarded because the landscaping in the development includes mainly native Australian, drought tolerant plants, which negated the need for a permanent irrigation system. A temporary system was installed for the first two years, which will use rainwater that is collected and stored on adjacent sites.

WAT-4 Cooling Tower Water Consumption 4/4

All four points were awarded because no cooling towers or evaporative cooling were specified; and the air conditioning plant is specified as air-cooled.

WAT-5 Fire System Water Consumption 1/1

The project received the available point for this credit because the adjacent fire training facilities collected all their run-off storm water in a large tank. The water used for fire system testing in the office facilities will be collected in this tank and reused for landscape irrigation and firefighting training.

The project is fitted with a 750,000-litre underground water storage tank, with 100% of storm water on site collected for re-use (GBCA, [n.d.]:2).

This project took a holistic view to the water use related to the firefighting training being provided on site, and was even awarded an innovation point for the advanced water recycling system put in place to capture water that would have otherwise gone to waste (Reinink, 2016: Personal communications).

No. 1 Bligh Street, Australia

Another project worth mentioning is 1 Bligh Street, a 42,282 m² building that noted 10 green activities over the 9-year timeline of the project (GBIG, 2016:1). The project received its first 6 Star Green Star AUS – Office Design v2 certification in 2010 by securing a total number of 84 weighted points (GBIG, 2016), and more pertinently, it secured all available points within the Water Category.

The image below places the building in its wider urban context (building with oval roof), showcasing the “500 square metres of roof-mounted solar panels will capture solar energy to directly power an absorption chiller (sic) to drive the cooling systems, an advanced hybrid of VAV and chilled beam air conditioning technology” (Levis, 2011: para. 8).



Source: H.G. Esch as used on <http://www.detail-online.com/article/1-bligh-street-in-sydney-wins-international-highrise-award-2012-16479/>

In 2012 and 2013, the project was shortlisted in the WAN Sustainable Building of the Year¹⁰⁵ driven by WorldArchitectureNews.Com, and now in its 8th year. Also in 2012, the building achieved its second 6 Star Green Star AUS – Office As Built v2 certification, with a slight dip in points to 81 weighted points. The project retained all 13 points in the Water Category (GBIG, 2016).

The GBCA describes the project as the first high-rise office building in Sydney to use a black water recycling system which entails the treatment of black water at a centralised plant, destined for reuse in toilet flushing and as make-up water in the cooling towers (GBCA, 2011: para. 10). This intervention expected to reduce the demand for municipal water by almost 100,000 litres of water a day, equivalent to filling an Olympic swimming pool bi-weekly (GBCA, 2011: para. 10).

The project also includes a 65,000-litre rainwater harvest tank, which recycles rainwater for irrigation (GBCA, 2011: para. 11). Furthermore, 3 star WELS-rated showerheads, 5 star-rated hand washbasin taps and 4 star-rated toilets were used

¹⁰⁵ The WAN Awards is described as the world's largest Architectural Awards Program (World Architecture News ([n.d.] webpage: <http://backstage.worldarchitecturenews.com/wanawards/information>)

throughout (GBCA, 2011: para. 11). A building management system was also put in place to monitor all water use. All the interventions implemented reduced reliance on municipal potable water sources by more than 90%.

In addition, this project also achieved LEED Commercial Interiors Platinum rating in 2009 (which also included achieving all 11 available points), it was chosen as the Best Regional Project – Asia Pacific by the USGBC Best of Building Awards in 2014; and in 2015 it achieved a 4.5 NABERS water star rating¹⁰⁶. Clearly showcasing the interventions identified and implemented in this project had a significant impact on the operational performance ability of the building, a feat recognised by various institutions and certification processes.

The Gauge, Melbourne, Australia

Several certified buildings were included in the GBCSAs Rands and Sense published in 2010, one of which was The Gauge project. The building, consisting of six floors offices (approximately 9,000m² net lettable commercial space) and approximately 1,300m² of ground floor retail space was the first to achieve a 6 Star Green Star – Office As Built v2 certification (GBCSA, 2010:32).

Not only is this project expected to “reduce potable water consumption by a further 30% when compared with typical existing 5 Star Green Star rated buildings”, but with the new building model used by the owners (Lend Lease), it was possible to deliver an excellent “A Grade office building at a competitive development cost” (GBCSA, 2010:32).

The image below shows the completed project, and it is also possible to make out the green wall installed as part of this project.

¹⁰⁶ No detail is provided in the online overview of the project, but per the NABERS website, a rating of 4.5 stars falls between 4 stars which is classified as Good Performance, and 5 stars which is Excellent Performance (NABERS, [n.d.]: para. 6).

The GBCSA (2010:32) states that The Gauge tackled the issues of a water-scarce future “through intelligent design and water efficient technologies like cooling tower control systems that limit water wastage, high efficiency fixtures and fittings in urinal and toilet facilities, as well as a fire system tank that enables collection and reuse of fire system water”.

The project includes an “on-site black water sewage treatment system” which is responsible for recycling approximately 92% of water used on-site per annum and re-using the water for flushing toilets. Although the reduction in potable water consumption is regarded as a substantial environmental outcome, it is also described as “a profitable one as a reduction in water utility costs is established and sustained for the life of the building” (GBCSA, 2010:32).



Source: No photo credit is provided. Image taken from Building website:
<http://www.825bourkestreet.com.au/Core/Content/Public-Home-Page/Content3245.aspx>

5.7.2 New Zealand Examples

The Meridian Building

Along with 80 Queen Street in Auckland, this was one of the first Green Star NZ Office certified buildings in New Zealand. Both projects achieved a 5 Star Green Star rating (NZGBC, 2015: para. 3). The case study documentation created for the Meridian Building (NZGBC, [n.d.](a):1) describes the project as “New Zealand’s first completed 5 [sic] Green Star building rated under the New Zealand Green Building Council’s (NZGBC) Green Star - Office Design v1 certification scheme and is Meridian Energy Ltd.’s head office”.

The project was driven by the quest to create a “landmark building, befitting the capital and the site overlooking the harbour, coupled with leading-edge environmental performance” (NZGBC, [n.d.](a):1).

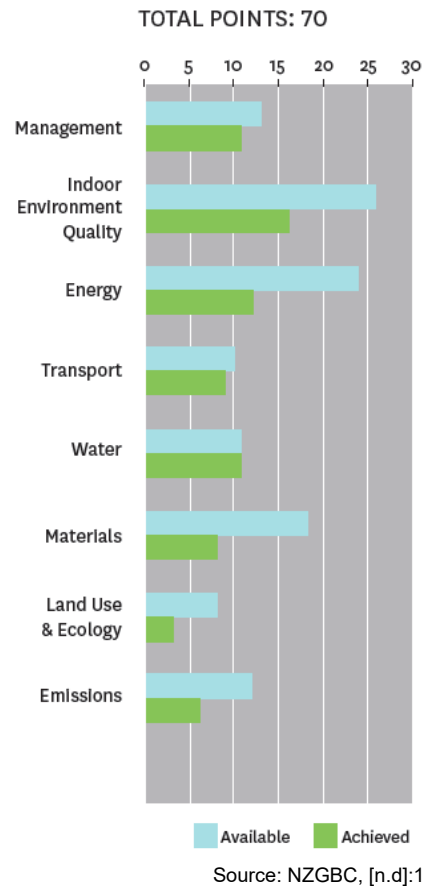
The building is also described as “the first to be constructed on Wellington’s waterfront in a decade”, a 5,246 m² building of which the office component represented 4,040 m², retail 832 m², balconies and storage etc. came in at 374m² (NZGBC, [n.d.](a):1).

The accompanying figure provides an overview of how the project achieved a total of 70 points during the certification process. From the figure, the project secured all the points available in the Water Category, the only category in this project, which achieved a full score.

The specific interventions included as part of the Water Category credits targeted were:

- Waterless urinals and sensor taps;
- It has a 16,000-litre rainwater collection tank (Rodio & Allen, [n.d.]:21) and 80% of toilet flushing uses harvested rainwater; and
- BMS (also referred to as the electronic brain of the Meridian (Rodio & Allen, [n.d.]:23) linked to water sub-metering.

Rodio & Allen ([n.d.]:20) illustrated that where a typical Wellington Office uses 1,170 litres/m² water per year, this project achieved a 23% reduction in potable water use by using only an average of 276 litres/m² per annum.

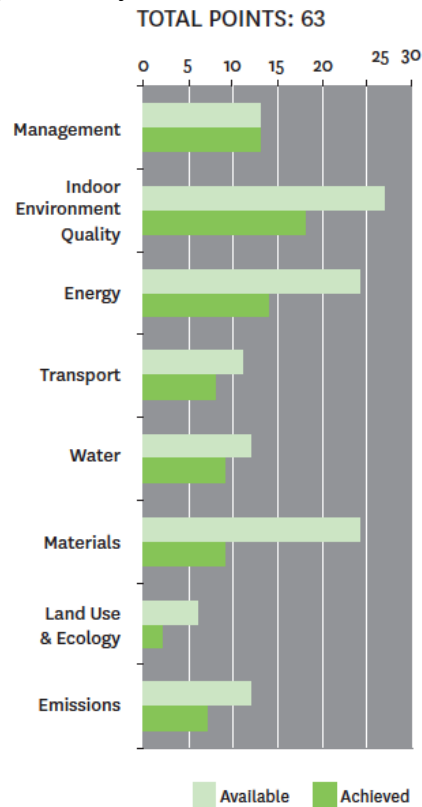


80 Queen Street

The project consisted of 22,162m² of office space and just over 1,000m² of retail area. This project is noteworthy because although it did not start out with a Green Star focus (NZGBC, [n.d.](b):1) it still managed to achieve a total of 63 points, and achieve a 5-Star Green Star rating.

This was one of the first two certified buildings in New Zealand, and the following figure provides insight into the allocation of points achieved by the project across the nine categories available in the Green Star Office rating tool.

It was also the first New Zealand project to achieve what is described as “the first 5–Star Green Star Trifecta”, earning 5-Stars both for Design, As Built and Interiors (Deloitte, 2010: para. 1).



Source: NZGBC, [n.d.](b):1

The specific water related interventions included in the project, is set out as follow (NZGBC, [n.d.](b):1):

- Significantly reduced potable water usage to 6 litres/day/person;
- Use of an efficient cooling tower with a minimum of 6 water cycles to reduce potable water usage;
- Rainwater collection and recycling to flush WC's;
- Waterless urinals, sensor taps and water efficient fitting specifications; and
- Water meters installed and an Electronic Management System (EMS) for alarmed leak detection system.

The Christchurch Civic Building

Described as “the greenest building in New Zealand” (NZGBC, 2010:7), it achieved a 6 Star Green Star – Office Design certification in 2010 with a record setting 83 points (Te Rūnanga o Ngāi Tahu, 2010:1). According to the NZGBC website, in

2013 this building achieved “the first 6 Green Star Trifecta” – “gaining a World Leadership 6 Green Star for Design, As Built and Interiors” and it was “only the third building in Australasia to achieve this triple honour” (NZGBC, 2015: para. 11).

The building is expected to “provide one million litres of water annually” through rainwater harvesting, which it will use “to flush the toilets, for landscape irrigation and a water feature” (Te Rūnanga o Ngāi Tahu, 2010:1).

5.7.3 South African Examples

WWF Building

The project is described as a “modest four storey building, which includes a roof garden and sits on a tight 248 square metre corner site in the Johannesburg CBD” (GBCSA, [n.d.](a):1). With a total GLA of 907 m², the project is reflective of the WWF’s values and attitude to environmental responsibility and conservation of natural resources (GBCSA, [n.d.](a):1).

The project achieved a 6 Star Green Star RSA Office rating, and was also the “first retrofitted building in the country” to receive the honour (WWF, 2015:1).



The intention behind the water use related interventions were aimed at reducing the building’s water footprint with features “introduced to curb the reliance on both municipal water and electricity” (WWF, 2015:1). Water use specifically, was addressed by introducing on-site treatment of effluent water and re-use of the treated water in the building. The project also boasts “an indigenous rooftop garden with water-efficient plants that are watered by rainwater” (WWF, 2015:1).

Grundfos Office Building

"The Denmark-based global pump manufacturer Grundfos has added its weight to South Africa's Green Building drive, with the company's newly constructed head office for sub-Saharan Africa aiming to achieve a 5 Star Green Star rating" (Green Building Guide, 2013: para. 1).



Copyright: Lynne Blumberg Interior Design

This building is located at the "junction of the R24

and N12 highways in Johannesburg, near the Gillooly's interchange" (Green Building Guide, 2013: para. 1). The building offers a gross floor area (GFA) of 3,400m² in a fully integrated tenant fit-out. The project achieved a total of 60 points and a 5 Star Green Star RSA Office v1 Design rating.

In addition to the installation of "a rainwater water harvesting and filtration system that utilises Grundfos pumps and filtration equipment" (Growthpoint, [n.d.]:19) which can purify water to drinking quality with municipal water used only for top-up during the dry winter months; the project secured all the available points in the Water Category.

Estuaries Plaza, Cape Town

Estuaries Plaza is a 4,136m² three-storey commercial office development located in Century Avenue, Century City, Cape Town (GBCSA, [n.d.](b):1). This project is said to have "targeted Green Star RSA certification relatively late in the built programme and after an extensive screening process, opted to implement a fully independent water system to maximise the points available for implementable credits" (Brom, 2016:108).

All wastewater is collected and “treated via a three-stage process: a bio digester, an HWT¹⁰⁷ organic filtration system and then a sophisticated reverse osmosis (RO) machine” (Brom, 2016:108). According to Fabio Venturi, the Green Star consultant on the project: “Initially only the bio digester and RO system were planned, but through commissioning it quickly became evident that additional intermediate treatment was required to ensure efficiency and predictability” (Brom, 2016:108). It was at this point that the HWT organic filtration system was brought into the project. This system includes composting worms, which helps create the final water output, which “is now purer than bottled water” (Brom, 2016:108).

Although it seems that the system incorporated into the Estuaries project required a significant investment from the client, Venturi pointed out that this approach provided a way to future-proof the project, especially in light with the ongoing water crises being experienced in South Africa (Brom, 2016:108).

5.8 Other Water Related Green Star Credits

Although not strictly part of the focus of the current research, as indicated in a previous section, the dataset on certified buildings obtained from the GBCSA provides insight into the project performance in all credits within Green Star, in addition to the Water Category. It is therefore possible to gain limited insight into the overall approach to the role of water on a project site. The two credits of interest are: EMI-05: Watercourse Pollution and EMI-06: Discharge to Sewer.

No comparative assessment of these credits was included in Chapter 4, but because these credits have a limited impact on actual water usage, which this research is concerned with, the absence of data to allow for further comparison was not regarded as detrimental to the overall research project. The following two sub-sections provide an overview of these credits presented as set out in the RSA certified building dataset.

5.8.1 EMI-05: Watercourse Pollution

The original intent of this credit was set out as follow: “To encourage and recognise developments that minimise storm water run-off to, and the pollution of, the natural watercourse” (GBCSA, 2008:325).

¹⁰⁷ Household water treatment (HWT).

In 2010, the GBCA announced that the EMI-05: Watercourse Pollution will be replaced in all its tools (except for the Office Interiors v1.1. tool) with the EMI-05: Storm Water Credit. The intent of this new credit was to include revised credit features with new benchmarks and reduced documentation requirements. The most promising aspect however, was a move toward requiring teams to investigate the use of Water Sensitive Urban Design as a possible approach to acknowledging storm water as a resource and not purely a waste product (GBCA, 2010:1).

The newly created credit also recognised the associated benefits when storm is treated either on site, or prior to discharge, or a combination of both, to remove pollutants (GBCA, 2010:1).

The GBCSA announced its own changes to this credit in 2012. The title remained the same, but the wording of the credit aim was revised slightly – with the addition of the words *and wetlands*: “To encourage and recognise developments that minimise storm water run-off to, and the pollution of, the natural watercourse and wetlands” (GBCSA, 2012(b):1).

Per the new credit, up to three points is available, and awarded separately (GBCSA, 2012(b):1):

One point is awarded where:

- The development does not increase (pre-development) peak storm water flows for rainfall events of up to a 1-in-2-year storm; AND
- The Total Suspended Solids (TSS) are reduced by 80% for the runoff volume resulting from the 1-in-2-year storm; AND
- Litter, oil and grease are trapped at source

One point is awarded where:

- The development does not increase (pre-development) peak storm water flows for rainfall events of up to a 1-in-20-year storm; AND
- Litter, oil and grease are trapped at source.

One point is awarded where:

- The runoff volume resulting from the 1 day rainfall, that is equalled or exceeded on average 3 times per year, is either captured and re-used on-site or infiltrated within the site; AND

- Litter, oil and grease are trapped at source.

These changes made an already difficult credit even more so, and from the calculations made using the GBCSA dataset, most certified projects are unable to secure any of the available points.

Table 5.25: EMI-05 - Watercourse Pollution

Building Phase Rating Tool Version	GBCSA		
		Design V1	As Built V1
No. of points available	N/A	0%	0%
	0	47%	38%
	1	18%	25%
	2	26%	31%
	3	9%	6%

Source: Adrie Fourie- Calculations based on GBCSA dataset, 2016

From the data, it seems that most both Design (47%) and As Built (38%) projects did not achieve any points under this credit. Across the dataset, the average number of points projects managed to achieve was one. It further appears that a further 26% of Design and 31% of As Built projects managed to outperform the average by securing two of the available points and a mere 9% and 6% respectively secured all three points.

5.8.2 EMI-06: Discharge to Sewer

The aim of this credit is: “To encourage and recognise developments that minimise discharge to municipal sewer” (GBCSA, 2008:331).

Points achieved through this calculator is calculated by the Green Star RSA Sewerage Calculator and rewards projects for the extent to which building outflows to the sewerage system have been reduced. Points are awarded on an incremental scale, of up to 4 points, with an additional 5th point available where at least one of the first four points is achieved; a black water system maintenance plan is in place, and a maintenance contract for a minimum of five years is also in place (GBCSA, 2008:331).

Most Design (74%) and As Built (69%) projects managed to reduce discharge to sewer by 50%. There is also 25% of As Built projects that could show a 70%

reduction, and at least 5% of Design projects which achieved one of the first four points, and included the black water maintenance plan and contract.

Table 5.26: EMI-06: Discharge to Sewer

Building Phase Rating Tool Version		GBCSA	
		Design V1	As Built V1
No. of points available	N/A	0%	0%
	0	0%	0%
	1	12%	6%
	2	74%	69%
	3	7%	25%
	4	2%	0%
	5	5%	0%

Source: Adrie Fourie - Calculations based on GBCSA dataset, 2016

From discussions included in the previous sections, at least one RSA certified project originally included a black water treatment system in the original building design, but due to the aversion to the perceived high risk associated with such a system, or problems relating to obtaining the required local authority approval, it was never actually brought online.

These findings indicate that there is still significant room for improvement related to how projects deal with this credit, and significant value in terms of identifying appropriate grey and black water recycling systems to provide an alternative water source.

5.9 Suggested Alternative Interventions that Require Investigation

5.9.1 Going Beyond Green Star

The research presented in this dissertation compared Green Star with other green building rating systems to provide context to the specifics included in its approach to Water. Although it would never be possible for any green building rating system to include an exhaustive list of all possible water reduction strategies, respondents to the survey linked to this research, were asked whether they have ever participated in projects that pursued strategies not currently included within the Green Star RSA tools.

Only 33% of respondents indicated that they were part of project teams that identified strategies that went over and above what is already specified by Green Star. When asked to identify those interventions, they listed the following:

- Harvesting condensation from air conditioning (16%),
- Fog harvesting (8%);
- One respondent felt that any type of moisture harvesting would purely be regarded as an alternative source of water and would be rewarded as such by the Potable Water Calculator (Respondent K, 2016:7);
- Capturing excessive rainwater to supply a neighbouring gym with water (8%);
- Storm water re-use on site, or attenuated and infiltrated which resulted in a 0% discharge to the municipal storm water system (8%);
- 8% of respondents indicated involvement in filtering of rainwater to potable quality – with water from the first cycle of filtration being used for toilets, and the second cycle supplying water for taps. It should be noted that this project could secure points under the Innovation category; and
- 16% of respondents indicated that ground water was investigated as an alternative water source, a strategy that is now accepted by Green Star RSA for irrigation purposes only.

Another respondent identified the approach by the Living Building Challenge, which allows for the use of borehole water as an alternative source, if projects can demonstrate that it facilitates the return of a similar amount of water to the groundwater source when possible (e.g. rainwater harvesting and attenuation for filtration); as a possible initiative to be considered by Green Star (Respondent B, 2016:7). Requiring Green Star projects to identify alternative sources but then placing undue restrictions without allowing for water balancing processes, as defined by the Living Building Challenge does seem to hamper incubation of innovative approaches.

The Living Building Challenge is ultimately focused on two aspects associated with water use in a building – on the one hand there is a drive toward net zero water, implying the use of a closed loop system reusing recycled waste water or captured rainwater; and on the other hand it deals with ecological flow of water, which entails that storm water and building waste water must be managed on-site to satisfy water demand internally or groundwater recharge (Cascadia Green Building Council, 2011:18-19).

The Living Building Challenge leans extensively on the use of a water balance to manage water. This requires detailed records on the amount of water that enters a building and the amount of water that exists to be kept (Cascadia Green Building Council, 2011:31). For a project to achieve net zero water, the water balance information should align with the natural hydrology of the site.

There was also a recommendation for future Green Star rating tools to borrow extensively from the Green Star Communities tool which advocates a similarly holistic approach to water management by providing a performance pathway¹⁰⁸ for reducing potable water demand in site through the application of Water Sensitive Urban Design (WSUD) principles (Respondent B, 2016:7). The WSUD best practice hierarchy relates to retention and restoration, non-structural source controls (including educational and enforcement measures to minimise water use and polluting activities), structural source controls (relating to physical infrastructure components) and structural in-system controls which work on a precinct on region-scale to augment source control (GBCA, 2015:186).

Clearly, both these approaches are in line with the recommendations made throughout this dissertation, calling for a more holistic consideration of water use within a building and water management on a site.

5.9.2 Adapting Green Star

The findings from the Green Star and Water Conservation survey show that some projects pursued alternative initiatives in addition to the strategies or credits being rewarded by Green Star; most likely by securing additional points through the Innovation category.

Many of the respondents that participated in the survey also indicated extensive experience in using green building rating systems other than Green Star. It was based on this diverse exposure to the alternative interventions that might be captured by other systems, that respondents were asked whether they believe any additional strategies should be considered for inclusion in Green Star.

¹⁰⁸ The Green Star Communities tool has two pathways of obtaining credit points. This prescriptive pathway is basically a checklist of requirements that projects are required to satisfy in order to get the points, and the performance pathway is where projects can use modeling or design element insight to prove how the credit criteria was satisfied (Adrie Fourie, 2017 based on GBCA (2015:186).

There were 42% of the respondents that indicated alternative strategies should also be incorporated into Green Star while 33% felt that any additional interventions should be treated like innovation credits and therefore rewarded elsewhere in the Green Star system.

However, at least one researcher identified restrictions associated with this suggested approach. In the research Hes (2007) conducted, reference was made to one specific incident referring to criticism from a project team against Green Star. In a journal article, the researcher (Hes, 2007:8) refers to notes on a meeting relating to the Green Star certification on the Council House 2 project in Australia. The notes indicate that during one specific design meeting, an option to save additional water was put forward by one team member, while another indicated that all available points in the category had already been secured; which led to agreement around the room that no further investigations on the proposed initiative would be required (City of Melbourne, 2006:5 as cited by Hes, 2007:5). This lack of support to investigate a new option that could have led to greater water savings was an unfortunate incident as Green Star specifically provides project teams with 5 innovation points specifically for initiatives going beyond Green Star, in terms of approach and potential use of technology (Hes, 2007:5). Yet, even the use of innovation credits has been identified as a restriction where a specific project is said to have used all 5-innovation points and could therefore not pursue any further options to secure additional points (Hes, 2007).

Although data related to RSA certified projects in terms of innovation is limited, the GBCSA dataset does provide some insight. There are three credits contained within the Innovation category: INN-01: Innovative Strategies and Technologies; INN-02: Exceeding Green Star RSA Benchmarks; and INN-03: Environmental Design Initiatives.

In terms of **INN-01: Innovative Strategies and Technologies**, 23% of all certified projects obtained some points under this credit. The majority (12%) secured 2 points, 7% obtained 1 point, 1% got 4 points and 3% secured all 5 available points. This credit rewards a maximum of 5 initiatives, with a maximum of 2 points associated with each initiative.

For **INN-02: Exceeding Green Star RSA Benchmarks**, a total of 12% of projects achieved some points; 5% achieved 1 or 2 points, and a further 3% secured 4 of the 5 available points. Once again there is the potential to put 5 innovation initiatives forward for consideration with a maximum of 2 points awarded for each.

Lastly, 15% of the certified projects obtained points under **INN-03: Environmental Design Initiatives**; 8% secured 1 point and a further 7% secured 2 points.

Using the Innovation category, projects have at least 5 additional points available, awarded at the discretion of the GBCSA, it should be kept in mind that under the INN-01 credit¹⁰⁹ initiatives will only be rewarded for use of three projects under the same rating tool (GBCSA, 2008:351). If more than three projects target the same initiative certainly that could be regarded as a move toward mainstreaming of that approach in standard building practice. Then again, as respondents indicated, if projects are not rewarded for effort and additional investment through points, in all likelihood the final decision will ignore that additional improvement in the final design. Surely what is needed is a system where, once support for an initiative achieves critical mass, it should be absorbed into Green Star in a more formal manner to ensure continuous recognition. Otherwise, how is market transformation encouraged persistently?

Of the 33% of respondents that indicated additional strategies should be incorporated into Green Star, felt that this related to:

- The need to undertake research relating to the use of boreholes or wells to obtain points (8%);
- Operational initiatives that relate to behaviour changes in water usage (8%);
- 8% indicated that WAT-03 requires a clearer path to compliance and called for additional research on claims related to irrigation systems;
- 8% called for the inclusion of a credit like the LEED Process Water reduction credit that will allow water used in canteens to be appropriately captured;
- 8% also indicated (albeit under a different question within the survey) that Green Star should also differentiate in some way for water used by car wash bays at offices; and

¹⁰⁹ Projects can target initiatives under INN-02 and INN-03 more than 3 times.

- 16% indicated that additional strategies should only be rewarded as part of the Innovation category as duplication of such interventions might be limited by geographical and therefore climatic zone differences.

5.10 Conclusion

The datasets and related information provided by the GBCA, NZGBC and GBCSA was rich with information, and several assessments were possible.

From a preliminary assessment, the following general findings are noted:

- Most Australian and New Zealand projects achieved 5-star certification level, and in South Africa the best performing category is that of 4-stars;
- In all three countries, the location of Green Star certified projects corresponds with major growth nodes and development trends; and
- Only a very small percentage of projects obtain all available Water Category points: 9% of projects in Australia, 12% in New Zealand, and only 3% in South Africa.

The most comprehensive dataset was obtained from the GBCSA, which set out how each project fared in all categories, not only focussing on the outcome of credits contained within the Water Category. Using this dataset, it was possible to determine how points achieved in the Water Category compared with achievements in other categories:

- The average number of points projects achieved in the Water Category represents 75% of all available points for both Design and As Built projects, higher than any other category;
- 65% of Design projects can achieve either the average number of points calculated or higher, the Water Category once again outperforming the rest;
- For As Built projects the situation is similar, with the addition of the Land Use and Ecology category also getting 63% of projects to obtain at least the average number of points, which is the same for the Water Category. The difference here is that the average number of points in Land Use and Ecology only represents 26% of the total available points, while in Water this represents 75% of all available points.

Still using the GBCSA dataset, some RSA specific findings were made, augmented where relevant by the findings of the Green Star and Water Conservation Survey used as part of the research process:

- Generally, the Green Star Strategy is developed early in the design process, specific points to be targeted are identified, and, if possible, as the project unfolds, this target will be driven upward - costs and design permitting;
- There seems to be a very high likelihood of project teams targeting all the credits within the Water Category, and although respondents indicated that the WAT-04: Heat Rejection Water credit was less likely to be targeted, the findings from the dataset assessment show a different story; and
- Most respondents indicated that local legislation and policies were considered during the certification process, but on closer inspection, very few reviewed policies or by-laws relating to water efficiency (and which is in place in certain municipalities).

The next phase of the assessment entailed analysing the contents of each dataset separately, and using the findings to compare outcomes between the three datasets. Each dataset was separated into Design and As Built projects to further aid comparison. The analysis provided insight into the extent to which projects target all available points. From this assessment, the following was noted:

- WAT-01: Occupant Amenity Water seems to be the worst performing credit in New Zealand under v1 and 2009; followed closely by WAT-03: Landscape Irrigation for As Built projects. The best performing credit seems to be WAT-04: Heat Rejection Water;
- In Australia, projects certified under v1 and v2 are least likely to obtain all available points for WAT-04: Heat Rejection Water; with most projects obtaining all points under WAT-02: Water Meters. For v3 projects this shifts, and only 2% of projects obtained all available points under WAT-02, with the top honours going to WAT-05: Fire System Consumption Water; and
- In South Africa, WAT-03 also fares badly for both Design and As Built projects, with WAT-02 and WAT-04 the credits in which projects are most likely to obtain all available points.

Although there seems to be some similarities across the three countries, in all probability the decision to target specific credits over others, and the level of points achieved, could be due to: ease of obtaining credits, local conditions, costs and available technologies that assisted project teams in the decision-making. The main mechanism provided by the Green Star rating system to motivate projects to target credits (regardless of environmental category) remains the number of points available. Throughout this chapter the impact which a change in the number of points associated with certain water credits were noted, and indications from the industry supports the notion that should points be reduced, the likelihood of projects still targeting those credits significantly reduce. By assigning an appropriate number of points to water, the three GBCs are clearly setting out the importance of facilitating a change in approach to design interventions that relate to the reduction of potable water use.

There are some excellent examples in each country that illustrate Green Star Water interventions in action. Each GBC has also shown commitment to constantly evolving their approach to certification and the content captured by these systems, allowing the evolution of a dynamic rating systems driven by market transformation.

Some potential gaps exist and if filled, could create a more robust tool. According to the survey respondents this relates specifically to in-depth analysis and understanding of weather data; water efficiency benchmarks and addressing the current lack of appropriate industry data relating to the efficiency expectations of irrigation systems. There is an increased awareness of the potential application of grey- and black water recycling systems on a larger scale, but building level buy-in is essential.

Although the main research question under consideration relates specifically to the mechanism provided by Green Star to facilitate a change in approach to building design, which has clearly been demonstrated to be through the use of a points-based system, the next chapter provides insight into how external factors, benefits or considerations could provide additional motivation to project teams to change their design approach.

6 EXTERNAL FACTORS CONTRIBUTING TO GREEN BUILDING INDUSTRY GROWTH

6.1 Introduction

The Green Star system “established individual environmental measurement criteria” to “evaluate the predicted performance of buildings based on a variety of environmental criteria”, which could also include “water efficiency, indoor environment quality and resource conservation” (GBCSA, 2014:5,9,17).

For the current research, there was a clear distinction between measuring the effectiveness of Green Star as a mechanism to facilitate change, and understanding or assessing the effectiveness of green buildings in terms of operational benefits.

In the preceding Chapter, the discussion focussed on the internal mechanism (the points reward system) which Green Star uses to facilitate a move away from a business-as-usual approach to building design and operation, toward the creation of more environmentally efficient buildings. There are however a range of external factors and/or benefits that could provide further motivation for pursuing specific green building interventions.

As alluded in Section 1.1.5, Hes (2007: 3) did not limit the term ‘effectiveness’ to only to the “improved environmentally performing buildings, but also the long term [sic] effectiveness of the rating tools application and usability; and the ability for the tools to provide the outcomes expected by those using the tools.”

Hes (2007:4) distilled nine criteria from existing research to identify a framework within which the “effectiveness of green building rating tools” could be measured, which was used to compare a range of different rating systems (including LEED, BREEAM, Green Globes and CASBEE).

Although the criteria set out below was originally identified and used by Hes (2007:4) to assess the ‘effectiveness’ of rating systems, the current author refers to the criteria only as way to create additional insight into the context within which green building projects are most likely approached.

The criteria identified and regarded by Hes (2007) as a way to measure the effectiveness of rating systems but that rather refers to the external benefits or impacts associated with green buildings, are:

- "Reduction in environmental impact;
- Positive social impacts;
- Positive impact on occupant comfort;
- Positive affect on employee productivity;
- Cost savings;
- Ease of use, cost effectiveness and process;
- Rating and modelling accuracy;
- Ability to be dynamic and support continuous improvement; and
- Ability to support innovation in design" (Hes, 2007:2-3).

The intent of this chapter is not to refer extensively only to the research of Hes (2007); but to augment it with additional external sources with a focus on the external impacts or benefits associated with green buildings that might contribute to the decision-making process when design team use rating systems such as Green Star.

6.1.1 *Reduction in Environmental Impact*

Although in Hes' (2007) research the focus did not fall on one singular environmental aspect, the current research does. The focus of the current research falls on the ability of Green Star to facilitate water conservation in the built environment, and therefore a good starting point for understanding how external factors such as a reduced environmental impact could further motivate project teams to target certain credits and a specific number of points during the certification process.

The main motivation behind the Green Star Water Category and its related credits is to facilitate the reduction of potable water use. In earlier Chapters, reference is made to authors who indicate that such reduction strategies could translate into water savings as high as 80%; and some projects have managed even higher achievements.

Using the information on each credit that was set out in Chapter 4, it is possible to determine how each credit will facilitate a change in water use behaviour:

WAT-01: Water Occupant Amenity Water – rewards projects' reduction efforts incrementally using the potable water calculator, requiring the use of alternative sources of water to secure all the available points.

WAT-02: Water Meter – rewards projects that keep track of water use associated with major uses within a building, but more importantly enabling the early detection of expensive and wasteful water leakages.

WAT-03: Landscape Irrigation – projects rewarded by reducing potable water use for irrigation purposes between 50% and 90%.

WAT-04: Heat Rejection Water - projects rewarded by reducing potable water use for irrigation purposes between 50% and 90%.

WAT-05: Fire System Water Consumption – rewards projects for temporary storage of fire protection system test water and maintenance, as well as reuse of such water onsite.

From the findings of the analysis of certified building data, as set out in Chapter 5, it has been shown that a significant number of projects have been able to secure a very high amount of the available points in the Water Category. A small percentage of projects could secure all available points, leading the charge in facilitating industry change and driving forward the need for mandatory standards and guidelines to be improved and widely implemented.

Although the current research did not review the specific level of water savings for the specific projects assessed as part of Chapter 5, there are several sources available that illustrate the associated environmental impact, some with specific reference to water conservation levels reached.

One such study conducted by the Green Building Council of Australia sheds some light on the potential water savings such certifications translate into. Through an assessment of 428 Green Star-certified buildings, of which 249 were certified using the Office tool, the GBCA calculated the anticipated water savings associated with the proposed interventions as set out in the certification submission for each project.

Using data contained in the certification submissions of these projects, and comparing the data to standard minimum practice benchmarks, the following key findings related to water usage was determined (GBCA, 2013:3):

- Green Star buildings use approximately 51% less potable water than an average building; and
- Green Star certified buildings save enough potable water to fill more than 1,300 Olympic swimming pools every year – that is, over 3,300,000 kl per annum.

The GBCA assessment did a further breakdown of the collected information and delved into each building type separately. The following table provides an overview of what the average Green Star office building in Australia looks like. Although the information set out in the table is based on prediction, a study conducted by Bell, Milagre & Sanchez (2013) “support the assumption that Green Star buildings’ estimated performance is generally representative of operational performance” (GBCA, 2013:8). The study by Bell et al., (2013:3) assessed 70 Green Star certified office buildings to compare modelled and actual greenhouse gas (GHG) performance.

Table 6.1: The Average Green Star Office Building (Australia)

	All projects (Average 4.72 Stars)	4 Star	5 Star	6 Star
Size (m ² NLA ¹¹⁰)	15,900	11,200	16,900	26,500
Water Consumption (L/m ² /annum)	500	540	510	430

Source: GBCA, 2013:4-5

The findings of their assessment indicated that:

- 57% of the Green Star certified buildings achieved their modelled GHG performance;
- 17% performed better than previously predicted; and
- 26% required some operational adjustments to reach the modelled savings (Bell et al., 2013:3).

The study might have been focussed on achievement in terms of GHG emissions, but as part of the assessment, 48.5% of the sample buildings also had their potable water operational water performance assessed (Bell et al., 2013:3). The indications

¹¹⁰ Net Lettable Area

from the findings were that there is a typical correlation between improvement in GHG efficiency and potable water performance.

According to the Australian Department of Heritage and Environment (2006:2), the commercial office-building sector can be regarded as a significant water end user. They provide the following example to demonstrate: “Office water use can account for 10% of capital city water consumption; a moderate sized building of 10 000m² typically consumes over 20 000 litres per day or more than 7 million litres per year – enough to supply 40 average homes” (DEH, 2006:2).

These benchmarks seem to be in line with the findings from research undertaken by Sydney Water and GHD Pty Ltd, which was set out in more detail in a previous section of this dissertation.

The GBCSA undertook similar research where it assessed the submission data of anticipated improvements to building performance associated with the first 50 buildings certified (GBCSA, 2014(a)). The research assessed 45 Green Star RSA office certified buildings, one building certified under the Retail Centre v1 tool, two buildings certified under Public and Education Building PILOT and two Multi-Unit Residential PILOT buildings. It was determined that if the buildings “are operated as their designs intended” the following predicted water savings will be achieved:

- “124 million litres per annum of water;
- 250 million litres predicted to have been saved to date by these buildings since they were built; and
- The average predicted potable water savings of these projects is 48% more efficient than the reference case, which is based on WELS Two Star fittings” (GBCSA, (2014)(a):7).

By March 2016, the total number of Green Star RSA certification grew to 140, with new leading building category leading industry transformation being Existing Buildings (GBCSA, 2016:1).

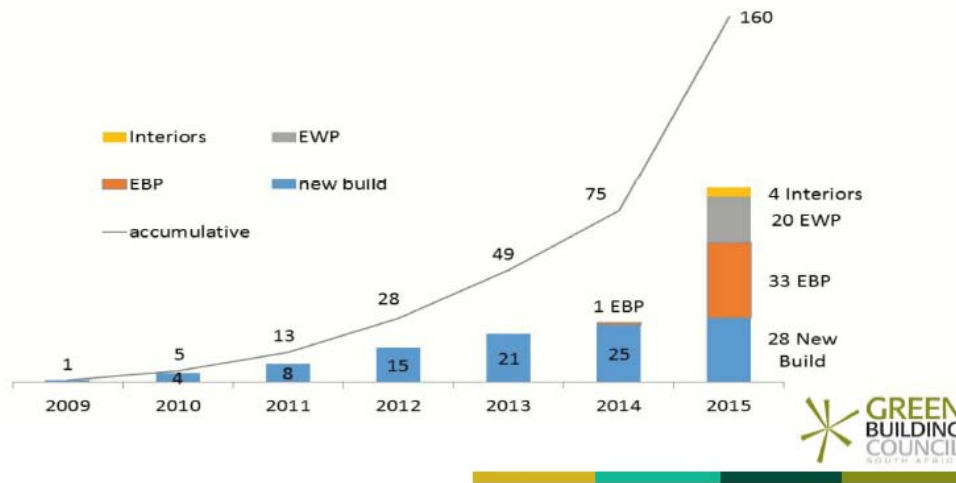


Figure 6-1: Total Green Star RSA and GBCSA Certifications (2016)

Source: GBCSA, 2016:1

Another category of certifications that feature prominently on the preceding figure is EWP, which refers to the GBCSA's Energy Water Performance certification ([n.d.](c): para. 6). Described as a key component of the Existing Building Performance Tool, the EWP is a free tool available to calculate a building's energy and water performance against industry benchmarks ([n.d.](c): para. 6). Although the EWP is technically accounts for 40% of the EBP certification, projects can apply for a separate certification only focussed on energy and water ([n.d.](c): para. 6).

Based on the updated certification data (GBCSA, 2016:2), the following figure provides insight into the total size of Green Star RSA certified buildings by province. No differentiation is made of the different land uses involved in these certifications, but it does indicate significant transformative action within the built environment in the South African context.



Figure 6-2: Total Green Star RSA Certified Space (2016)

Source: GBCSA, 2016:2

In line with the findings of the assessment of the South African Green Star certified office buildings, set out in Chapter 5 of this dissertation, Gauteng is still firmly in the Green Star RSA lead. The uptake of Green Star in other provinces can however be regarded as an indication of the increased uptake of the green building philosophy it represents, throughout the country.

Even more telling, is the data relating to water savings associated with these certifications which has increased from the 260 million litres mentioned in the preceding paragraph to just over 300 million litres of water (GBCSA, 2016:3) – an accomplishment in and of itself; but more importantly this saving accounts for water now available to other uses in the South African context (e.g. households, irrigation farming, industry, etc.).

As demonstrated in an earlier section of this dissertation, a significant aspect of motivating for the adoption of green building practices and Green Star specifically is the anticipated financial savings associated with operation improvements. The GBCSA (2016:4) have translated both the energy and water savings into financial terms. The following figure provides some insight:



Figure 6-3: Total Green Star RSA Energy and Water Savings (2016)
Source: GBCSA, 2016:4

Clearly, by improving energy and water performance of the built environment can translate into significant financial savings. The researcher believes the water related financial savings could have been significantly higher, if water was accurately priced to reflect its importance and increasing scarcity. Unfortunately, this issue falls beyond the scope of the current investigations.

6.1.2 Positive Social Impacts

Hes (2007:6) lists possible examples of positive social impacts referring to provision of public art, day care and education. The lack of accounting for external social impacts was noted by the GBCSA, and in 2011, the Socio-Economic

Category framework was introduced to the market “to support the extension of the GBCSA’s vision” (GBCSA, 2014(d):xii). This framework entails a separate category of credits, available to qualifying projects¹¹¹, and if achieved, will be acknowledged by a separate certificate and plaque for the building. Due to the significant societal concerns of South Africa, this category “will allow private companies and public entities to benefit from demonstrating their commitment to socio-economic development issues, alongside or as part of their Corporate Social Responsibility” (GBCSA, 2014(d):xii).

The SEC includes 7 possible credits: employment creation, economic opportunity, skills development and training, community benefit, empowerment, safety and health; and mixed income housing¹¹².

The intent is not to provide an exhaustive overview of the SEC or its credits, but rather to demonstrate that Green Star is increasingly looking for ways to expand its initial “exclusive focus on environmental impacts”, opening opportunities for projects to also consider and address social and economic impacts (GBCSA, 2014(d):1).

6.1.3 Positive Impact on Occupant Comfort

What Hes (2007) looked at with this criterion, is whether a green building created a better environment for the end-user when compared to a non-certified building. Hes referred to studies conducted by researchers at Berkeley University in the US that compiled a database of 181 buildings, of which 160 were regarded non-green and 21 defined as green (Hes, 2007:7). Hes indicates that the research showed that there was a “higher level of overall satisfaction for the users of the 21 green building [sic] specifically concerning thermal comfort and air quality”, but they also found that “lighting and acoustic quality rates were comparable to the non-green buildings” (2007:7)¹¹³.

It should however be kept in mind, occupant comfort and employee productivity, is dependent on projects having a very strong focus on achievement in the Indoor

¹¹¹ Office v1; Retail Centre v1; Multi Unit Residential v1, Public & Education Building v1 and Interiors PILOT

¹¹² Only applies to the multi-unit residential tool.

¹¹³ Hes (2007:7) refers to Abbaszadeh et al (2006) when referring to the Berkeley research.

Environment Quality category (Reinink, 2016: Personal communication). In Chapter 5, as part of the discussion linked to Table 5.7 and Table 5.8 the researcher could determine the average number of points achieved in the IEQ category by projects certified under the Green Star RSA Office rating tool. The analysis showed that 47% of Design, and 50% of As Built projects could secure 50% and 55% of the average number of points in that category¹¹⁴.

6.1.4 Positive Affect on Employee Productivity

There are many factors that can influence productivity, and Hes (2007:6) indicates that because productivity, like comfort, is difficult to measure, absenteeism is often used as a main indicator. Hes however cautions against having a too narrow view on productivity and factors that impact it, indicating that issues like “company moral, attitude, staff, management and factors outside of work (e.g. family) can have significant impacts on productivity” (Hes, 2007:8).

Vista Window Film (2013: line 1)¹¹⁵ compiled a list of what they believe are the “top 5 studies linking green building¹¹⁶ to productivity”:

Study 1: Environmental Standards and Labour Productivity: Understanding the Mechanisms that Sustain Sustainability (2012) - UCLA's Institute of the Environment and Sustainability

- Survey of 10 000 employees across 5 200 French companies.
- Found that companies that voluntarily adopt green practices and standards have employees who are up to 16% more productive.

Study 2: Effects of Green Buildings on Employee Health and Productivity (2010) - Michigan State University's School of Planning, Design and Construction

- Two groups of employees, recently moved from a conventional building to a LEED-certified venue were surveyed.

¹¹⁴ The total number of points available in the IEQ category is 28, and when accounting for certain points that fall away if certain aspects are regarded as ‘Not Applicable’ this number drops to 27. The average number of points achieved by Design projects are 14 and for As Built this number sits at 15.

¹¹⁵ This is a premium brand of professional installed architectural window films for homes and commercial buildings. The window film is easy to apply to a window's interior, and it helps keep indoor temperatures comfortably consistent.

¹¹⁶ Although this research relates to green buildings in general and not specifically to Green Star rated buildings, there is a strong likelihood that project owners that use green building rating systems are focussed on creating strong and productive assets, which in turn leads to improved performance of the tenants located in such assets, securing the long-term longevity of the tenant relationship.

- The effect of allergies or asthma on absenteeism dropped by almost 50%, with an overall reduction in allergies or asthma noted by 60% of respondents; with a 30% drop in absenteeism due to depression and/or stress also noted.

Study 3: Greening the Building and the Bottom Line: Increasing Productivity through Energy-Efficient Design (2010) – Rocky Mountain Institute, U.S. Department of Energy

- Reviewed eight case studies across different building types.
- Found that energy-efficient improvements to lighting and HVAC systems lead to a general increase in employee comfort and productivity.

Study 4: Green Buildings and Productivity (2009) – University of San Diego, CB Richard Ellis

- Studied 534 tenants moved from conventional buildings to LEED-certified or ENERGY STAR- labelled buildings.
- 54.5% reported increased productivity and 45% a decrease in sick days.

Study 5: Linking Energy to Health and Productivity in the Built Environment (2008) – Carnegie Mellon University's School of Architecture

- Examined hundreds of case studies, and found that improved Indoor Air Quality (IAQ) led to productivity increases of 0.5% to 11%, and providing access to sunlight increased productivity by 5% to 15%.

In a study by the WGBC, the importance of understanding the human impact of green buildings can play a significant role in creating a positive business case (2014:2). Approximately 90% of all business operating costs is linked to staff in the form of salaries and benefits (WGBC, 2014:2). A summary of evidence found during the WGBC investigations regarding the impact of buildings on a workforce is set out below, creating further insight into the benefits associated with green building¹¹⁷.

The summary builds on extensive literature investigations, the findings of which were distilled and translated into list below. Each aspect is associated with a

¹¹⁷ The WGBC (2014:7) report does contain a disclaimer on the evidence presented, indicating that specific local geographic conditions also have an important role to play, but they highlight the importance of local climate and specific cultural conditions when designing appropriate workspaces.

specific component with building design, and the potential impact it could have on occupants when design is done keeping users of the space in mind (WGBC, 2014:8-9):

- **Indoor Air Quality:** By lower the CO2 content of offices, improvements on productivity of around 8-11% can be achieved;
- **Thermal Comfort:** Closely linked to IAQ, providing people with even a small degree of personal control over temperature could see a single digit improvement in productivity;
- **Day lighting¹¹⁸ and lighting:** Access to day lighting and access to outside views of nature are difficult to separate, the body of knowledge associated with the benefits are growing all the time.
- **Biophilia¹¹⁹:** There is growing scientific evidence about the positive impact a link between building occupants and nature can have, especially as it relates to mental health;
- **Noise:** Keeping noise at appropriate levels decreases distraction and could support productivity;
- **Interior layout:** Linked to noise, configuration of work areas impact on concentration, confidentiality, creativity and the potential for collaboration. Existing evidence on the impact it has is still relatively undefined, but growing;
- **Look and feel:** This could be experienced differently by people of varying ages, gender and culture, with mounting research indicating that it impacts mental wellbeing and mind-set; and
- **Active design and exercise:** By getting people to be more active could lead directly to improvements in health. This could be achieved by appropriate design but also include activity based elements, such as gyms, bicycle facilities and green spaces into buildings. Some research suggests that healthier lifestyles could lead to a decrease in the number of sick days building occupants might take.

These lists are by no means regarded as exhaustive, there is however a clear indication that the industry is taking note of the associated benefits of green building, and Hamman (2016: Personal communications) notes that for projects

¹¹⁸ Term taken from the WGBC (2014:8) report.

¹¹⁹ A term originally coined in 1943, which described the attraction of humans to nature and other living organisms (WGBC, 2014:40).

pursuing certification under the Green Star Interiors and Existing Buildings rating tools, it is essential for projects to submit User Occupancy Surveys, which will start building up an extensive dataset where Green Star rated buildings are concerned regarding actual building user experience.

6.1.5 Cost Savings

This could refer to operational savings that a building can expect because of the efficiency improvements made due to the green building practices introduced; nonetheless it can also be linked to improved productivity and decreased absenteeism.

There is also the consideration of financial benefits. Various research studies have been conducted to assess the benefits that can flow from green buildings, either to the environment, property owners, tenants or employees working in such buildings. A list of such benefits is included in a booklet on the first 50 Green Star RSA certified buildings, and are:

- Lower operating costs;
- Higher returns on assets;
- Increased property values;
- Enhanced marketability;
- Reduced liability and risk;
- Retaining government and other major tenants;
- Minimising churn;
- Responsible investing;
- Increased productivity;
- Attracting and retaining talent; and
- Combating climate change (GBCSA, (2014)(a):11-12).

Kats (2003:3) also supported the findings that “Green Buildings provide financial benefits that conventional buildings do not” and he further highlights that “these benefits include energy and water savings, reduced waste, improved indoor environmental quality, greater employee comfort/productivity, reduced employee health costs and lower operations and maintenance costs”.

Although it is not within the scope of the current research to assess all the benefits associated with Green Star to determine whether the Rating System is effective in general, it was illustrated in Chapter 5 that industry professionals have found financial considerations to be a very important driver in the decision-making process regarding the identification of which credits to target during the certification process.

The following points listed, set out some of the financial impacts, which have been noted in New Zealand-based research:

- According to work done by the NZ government, it was found that “the Return on Investment for green buildings has jumped 50% in three years as building values rise and operating costs tumble” referring to a recent survey of the commercial building sector undertaken in the US (NZGBC, 2010:2);
- The report (NZGBC, 2010:2) also state that due to the public perception that green certified buildings are more environmentally responsible there is also an increase to the marketability of such buildings;
- “Optimising building systems can lead to substantial savings in capital costs. Davis Langdon found in Australia that a 4 Green Star certified building could expect to experience a 2% – 5% saving on the up-front capital cost” (NZGBC, 2010:3);
- As a way in which to pursue asset protection, the New Zealand government and large corporate organisations are “increasingly incorporating green principles into their property requirements” which anticipates “potential future changes in market demand and legislation thereby protecting expensive developments” (NZGBC, 2010:3). Further proof that Green Star delivers on its attempt to constantly motivate the building industry to outperform current building regulations and, as part of the advocacy process it creates, maintains the awareness with the relevant authorities to develop increasingly stringent building regulations and guidelines to adapt to new technologies and improvements to the building industry knowledge base;
- Another important benefit, which has been identified, is the fact that “debt funding may soon become easier and less expensive for certified green buildings in New Zealand”. This is said to be because “there is often less perceived credit risk in the development of certified green buildings, due to their ability to command higher rents and better tenants” (NZGBC, 2010:3); and

- There is also evidence that green buildings command higher property values. “In the US, it is now the norm for certified green buildings to command a 30% price premium over similar non-certified buildings due to the economic benefits they offer” (NZGBC, 2010:4).

These are just a few of the known ways in which using a green building rating system can contribute to financial benefits for project owners. With more Green Star projects entering operational phases every day, the pool of data will increase and more in-depth analysis of actual outcome data will be possible in future.

6.1.6 Ease of Use, Cost Effectiveness and Process

According to Hes (2007:8), tools like LEED and Green Star have worked toward creating simplified systems using credits and points associated with specific components of building design. Hes (2007) further notes that this could lead to project teams becoming more focussed on achieving specific points, than really investigating the intent behind a specific credit.

As set out in Chapter 5, some of the respondents to the Green Star and Water Conservation survey also noted that should projects no longer be rewarded (in the form of Green Star points) for certain interventions, for example the installation of water meters, the credit will no longer be pursued - clearly supporting Hes' finding.

There is also the question of whether teams really do need the third-party assessment to acknowledge that a building design checks certain environmentally beneficial boxes. The certification process itself has a cost, and if buildings are interested in certifying various development stages (i.e. Design, As Built, Interiors and Performance), the financial implications for a project increase drastically.

Importantly, Green Star provides free access to the market to all its tools, allowing projects to review and self-assess without any requirement to proceed with the formal certification process. Thereby ensuring that the benefits of the Green Star system can be felt in projects lacking the financial capacity to carry the additional certification cost. The Green Star system is also reviewed regularly to ensure that the tools are consistently improved upon, and as regulation becomes more

stringent, the tools once again provide a lead to drive the industry even further in terms of improving building performance.

6.1.7 Rating and Modelling Accuracy

Various studies are referred to in the research done by Hes (2007), indicating various flaws that have been identified with modelling accuracy especially as it relates to energy prediction. Aspects that impact on the accuracy link to “occupant behaviour, use of model based assumptions while reality is much more complex, changes post modelling, error in installation and poor maintenance” (Johnson (2003:9) as referenced by Hes (2007)). This discrepancy between what is modelled and actual outcome is referred to as the “credibility gap” (Hes, 2007:9).

This gap between reality and prediction is also noted by a survey respondent. Using historic rainfall data can lead to an oversizing of rainwater harvesting storage tank requirements, which increases investment costs, and loss of valuable development area. There is a call for greater accuracy in the calculations contained within the Potable Water Calculator, more fine-grained rainfall data and reliance on more recent information instead of reliance on historic data. With the changing weather patterns a more dynamic approach would be required to stay relevant.

This criterion is more a point of concern that it is an impact or benefit associated with green building or Green Star certifications. There is however a drive in the industry to use the data coming out of Green Star certifications to provide a more accurate pool of data. The evolution of the associated calculators used as part of the certification process is no exception and the relevant GBCs are always interested in receiving industry feedback and improving the tools available to the market.

6.1.8 Ability to be Dynamic and Support Continuous Improvement

Green Star has created tools specifically aimed at different developmental stages: Design, As Built, Interiors and Performance. This allows for dynamic responses to changing project conditions while adding an additional layer of complexity; requiring project teams to demonstrate at every stage how the credit criteria are met, submitting the required proof documentation for certification at every stage (Hes, 2007:9).

Like BREEAM and LEED, Green Star is also committed to the continual improvement of existing tools, with review processes undertaken every couple of years (Momberg, 2016: Electronic communications), which allows for the capturing of any significant changes to the industry, and increasing the level of difficulty associated with achieving points related to the various credits. This is further demonstrated by the number of versions of the Green Star office tool reviewed in Chapter 4.

6.1.9 Ability to Support Innovation

As set out in Chapter 1 and 2, Green Star includes an Innovation category. There are an additional 5 points available to teams, to submit interventions not covered elsewhere in the tool. There are however still limitations to this approach. Only the first three projects to submit a specific intervention related to technology (INN-01), as part of its overall Green Star strategy will be able to obtain the points assigned. Once three projects have secured the points, these innovations are captured in the innovation database of the GBCSA (Westbrook, 2016: Verbal communications). Interventions pursued as part of INN-02: Exceeding Green Star Benchmarks and INN-03: Environmental Design Initiatives provide a relatively high degree of replicability.

Furthermore, innovation challenges are also used by GBCs to provide projects with the opportunity to earn innovation points. These challenges aim to get projects to think beyond Green Star, toughing on social, economic and environmental sustainability issues (GBCSA, [n.d.](d): para. 6). Such challenges can be obtained from the relevant GBC, and if the challenge does not relate to a credit already contained within the specific rating tool under which certification is pursued, teams can gain additional credits/points if the challenge is adequately addressed (GBCSA, [n.d.](d): para. 6).

Another aspect associated with innovation, is that of Market Transformation. “The GBCSA was formed in 2007 to lead the transformation to an environmentally-sustainable built environment in South Africa” (GBCSA, 2012:9). Now, according to the “Dodge Data Analytics World Green Building Trends 2016 SmartMarket Report predicts that South Africa could become a leader in the green building sector in the next three years” (World Green Building Council, 2016: para. 2). This

shows significant growth of the green building industry and the take-up rate of Green Star as a certification tool.

Additional insight, albeit from a discussion on a different rating system, LEED, shows the reason why the level of ratings used in green building systems is constantly evolving. The course, moderated by Greg Shank from Altura Associates, also included sections presented by Mary Ann Lazarus (MALEco), Sue Clark (Sweden Green Building Council) and Ben Myers (Boston Properties).

The moderator of the LEED training session (Shank, 2015: Digital recording¹²⁰), states that this constant evolution is to ensure “that we stay ahead of codes and what buildings have to do from a legal standpoint”. The figure below illustrates how the constant evolution process aims to move green building practice closer to zero impact while at the same time moving away from negative environmental impacts. Eventually the evolution process leads to the use of higher performance brackets (i.e. Platinum, Gold, etc.) to reward buildings that go beyond zero impact, motivating projects to achieve some sort of positive environmental impact.

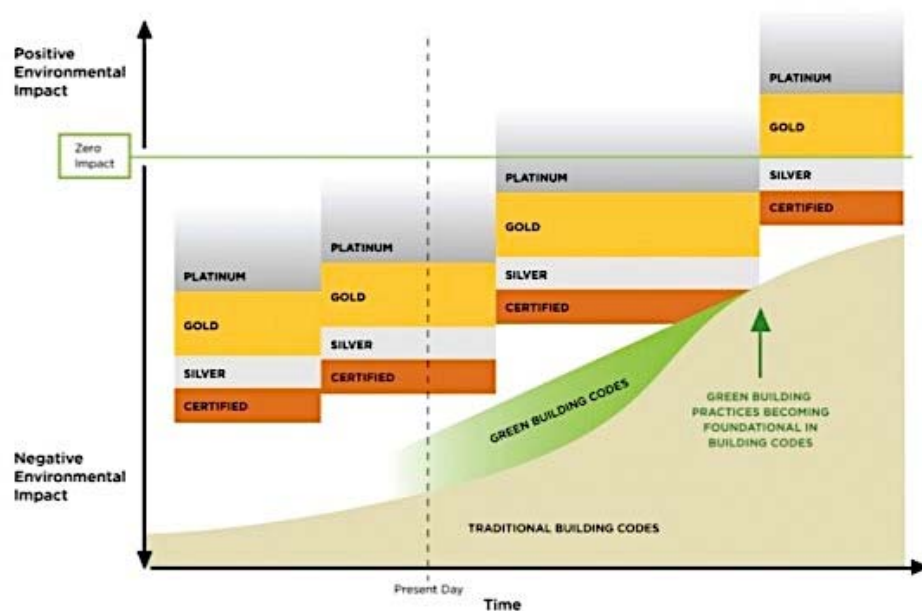


Figure 6-4: Evolution of LEED
Source: Shank, 2015: Digital recording

¹²⁰ The source refers to a recording made of a course moderated by Greg Shank therefore page numbers are not relevant.

This evolution of green building standards is also an indication of the commitment that systems such as LEED and BREEAM must regularly review and update the different tools within the rating systems, constantly improving the benefits associated with applying these systems to building design and operation. Green Star has also adopted a similar revision and updating process. This is evident in the various versions of the Green Star tools available in each of the focus countries, set out in more detail in Chapter 5 of this dissertation.

Lazarus, another presenter in the course moderated by Shank (2015: Digital recording) points out that there is collective power in the hands of design professionals to make a clear impact on how the industry transforms. In her segment of the presentation, Lazarus refers specifically to market transformation in terms of materials and she talks about a letter writing campaign that was started by several well-known architecture firms where they approached manufacturers. This campaign clearly indicated to these manufacturers that to stay relevant and to even be considered for specification in their designs, transformation was needed – these manufacturers were warned that they would need to provide things like environmental product declarations and health product declarations.

So, although driving industry transformation using LEED by different professionals, Lazarus (Shank, 2015: Digital recording) indicates that a lot more people need to become involved to really make a difference in how the industry operates. The question for the current research is to what extent transformation of the industry has taken place because of Green Star.

Two authors identified a way in which Green Star is transforming the industry – transforming the way the entire design process happens. According to Wilson & Tagaza ([n.d.]:4) “successful green building projects require a considerable investment in an integrated design team at conceptual development stage with the following players represented: project owner, project manager, building contractor, architect, services engineer, structural engineer, civil engineer, environmental engineer, landscape consultant, heritage consultant, cost planner, building surveyor, and acoustic expert”. The process of design has changed. Successful Green Star projects have realised that it is no longer appropriate for designs to be conceived by architects and developers only then to be handed off to the structural

and services engineers (Wilson & Tagaza, [n.d.]). The authors further uphold that utilising the full benefit of idea sharing by taking an integrated design team approach leads to improved designs. Although this integrated process is said to require more time from design teams, “an understanding is required that the anticipated life-cycle savings can only be fully realised if the ESD¹²¹ features and practices are fully integrated at the conceptual design phase so that they function as one holistic system rather than as a collection of stand-alone independent systems” (Wilson and Tagaza, [n.d.]:5).

An example of industry transformation as a direct result of Green Star is the paint sector. For the development of Nedbank Phase II in Sandton, it is said that the “project was instrumental in getting one of the large paint manufacturers to supply paint with volatile organic compound (VOC) levels within the maximum limits as set by Green Star RSA months earlier than the paint company had planned to make it available to the South African market. This is a powerful example of the capacity of Green Star RSA to transform the market as this paint is now available to all projects in the country” (GBCSA, 2012:38).

An example where transformative action was started separate from Green Star and then incorporated into the rating system relates to the energy building regulations. According to the GBCSA (2012:42), the Regulator issued NBR-XA in 2011, and the South African Bureau of Standards (SABS) developed South African National Standard (SANS) 10400-XA to include green building elements into the South African National Building Regulations. SANS 10400-XA standards refer “in part to the aspirational and voluntary SANS 204 standard, the first version of which has been available since 2008” (GBCSA, 2012:42), and it is important to note that “SANS 204 is used by the GBCSA as a minimum energy requirement for projects seeking Green Star RSA certification. There is also Green Star RSA rewards projects, which exceed the requirements of SANS 204” (GBCSA, 2012:42). More specifically, SANS 10400-XA set out new regulations which “address the design and construction process by providing for minimum requirements for design elements such as glazing, insulation, shading, orientation and building services, including air conditioning, hot water and lighting” (GBCSA, 2012:42). The SANS

¹²¹ Ecologically Sustainable Development

204 document was already in development in 2004/05 and was therefore the only document of its type, related to energy efficiency available to the GBCSA at the time of the development of the South African Green Star rating tools (Reinink, 2016: Personal communications).

The GBCSA also highlights the fact that “the process has also begun to draft minimum standards for water efficiency in buildings, including the setting of maximum flow rates, flush rates, etc.” (GBCSA, 2010:42). This process, according to Rudolph Opperman (2016), a technical advisor for Architecture and the National Building Regulations, culminated with a draft version of the proposed regulations being sent out for public comment in 2011. Unfortunately, it seems that this process has not received any further traction even after an investigation by NEDLAC in 2013, which highlighted the need for water regulations (Opperman, 2016). The loss of momentum behind the process is ascribed by Opperman, 2016: Verbal communications) to changing governmental priorities to focus on the perceived challenges within the steel industry. More information on the development of the SANS 10400 XB guidelines is provided in an earlier section of this dissertation. The important aspect to note is that once again, the process is in hand, and more importantly, moving forward. Soon new industry standards will be available, enabling the GBCSA to raise existing benchmarks and targets that go beyond the minimum requirements required by law.

Another aspect mentioned in Chapter 5, which is indicative of larger industry change, is the use of appropriate systems that will address the current first flush systems used in rainwater harvesting. Using appropriate technology, as described by Sotiralis Consulting (refer to Chapter 5 for more details), to capture a larger volume of rainwater, will enable a larger reduction in potable water use through supplementation by alternative sources.

There is also increased interest from industry, as shown through the acceptance by the Century City community to receive treated effluent from the Potsdam Municipal Sewer Treatment facility. Once the treatment process is complete, the resulting water is of a quality like bottled water.

Although not directly related to Green Star, rather a parallel process to developing relevant building regulations related to the water efficiency of fixtures and fittings, it is anticipated that the launch and implementation of such regulations will facilitate the development of new technologies and products with increased water efficiency performance. This will further contribute to the transformation of the wider industry. This is also supported by feedback provided by respondents to the Green Star and Water Conservation survey, using appropriately designed fixtures and fittings have become standard practice.

As part of the review of a decade of Green Star compiled by the GBCA, Andrew Aitken, executive director of Green Star, states (2012:41): “When I started working with Green Star, a trip to a hardware store was a very different experience than it is today. Back then, shower heads used 22 litres of water per minute – today it is almost impossible to find one that uses more than 9 litres per minute”. Clearly the industry is being transformed and to ensure that the momentum of such changed is embraced and pushed even further it will be up to the design teams and industry professionals to keep asking manufacturers and other suppliers for improved products. The need to constantly update industry benchmarks and the extent to which Green Star rewards specific benchmarks that are achieved is underlined. Where does the responsibility of driving that process lie? One of the earlier roles of Green Star was advocacy for the adaption of green building practices among industry leaders, with the ultimate goal of permanently transforming the industry. It therefore stands to reason that the responsibility to drive the process of constant improvement should start coming from the market itself. If projects request that Green Star reward specific actions that exceed the requirements of the rating system, the GBCA will have no other choice but to raise the requirements. This will show the industry that to keep gaining rewards for green projects, they can’t afford to become complacent.

It is this need for constant movement and improvement of the Green Star rating system that ensures tools are being updated and reviewed. In earlier sections of the dissertation mention was made of the intent by both the GBCA and the NZGBC to change the Water Category and the way in which credits are set out. Mostly this refers to the combination of the different credits that were previously regarded as

separate credits into one integrated credit, and moving the Water Meter credit to the Management category.

In the NZ revision of the Water Category, the changes will lead to the following:

- The number of points available for projects to achieve through fixtures and fittings will be lowered to 1-2 points;
- The number of points for landscaping will remain constant at 1;
- A new credit category is added: One point will be made available for projects that can demonstrate that 80% of showers have a timer to control shower times to a maximum of three minutes, with an additional point added where 80% of bathroom hand basin taps are controlled by a push button or sensor;
- Previous tools rewarded projects when they could demonstrate a reduction in the use of potable water for building cooling systems; the changes in the NZ system now only rewards projects with two points if there is no such system in place; and
- Lastly, the NZ system previously did not include a credit associated with a fire system test system, nevertheless it will now reward projects similarly to the requirements set out in the Green Star RSA – Office rating system.

It is also possible to assess market transformation through the concept of behavioural change. On the one hand, behavioural change could relate to how industry professionals approach the design process, moving away from a business-as-usual approach to rather embracing the strategies contained within the Green Star rating system. This aspect has been dealt with in Chapter 5 of this dissertation.

On the other hand, behavioural change refers to the way in which end-users use the green infrastructure and related systems created through the Green Star rating system. “Green Star RSA rewards project teams for developing a comprehensive Building Users Guide to inform the building owner, tenants and personnel of the environmental features in the building and the requirements for their maintenance” (GBCSA, 2008:5). This approach is to ensure that end users of green buildings don’t use the building contradictory to the specifications. The importance of educating end-users on the green features of a building has been highlighted by a user’s perception survey undertaken in Australia (Armitage et al., 2011). Specifics

around this aspect do, however, not form part of the scope of the current research. More detailed interaction with end users and facility managers would be required to identify if Green Star building user guides provides effective ways in which to ensure the longevity of green infrastructure.

6.2 Conclusion

Using the intent behind the Green Star Water Category as the ultimate starting point for measuring whether it should be regarded as an effective mechanism to facilitate water conservation in the built environment seems like the most logical place to begin the investigation.

Each of the credits within the Water Category has the potential of transforming how project teams, and ultimately building end-users, approach water use. Either through the removal of inefficiencies by using improved products, or the use of alternative sources of water.

As shown by the assessment of Green Star Office certified buildings set out in Chapter 5, there is no doubt that Green Star provides an effective mechanism (i.e. the points-based reward system) that can facilitate water conservation in the built environment. The Green Star system is adjustable to guide industry toward interventions required to address local contextual issues. For Australia, New Zealand and South Africa that turned out to be water. But with the way in which the points systems is supported by weighting factors, it is clear that the points configuration of the system can be adjusted as the Green Star suite of tools are adapted for other locales. This makes it a truly effective system.

In addition, with facilitating a reduction of potable water use, Green Star also results in additional benefits. These additional benefits relate to financial savings due to lower operating costs, improved end user experience, higher return on investment, increased property value, and ultimately future proofing an asset as it relates to uncertainty around energy and water supply. It is these additional benefits or impacts that act as further motivators for industry professionals to adapt green building practices and pursue certifications such as the Green Star Office rating for their projects.

Interest in the market has been peaked, as projects teams and clients alike are asking manufacturers to think differently about the products that are being created. Much in the same manner that the paint industry adapted its products to align itself with the requirements originating from Green Star projects, there is a clear indication that the industry related to water use components or capturing of alternative water resources in a building are taking up the challenge.

There is a further expectation that improved water efficiency standards and guidelines will assist Green Star even further with driving the market forward. Ensuring that the use of appropriately designed, water efficient fittings, fixtures and related systems become standard. Allowing Green Star to once again drive the market forward, facilitating improvements beyond the new standard. Driving the top 25% of the industry forward while creating a business case through performance data that can showcase the benefits to an industry larger as just those projects that consider going through the certification process.

7 CONCLUSIONS AND RECOMMENDATIONS

7.1 Summary of Findings

The research objective, as formulated in Section 1.2.1, was to create a clear understanding of the role that green building rating systems could play in water conservation in the built environment by facilitating a move away from a business-as-usual design and development approach, toward a more robust, environmentally sustainable industry.

The research investigated industry implementation of the Green Star system in Australia, New Zealand and South Africa, with a specific focus on improved approaches to potable water dependence. The research identified several recommendations that could guide future growth and development of the Green Star rating system and the various tools it encompasses, to ensure improved industry take-up and environmental benefit.

This chapter presents the conclusions and recommendations drawn from the analysis and discussion set out in previous chapters. This Chapter starts by providing answers to the sub-questions as identified in Section 1.2.2, and will culminate with an answer to the main research question:

Is Green Star an Effective Mechanism for Facilitating Water Conservation in the Built Environment in Australia, New Zealand and South Africa?

The conclusions are followed by recommendations in Section 7.3, which outline a suggested way forward for the relevant GBCs in a bid to facilitate constant evolution of the Green Star system. Recommendations for potential areas of future research are also identified (see Section 7.4).

7.2 Conclusions

7.2.1 Water Stress Indicators Relevant to Commercial Offices

As set out in the Chapter 2, there is a vast range of different methodologies that can be used to determine the extent to which an area is susceptible to water stress conditions. Many of these indices provide a balanced overview by assessing human, ecological and economic water demand. The findings of such

assessments, as referenced in Chapter 2 provide a clear indication that Australia and South Africa face almost certain water stress, with New Zealand being less vulnerable to droughts but also experiencing its own water related challenges.

Understanding the vulnerability to water stress, it is possible to determine the potential impact on business and commercial office buildings should water availability become a more pressing and permanent issue. It is expected that businesses could experience:

- Increased occurrences of water black-outs;
- Increased cost of water to deter usage;
- Mandatory restrictions of use;
- Increased conflict between different users;
- Operational impacts;
- Increased political and economic instability;
- Reduced consumer demand for water intensive products; and
- Increase demand for water sensitive design.

Moving toward a green economy supported by focussed and appropriate green building practices, could aid in reducing undue pressure on water resources.

7.2.2 Development of the Green Star Water Category

Rooted in systems such as BREEAM and LEED, the Green Star system was originally created to fill a gap for an independent mechanism to encourage and assess sustainable building practices. Providing a tool to building industry professionals to assist with moving away from a business-as-usual approach, Green Star provides a list of possible improvements or interventions that a building design team could use to create a structure that responds to an ever-changing environment, where increased pressure on natural resources could impact future operations.

More specifically, the areas of building design and operation that require appropriate intervention related to the HVAC system, domestic amenities, leakage and irrigation related uses.

The fact that restricted water supply can lead to compromised building operations seem to be a very strong motivational factor behind Green Star; which has the ultimate goal of moving the market beyond accepted standard practice, toward finding more environmentally sustainable approaches that can reduce the negative impact of the built environment on resource use.

Borrowing extensively from the Australian experience, New Zealand and South Africa soon followed with locally adapted versions of the Green Star rating system. Using references to locally sourced information sources, data and organisations, each country ensured that the version of the Green Star system introduced to their respective markets allowed for easy adoption by the relevant building sector industry role-players. Without a certain degree of localisation, building professionals would not have realised the value of Green Star, and the growth of the industry would have been severely restricted.

Similar in its intent, there are slight differences between the country-specific approaches to Green Star, which also had to be considered during the analysis of the available datasets:

- In WAT-01: Occupant Amenity Water, the 2009 version of the NZ rating tool, this credit has seven available points, while in the other two countries, project teams can achieve five points at most;
- WAT-02: Water Meters, only has one available point under version 3 of the Australian tool, but two points in all the rest;
- South Africa assigned three points in total to the WAT-03: Landscape Irrigation credit, and the other countries only one point;
- The 2009 New Zealand version only assigned 2 points to WAT-04: Heat Rejection Water, but as described in earlier sub-sections, this is due to the movement of these two points into WAT-01;
- There is also no WAT-05: Fire System Water Consumption credit in any of the New Zealand versions under consideration; and
- The total points available in the Water credit is also not consistent across the three countries, with Australia assigning a total of 13 points, New Zealand 12 points and South African 15 points.

Comparing potential improvements associated with Green Star certified buildings, when compared to a reference case, is only as useful as the data is accurate. All three countries referred extensively to existing Australian information, with some New Zealand based research also being undertaken recently to address what was regarded as a gap in the industry. In South Africa, significant research has been undertaken by the Stakeholder Accord on Water conservation to inform the setting of targets on water efficiency in the commercial sector, it is however unclear to what extent the findings were incorporated into the Green Star RSA version, and an update of both processes might be beneficial to the larger sector.

The use of a weighting system, as well as the specifics of localised weather and rainfall conditions allow for some geographical differentiation when using Green Star. However, it seems that there is currently no mechanism in place to ensure that project teams are required to pay greater attention to water efficiency related bylaws or water restrictions.

7.2.3 Green Star Office Certified Buildings – The Findings

By the 16th of January 2016, a total of 667 projects were certified in all three countries under the Green Star Office tool. Each GBC provided a database of Office certified buildings, which included 621 projects – 480 AUS projects, 68 NZ projects and 73 RSA projects - representing just over 93% of Office certified projects in total.

In all three countries, most projects can reach 4- or 5 Star certification levels, which per the industry professionals that participated in the current study research survey, is mostly achieved through subtle design changes with little to no financial implications for the overall project costs. The apparent link between overall city growth patterns and Green Star certifications demonstrate the building industry's commitment to no longer create assets that rely on the design-as-usual approach, but rather in a manner that promote environmental efficiencies and reduced negative impacts on scarce resources.

The RSA dataset was more comprehensive and provided insight into how the Water Category fared when compared to the other categories of Green Star. By reviewing the dataset, the Water Category stands out above the other categories.

The average number of points projects secure, represents 75% of all available points for both Design and As Built projects, higher than any other category.

- 65% of Design projects could achieve either the average number of points calculated or higher; and
- For As Built projects the situation is similar, only with the addition of the Land Use and Ecology category also getting 63% of projects to obtain at least the average number of points, which is the same for the Water Category, with the difference being that the average number of points in the Land Use and Ecology only represents 26% of the total available points, while in Water this represents 75% of all available points.

Feedback provided by industry professionals indicate there is a lack of coordination between the Green Star rating system and local legislation relating to water conservation or efficiencies. In some instances, this is also due to a lack of appropriate standards and guidelines being in place. This is especially true for South Africa where such guidelines are currently still in development stages where Green Star is providing the lead in how efficiencies can be attained. The research also indicates that those points linked to interventions that could easily be achieved through simple design modifications and limited financial implications are still the most popular with project teams.

In addition to the preliminary findings set out above, each dataset was assessed in more detail. The findings from this process enabled the comparison between the data from each country, with the following noted:

- **AUS Findings:** Projects certified under v1 and v2, are least likely to obtain all available points WAT-04: Heat Rejection Water; with most projects obtaining all points under WAT-02: Water Meters. For v3 projects this shifts, and only 2% of projects obtained all available points under WAT-02, and the top honours went to WAT-05: Fire System Consumption Water.
- **NZ Findings:** WAT-01: Occupant Amenity Water seems to be the worst performing credit under v1 and 2009; followed closely by WAT-03: Landscape Irrigation for As Built projects. The best performing credit seems to be WAT-04: Heat Rejection Water;

- **RSA Findings:** WAT-03 also fares badly for both Design and As Built projects, with WAT-02 and WAT-04 being the credits in which projects are most likely to obtain all available points.

There are various decision-making drivers that impact on the choices of project teams to target specific credits, and in most instances, it is design, which is the main motivator, and cost implications seem to be the biggest deterrent. A lack of sufficient point recognition by Green Star for certain interventions is also causing project teams to abandon potentially ground breaking innovation strategies.

Some potential gaps exist within the Green Star system, which, if filled, could create a more robust tool. To adequately inform the redevelopment process, more in-depth information on benchmarks; changing climatic conditions and the implications thereof for long-term planning; and the actual performance expectation of new technology are just some of the issues that require further analysis.

7.2.4 Measuring the Effectiveness of a Green Building Rating Tool

To answer the main research question of whether Green Star is an effective mechanism to facilitate water conservation in the built environment, one first needs to establish a way in which to measure effectiveness.

As explained throughout the dissertation, and addressed in more detail in Chapter 5, the Green Star rating tools depend on a points-based rewards system to motivate project teams to target certain credits. The more points assigned to specific credits or interventions, if those interventions can be attained with minimal financial investment was regarded by this researcher to be the main mechanism with which Green Star is facilitating water conservation in building projects. As illustrated by the analysis in Chapter 5, there is strong evidence that the number of points associated with the Water category, supported by the relative ease with which those points can be achieved through design-led changes provides a very strong mechanism to facilitate water conservation in the built environment. Although the main driving force might originally be only the points a project can secure, with only secondary consideration given to the impact the related changes

on potable water use, the outcome of the changed approach still attains a significant water saving in the long term, and a change in the related industry.

Each of the credits within the Water Category has the potential of transforming how project teams, and ultimately building end-users approach water use. Either through the removal of inefficiencies by using improved products, or the use of alternative sources of water

There are additional impacts or benefits that act as further motivating factors in getting design teams to change from a design-as-usual approach toward a more environmentally (and financially) sustainable tactic when creating building assets. These additional benefits relate to financial savings due to lower operating costs, improved end user experience, higher return on investment, increased property values and ultimately future proofing an asset as it relates to uncertainty around energy and water supply.

All players within the building industry (designers, end users and manufacturers) all have a role to play to ensure the water conservation efforts of the built environment. There is an expectation that improved water efficiency standards and guidelines will assist Green Star even further with driving the market forward. This will ensure that the use of appropriately designed water efficient fittings, fixtures and related systems become standard, and in turn allow Green Star to once again drive the market forward, facilitating improvements beyond the new standard in place. Driving the top 25% of the industry forward while creating a business case through performance data that can showcase the benefits to an industry larger as simply those projects that consider going through the certification process.

7.2.5 Final Summative Remarks

The answer to the main question considered by this research dissertation is clearly positive, but for the impact of Green Star and green buildings in general to be felt more acutely, appropriate legal mechanisms are required.

The business case for Green Star certifications are ever evolving and with an increased number of buildings coming on line, operational data flowing from these buildings will further assist in strengthening the argument for going green. There

are a few related ways in which to determine the effectiveness of Green Star, and with the significant number of projects achieving higher points in the water category in relation to the other categories in the tool even though the relatively low price of water is not regarded as a major motivating factor, the significance of water as a scarce resource is clearly being noted.

To place water conservation in the built environment into an appropriate context, the technical teams responsible for the adaptation of the Green Star Office tool for each of the countries consulted various locally based sources of information and considered the local water context. Countries can determine the extent to which they are vulnerable to water stress by using a wide range of measurement methodologies, and as the pressure on water supplies increase, greater importance will be placed on such investigations and any review process of Green Star tools should consider the findings of such investigations.

Although there are somewhat conflicting views on the relevance of the benchmarks used in Green Star, it seems that the industry is growing and appropriate products are developed and presented to market. Choices regarding the most appropriate fittings and fixtures are made, while also taking into consideration for the downstream municipal sewer system water requirements.

The ongoing drought and related water restrictions in place across South Africa highlights the importance for Green Star to enable greater linkages between project specific approaches to water reduction initiatives and prevailing local policies and guidelines. Currently not addressed to its full potential, this does create an ever-increasing gap between the good being done by developers pursuing Green Star certification and the scale of change required to facilitate a wider understanding of the pressures on water resources and more efficient use.

There are several examples that were highlighted showcasing the innovation and foresight in transforming the building industry. More such examples related specifically to the Water category are however still needed, and with the proposed SANS 10400 XB to be developed and released in the future, the hope exists that more innovation will indeed be triggered.

Green Star provides a robust decision-making facilitation tool, based on an increased need for project teams to approach the building design process in a much more holistic manner. Facilitating and in fact necessitating a move away from the traditional approach to design using tried and tested methods; Green Star has created the momentum among professionals to question these methods in favour of finding more efficient and innovative approaches.

7.3 Recommendations

Green Star provides a robust, decision-making tool, used by design professionals to guide clients on best approaches toward creating sustainable, financially viable assets. The benefits associated with such assets are increasingly well defined and documented.

The strength in a voluntary system lays with the level of industry transformation it leads to, and ultimately, with such transformation being captured by mandatory standards and guidelines.

In the short term, greater integration between government planning and Green Star research is required. Although water efficiency labelling schemes are already in place in Australia and New Zealand, this is currently still uncharted territory in South Africa. There is no doubt that government should be the lead actor in such a process, and there exists a unique opportunity using research such as this - and further engagement through the GBCSA with its members, certified project owners and Green Star Accredited Professionals - to obtain value insight into benchmarks, targets and possible gaps in the system.

With extensive use made of regional water restrictions during the ongoing drought in South Africa, it also becomes crucial for these restrictive conditions to be acknowledge in some way in the potable water calculator that Green Star relies on for projects to demonstrate the extent to which water savings will be achieved by the projects undergoing certification.

The findings of this research could also be used by the various GBCs when reviewing any Green Star tools, identifying specific areas or credits currently not gaining sufficient traction to make a valuable contribution to water conservation,

and formulating ways in which to rectify the challenges (i.e. increased number of points associated with specific interventions, stimulating market research processes to address information gaps on specific technological advancement, and increased education and information dissemination on the urgency of adopting appropriate and effective interventions to facilitate water conservation).

7.4 Suggested Future Research

The objective of the Green Star and Water Conservation research was to determine whether Green Star could be regarded as an effective mechanism for facilitating water conservation in the built environment in Australia, New Zealand and South Africa. The outcome of the research indicates that by motivating projects to undertaken water reduction strategies by rewarding them with Green Star points counting toward certification levels, is indeed effective. Unfortunately, the relatively low cost of water creates some reluctance to commit to expensive interventions and where point rewards fall away, so does the willingness of project teams or building owners to pursue that aspect of design.

The current research did not assess the extent to which water use was reduced as a result of the interventions rewarded by Green Star, and this could be a valuable further research area. This links to the increasing number of projects certified under the rating system becoming operational, and the expectation is that significant actual water use data in new buildings designed and operated along Green Star standards, will become available. This will further be supported on data related to refurbishment of existing stock under the Green Star EBP tool.

The increased access to up-to-date water use data could help to shed light on:

- Whether current water use modelling approaches can be regarded as accurate (by comparing expectation with reality);
- Whether building performance is consistent with expected performance modelling or whether there are discrepancies (either improved or less so); and
- The cost savings realised because of the water use related efficiency.

Further research is also required into suitable benchmarks and products created to align with Green Star and other industry requirements, to ensure that the operations of a building are not negatively compromised while simultaneously

ensuring that efficiency measures incorporated into green buildings in turn do not negatively affect the municipal water system. If this impact is unavoidable, research will be required to identify alternative measures or systems that could be used on a municipal level to support appropriate water efficiency.

Although the current research shed some light on the location of Green Star certified projects, it would be interesting to place these projects within a greater context. Future research could try to assess rated versus non-rated projects, unpacking the extent to which new buildings (and even existing stock) are taking up the Green Star challenge.

Additional green building specific future areas of research could focus on the potential benefits of using a more holistic approach to water use in buildings, as encourage by tools such as the Living Building Challenge and the ENV-24 credit of the Green Star Communities tool. Focussing more on a total water balance approach to specific sites, not only focussing on building specific water use.

Although not Green Star specific, while still green building related, is the issue of water efficiency. The ongoing process of formulating the SANS 10400 XB water efficiency standards also provides further research opportunities. There is significant potential for determining how these new regulations could affect existing water efficiency by-laws. If these new SANS regulations are to replace the by-laws, it is imperative to understand what the most appropriate approach would be to deal with the existing enforcement challenges.

It is crucial for government to take the lead on highlighting the importance of water efficiency, not only during times of extreme weather (i.e. droughts), but rather a more permanent long-term change in how water use is managed and increased efficiency enforced.

Another tool available to government, to capture the importance of water as a scarce resource, is using appropriate tariff structures. Although the current research did not assess the role of water tariffs in the decision-making process, the research highlights that due to the low cost of water (especially in South Africa), project proponents are reluctant to invest significant amounts in water related

interventions, as the cost/benefit just does not add up in the long-term. A possible area for future research will be to determine the most appropriate tariff to be used to act as a further incentive for the more efficient use of water.

Leakage beyond building boundaries has been identified as an important factor responsible for significant water loss. This infrastructure is the responsibility of the relevant local authority and therefore an excellent starting point in providing water use leadership could start here. A possible investigation could assess how Green Star could be used to catalyse investment from the public sector to create an integrated approach in addressing this issue on a larger scale. Moving beyond the building scale, ensuring green building benefits are amplified.

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9 APPENDICES

The appendices were created to provide supplementary information regarding the research, process followed and specific source documents of significant insight or value. The following ten appendices are included in this dissertation:

Appendix A – A comparison of municipal bylaws dealing with water conservation and water efficiency (as compiled by Still et al., 2008:E1-E14)

Appendix B – Green Star RSA Office V1 Credit Summary

Appendix C – Overview of BREEAM Core' Weightings Development Process

Appendix D – The Importance of Cycles in Cooling Tower Treatment

Appendix E – Overview of the Assessed GBC Datasets

Appendix F – GBCA Research Application and Supporting Documents

Appendix G – GBCA Confidentiality Agreement

Appendix H – Motivation for NZGBC Dataset Access

Appendix I – NZGBC Confidentiality Agreement

Appendix J – Green Star and Water Conservation Semi-Structured Questionnaire

Appendix K - Green Star and Water Conservation Survey Response Summary

These appendices were included to provide the reader with in-depth insight into specific topics referred to as part of the research, and it was also used as an effective way in which to relate extensive information related to the research process itself.

**APPENDIX A – A COMPARISON OF MUNICIPAL BYLAWS DEALING
WITH WATER CONSERVATION AND WATER EFFICIENCY (AS
COMPILED BY STILL ET AL., 2008:E1-E14)**

APPENDIX B – GREEN STAR RSA OFFICE V1 CREDIT SUMMARY

Table B1: Green Star Office v1 Credit Summary

Category	Title	Credit No.	Points Available
Management	Green Star RSA Accredited Professional	Man-1	2
	Commissioning Clauses	Man-2	2
	Building Tuning	Man-3	2
	Independent Commissioning Agent	Man-4	1
	Building Users' Guide	Man-5	1
	Environmental Management	Man-6	2
	Waste Management	Man-7	3
	Airtightness Testing	Man-8	1
	Total		14
Indoor Environmental Quality	Ventilation Rates	IEQ-1	3
	Air Change Effectiveness	IEQ-2	2
	Carbon Dioxide Monitoring and Control	IEQ-3	1
	Daylight	IEQ-4	3
	Daylight Glare Control	IEQ-5	1
	High Frequency Ballasts	IEQ-6	1
	Electric Lighting Levels	IEQ-7	1
	External Views	IEQ-8	2
	Thermal Comfort	IEQ-9	2
	Individual Comfort Control	IEQ-10	2
	Hazardous Material	IEQ-11	1
	Internal Noise Levels	IEQ-12	2
	Volatile Organic Compounds	IEQ-13	3
	Formaldehyde Minimisation	IEQ-14	1
	Mould Prevention	IEQ-15	1
	Tenant Exhaust Riser	IEQ-16	1
	Environmental Tobacco Smoke (ETS) Avoidance	IEQ-17	2
	Total		28
Energy	Conditional Requirement	ENE-	0
	Greenhouse Gas emissions	ENE-1	20
	Energy Sub-Metering	ENE-2	2
	Lighting Power Density	ENE-3	4
	Lighting Zoning	ENE-4	2
	Peak Energy Demand Reduction	ENE-5	2
	Total		30
Transport	Provision of Car Parking	TRA-1	2
	Fuel-Efficient Transport	TRA-2	2
	Cyclist Facilities	TRA-3	3
	Commuting Mass Transport	TRA-4	5
	Local Connectivity	TRA-5	2
	Total		14
Water	Occupant Amenity Water	WAT-1	5
	Water Meters	WAT-2	2
	Landscape Irrigation	WAT-3	3
	Heat Rejection Water	WAT-4	4
	Fire System Consumption	WAT-5	1

Category	Title	Credit No.	Points Available
	Total		15
Materials	Recycling Waste Storage	MAT-1	2
	Building Reuse	MAT-2	5
	Reused Materials	MAT-3	1
	Shell and Core Integrated Fit-Out	MAT-4	1
	Concrete	MAT-5	3
	Steel	MAT-6	3
	PVC Minimisation	MAT-7	1
	Sustainable Timber	MAT-8	2
	Design for Disassembly	MAT-9	1
	Dematerialisation	MAT-10	1
	Local Sourcing	MAT-11	2
	Total		22
Land Use and Ecology	Conditional Requirement	ECO-	0
	Topsoil	ECO-1	1
	Reuse of Land	ECO-2	2
	Reclaimed Contaminated Land	ECO-3	2
	Change of Ecological Value	ECO-4	4
	Total		9
Emissions	Refrigerant / Gaseous ODP	EMI-1	1
	Refrigerant GWP	EMI-2	2
	Refrigerant Leaks	EMI-3	2
	Insulant ODP	EMI-4	1
	Watercourse Pollution	EMI-5	3
	Discharge to Sewer	EMI-6	5
	Light Pollution	EMI-7	1
	Legionella	EMI-8	1
	Boiler and Generator Emissions	EMI-9	1
	Total		17
Innovation	Innovative Strategies and Technologies	INN-1	2
	Exceeding Green Star RSA Benchmarks	INN-1	2
	Environmental Design Initiatives	INN-3	1
	Total		5

Source: GBCSA, 2008:2-3.

APPENDIX C – BREEAM CORE WEIGHTINGS DEVELOPMENT PROCESS

A weightings consensus exercise was carried out by a panel of environmental experts including:

- Government policy makers and researchers
- Construction professionals
- Construction materials producers and manufacturers
- Property institutional investors
- Environmental activists and lobbyists
- Local authority policy makers and planners
- Academics and researchers

The expert panel evaluated the relative importance of an extensive range of environmental issues with respect to buildings and construction. Environmental issues included:

- Climate change
- Resource use
- Health and comfort
- Pollution
- Ecology

The expert panel's weightings were then applied across the relevant BREEAM environmental sections (i.e. Management, Health and Wellbeing, Energy, Transport, Water, Materials, Waste, Land Use and Ecology, and Pollution).

A LCA exercise was also undertaken to quantify the environmental impacts associated with non-domestic buildings throughout their life cycle in terms of energy use, transport related emissions, water use, materials use and waste generation. The LCA was undertaken using the BRE Environmental Profiles methodology, which assesses environmental impacts across the following categories:

- Climate Change
- Water Extraction
- Minerals Resource Depletion
- Stratospheric Ozone Depletion
- Human Toxicity
- Eco-toxicity to Fresh Water
- Nuclear Waste
- Eco-toxicity to Land
- Waste Disposal
- Fossil Fuel Depletion
- Eutrophication
- Photochemical Ozone Creation
- Acidification

The results from the LCA allowed the relative impacts associated with energy use, transport related emissions, water use, materials use and waste generation to be compared and to set the weightings for the relevant BREEAM environmental sections accordingly. The LCA results were then integrated with the consensus based results to produce the 'core' BREEAM weightings for each of the nine BREEAM environmental sections.

For each scheme covering a different building life cycle, an influence factor is applied to each of the core environmental section weightings to reflect how much influence the project team has on the impacts that arise from the issues covered by the section. For example, the project team for a new building has full control of the specification of materials, whereas operational energy use has an influence from user behavior that is outside the control of the project team. Following application of the influence factors, the weightings are then normalized to give a total of 100% across the nine environmental sections.

Source: McCabe, 2016: Electronic communications

APPENDIX D – THE IMPORTANCE OF CYCLES IN COOLING TOWER TREATMENT

Technical Bulletin 2-025
Cooling Systems
Updated 06/28/11

Introduction

The concept of Cycles of Concentration can be difficult to understand but is one of the most important parameters in managing a cooling water treatment program. Failure to maintain the proper cycles can result in corrosion and/or scale formation as well as greatly increase water and treatment costs.

Evaporation and Why Bleed is Needed

Cooling towers primarily reject heat by evaporating a small portion of recirculating water to the air. The dissolved minerals that were in the evaporated water are left behind and will concentrate in the bulk tower water as fresh makeup water is added to replace the evaporated water. As water continues to evaporate from the tower, the concentration of minerals will eventually reach a point where their solubility is exceeded and scale deposits occur.

To control the dissolved solids level, a portion of the tower water must be discharged to drain as bleed or blow down. Since the makeup water contains a lower concentration of dissolved minerals, bleed reduces the overall mineral concentration in the tower water.

One purpose of water treatment chemicals is to extend the solubility of these mineral salts so higher concentrations can be maintained without scale formation. This allows the tower system to operate with less bleed and greatly reduces the makeup water requirements. Also, most corrosion inhibitor programs are designed to provide effective control only if the specified cycles are maintained. Consequently, failure to maintain recommended cycles for the inhibitor being used can result in severe corrosion and scale.

Unless a portion of the tower water is discharged as bleed, scaling and/or corrosion will eventually occur regardless of what treatment chemicals are used.

Defining Cycles of Concentration

The term used in calculating and determining the amount of bleed is called Cycles of Concentration. Cycles can be defined as the number of times the dissolved minerals in the system cooling water are concentrated versus the level in the raw makeup water.

Cycles are NOT the number of times a given volume of water flows over the tower in a given time frame, and are NOT related to cycling the tower on and off in a given time frame.

Cycles and Water Usage

Maintaining recommended cycles is critical to conserving water and treatment cost, as well as scale and corrosion control. The table on the next page gives the impact on water and treatment usage as a function of cycles on a 500-ton chiller system running at full load for 24 hours per day (evaporation rate = 21,600 gpd).

The table shows a dramatic decrease in water and inhibitor cost by increasing cycles from one and a half to three. It also shows that increasing cycles follows the law of diminishing returns. As the cycles are increased past five, the increased savings becomes negligible.

The optimum cycles for any system is a function of makeup water quality, system temperatures, and, sometimes, system design. If makeup water hardness is high enough, you may be limited to low cycles, unless pre-treatment or acid feed is used.

Table D1: Cycles vs. Water and Inhibitor Costs

Cycles	Bleed (gpd)	Makeup (gpd)	Annual Water Cost*	% Reduction Water Cost	% Reduction Inhibitor Cost
1.5	43,200	64,800	\$70,956	00.0	00.0
2.0	21,600	43,200	\$47,304	33.3	50.0
3.0	10,800	32,400	\$35,478	50.0	75.0
4.0	7,200	28,800	\$31,536	55.6	83.3
5.0	5,400	27,000	\$29,565	58.3	87.5
6.0	4,320	25,920	\$28,382	60.0	90.0
8.0	3,086	24,686	\$27,031	61.9	92.8
10.0	2,400	24,000	\$26,280	62.9	94.4

*Based on water cost of \$3.00 per 1,000 gallons

Determining Tower Water Cycles

Determining the cycles can be done using system flow rate measurements or by chemical means. If there are water meters on the makeup and bleed lines, and water flows can be recorded in each, then mass balances can provide an accurate measurement of the average cycles over a given time period.

The formula used to calculate the cycles of concentration by mass balance is:

$$\text{Cycles} = \text{Makeup} / \text{Bleed}$$

This formula is derived from the overall mass balances of the cooling system involving evaporation, makeup, and bleed:

$$\text{Bleed} = \text{Evaporation} / (\text{Cycles} - 1)$$

$$\text{Makeup} = \text{Evaporation} + \text{Bleed}$$

If the makeup or bleed flow rate cannot be measured, there are chemical means commonly used to calculate the cycles at the specific time the water is sampled. The water characteristic chosen should reflect the dissolved solids or a very soluble ion. The ones usually used are conductivity, chlorides, or silica, depending on makeup water quality, ease of performing an accurate test, and other variables.

Determining the cycles involves performing a test for this same water characteristic on both tower and makeup water samples and calculating the ratio of "Tower Water Impurity" divided by "Makeup Water Impurity."

For example:

$$\text{Cycles} = \text{Tower Water Conductivity (or Chlorides)} / \text{Makeup Water Conductivity (or Chlorides)}$$

It is desirable to periodically perform additional testing and compare the calculated cycles with cycles based on hardness to ensure scaling is being controlled.

Controlled and Uncontrolled Bleed Losses

Bleed is the removal of ANY water from the system other than evaporation. It can be intentional, by opening a bleed valve, or unintentional, such as water loss from a pump seal, leaks in the system, overflow down the tower drain, or wind and drift loss. Both intentional and unintentional bleed control the cycles of concentration.

If the unintentional losses are high enough, your cycles may be lower than ideal. Excessive water use and treatment cost will be the result.

APPENDIX E – OVERVIEW OF THE ASSESSED GBC DATASETS

To guide the reader through the specifics of the information utilised in the research, the remainder of this Appendix provides insight into each of the datasets obtained, the specifics of the content, and any pertinent issues that impacted the analysis.

E.1 The GBCA Dataset

E.1.1 Origin of the Dataset

The GBCA dataset, was provided to the researcher by Melinda Walters on the 22nd of January 2016.

E.1.2 Overview of the GBCA dataset

The dataset was constructed using the following table headings¹²³:

- Project Name;
- Project Number;
- Status (whether the project achieved certification or not);
- State;
- Rating Tool (differentiation between Design and As Built);
- Version (tool version used in the application process);
- Rating Achieved (4, 5 or 6 Stars);
- Round (there are two rounds in the submission process, this column indicated the point status per round);
- Title (credit title);
- Abbreviation (this is the same abbreviation throughout – WAT);
- Number (this refers to the credit number);
- Number of points available; and
- Number of points achieved.

Number of Projects Included in Dataset

An initial review of the dataset created the understanding that a number of 390 projects were included. A detailed review of the content, however, led to the identification of certain discrepancies, and the total number of projects that were actually included in the dataset was 480.

Details regarding the discrepancies identified and how these issues were addressed is set out below:

- A significant amount of projects achieved both a Design and As Built rating and were included in the dataset with the same project number – the final datasets used for analysis differentiated between Design and As Built and projects were therefore reviewed as such;
- The following 7 project numbers were missing from the dataset: 174, 290, 331, 354, 357, 387 and 388;
- The following 11 projects were included in the dataset, but excluded from the analysis as the projects were cancelled, and therefore no certification achieved: 39, 114, 128, 150, 162, 176, 233, 238, 292, 301, and 371;

¹²³ Where deemed appropriate, more information regarding the title is provided.

- Two projects were listed with identifiers (address, or project name) instead of a project number – subsequently included in the analysis section through use of the Project Number column; and
- 1 project was excluded as it was still in the Round 1 submission phase and no certification achieved yet;
- 1 project was removed as it did not achieve a rating;
- 1 project was removed as it was listed as a draft; and
- Two seemingly unrelated projects were listed as Project 353 and another two unrelated projects were listed as Project 356 – in all four instances, the individual projects were subsequently included in the analysis section through use of the Project Number column.

Design vs As Built

After the data clean up (as described above), the information was divided into two different datasets based on the stage of building development used to apply for certification – 'Design or As Built. In the two newly formed datasets, the number of projects included in each was as follow:

- Design included: 340 projects
- As Built included: 140 projects.

E.1.3 Protection of Information

The researcher was required to submit a research application to motivate the GBCA to share the required information. This application and the relevant Appendices attached to the application are attached to this dissertation as Appendix F. The GBCA requested that a confidentiality agreement be signed. A signed copy of this agreement is included in Appendix G.

In addition to the confidentiality agreement, the communication from Walters (2016) also included a disclaimer stating that “anything that identifies the project has been removed to protect confidentiality” (Walters, 2016). During the initial review of the information provided, the researcher realised not all project identifiers were removed, but in order to maintain the integrity of the confidentiality agreement in place between the researcher and the GBCA, these additional information markers were discarded.

E.2 NZGBC Dataset

E.2.1 Origin of the Dataset

Andrea Davison shared the NZGBC dataset on the 29th of June 2016.

E.2.2 Overview of the NZGBC dataset

The dataset was constructed using the following table headings¹²⁴:

- Project ID;
- Address;
- Region;
- Type (differentiation between Design and As Built projects);
- Registration date;

¹²⁴ Where deemed appropriate, more information regarding the title is provided by the researcher in brackets to clarify or further explain the data contained within a specific cell/column.

- Certification date;
- Total points;
- Weighted score;
- Water (which was a column indicating the total number of points within the Water Category a project achieved);
- Occupant water efficiency;
- Water meter;
- Irrigation; and
- Heat rejection.

Number of Projects Included in Dataset

An initial review of the dataset created the understanding that a number of 95 projects were included. A detailed review of the content, however, led to the identification of certain discrepancies, and the total number of projects that were actually included in the dataset was 68.

Details regarding the discrepancies identified and how these issues were addressed is set out below:

- 4 projects were excluded as these did not achieve certification;
- 1 project was excluded due to seemingly achieving more points for one of the credits that was available; and
- Another 22 projects were excluded due to insufficient information provided.

Design vs As Built

After the data clean up (as described above), the information was divided into two different datasets based on the stage of building development used to apply for certification – 'Design or As Built. In the two newly formed datasets, the number of projects included in each was as follow:

- 52 'Design' certified projects
- 16 'As Built' certified projects

E.2.3 Protection of Information

As part of the application process to the NZGBC for access to the certified projects' datasets, the researcher had to submit a motivation, attached to this dissertation under Appendix H. Upon approval of that application; the researcher was required to sign a confidentiality agreement, attached as Appendix I.

E.3 GBCSA Dataset

E.3.1 Origin of the Dataset

The GBCSA dataset was shared with the researcher on 5 November 2015.

E.3.2 Overview of the NZGBC dataset

The dataset was constructed using the following table headings¹²⁵:

- Category;
- Title (which referred to the credit title);
- Credit No. (which referred to the credit number); and

¹²⁵ Where deemed appropriate, information regarding the title is provided by the researcher in brackets to clarify or further explain the data contained within a specific cell/column.

- Then the projects were listed under columns titled B1 to 73.

The table also included additional information set out along the y-axis of the dataset. Firstly, it contained project specific information:

- Certification (level of certification achieved);
- Certification type (Design and As Built);
- GFA (gross floor area);
- UA (usable area); and
- Building type (differentiating between New Build and Refurbishment).

It also included data on each of the environmental categories of Green Star (i.e. Management, Energy, and Water).

Number of Projects Included in Dataset

A total number of 73 projects were included in the dataset.

Design vs As Built

No clean-up was required for the GBCSA dataset. The information was divided into two different datasets based on the stage of building development used to apply for certification – ‘Design or As Built. In the two newly formed datasets, the number of projects included in each was as follow:

- 57 Design certified projects
- 16 As Built certified projects

E.2.3 Protection of Information

The dataset did not contain any project identifiers and therefore no special arrangements were requested to protect project confidentiality.

APPENDIX F – GBCA RESEARCH APPLICATION AND SUPPORTING DOCUMENTS

APPENDIX G – GBCA CONFIDENTIALITY AGREEMENT

APPENDIX H – MOTIVATION TO NZGBC FOR ACCESS TO DATA

APPENDIX I – NZGBC CONFIDENTIALITY AGREEMENT

APPENDIX J – GREEN STAR AND WATER CONSERVATION SEMI-STRUCTURED QUESTIONNAIRE

APPENDIX K – GREEN STAR AND WATER CONSERVATION SURVEY SUMMARY

The aim of this Appendix is to guide the reader through the findings of the Green Star and Water Conservation semi-structured survey. This write-up provides an overview of the input provided by industry professionals targeted through purposeful sampling. Set out on a question-by-question basis. Where necessary, the feedback provided by respondents is set in its entirety¹²⁶. In most instances feedback was analysed and presented as a statistical overview.

Extensive reference is made to the findings of the survey in Chapter 5 and 6 of the dissertation.

K.1 Demographic Profile of Respondents

In the first section of the questionnaire, the intent was to create an overall understanding of the demographic profile of respondents.

Table K1: Age Profile

Age Bracket	% of Respondents
Below 20	0%
21-29	8%
30-39	50%
40-49	33%
50-59	0%
60-69	8%
70-79	0%
80-89	0%
Older than 90	0%

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

Table K2: Gender Profile

Gender	% of Respondents
Male	42%
Female	58%

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

Table K3: Level of Education

Level of Education	% of Respondents
Matric	0%
Certificate	0%
Diploma	0%
Undergraduate Degree	25%
Postgraduate Degree	75%
Other	0%

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

Table K4: Highest Level of Education Specified

¹²⁶ Please note that the language reflected in this section is not the researchers' own, but rather direct presentation of feedback provided by respondents.

Respondent	Occupation/Job Title
A	BCC (Hons) Property Studies
B	Masters
C	BA
D	Masters
E	B-Tech Mechanical Engineering
F	MSc Project Management
G	M (Arch) Professional
H	MSc Technology and Innovation Services for Developing Countries
I	Master's Degree & Postgraduate Diploma
J	BSc Civil Engineering, MBA
K	B. Phil Sustainable Development Planning and Management
L	B Com Hons

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

Table K5: Place of Employment

Company	% of Respondents
Aurecon	16%
Solid Green	33%
WSP	8%
Sow & Reap Consulting	8%
KudosAfrica	8%
Ludwig Design Consulting	8%
AGAMA Energy	8%
Independent Consultant	8%

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

Table K6: Current Occupation and Job Title

Respondent	Occupation/Job Title
A	ESD/Sustainability Consultant
B	Director
C	Sustainability Consultant/HOD: Principal Associate
D	Sustainable building consultant
E	Director, Sustainability Consultant
F	Green Building Professional
G	Building sustainability consultant
H	Project Manager
I	Senior Green Building Consultant
J	Director
K	Consultant
L	Associate - ESD Consultant and Project Manager

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

Table K7: Level of Experience in Green Star Certifications

Experience	% of Respondents
None	0%
Less than 6 months	0%
6 months to 1 year	0%
1 to 4 years	33%
4 to 8 years	42%

Experience	% of Respondents
More than 8 years	33%

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

Table K8: Green Star Accredited Professional Qualifications held

Accredited Professional Qualification held	% of Respondents
None	0%
Original AP certification	92%
AP Existing building performance	75%
AP Interiors	42%
AP New building	33%
Other (please specify)	33%
<i>EDGE AP</i>	16%
<i>LEED</i>	25%
<i>Green Star Communities</i>	8%
<i>WELL Building Standard</i>	8%

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

Table K9: Previous Green Star Certification Roles

Role	% of Respondents	Total Nr of Projects	% Green Star Office Certifications
Client	8%	1	0%
Lead AP	100%	114	39%
Administrative support	50%	36	17%
Specialist support	16%	7	3%
<i>Energy modeller</i>	8%		
<i>Simulations</i>	8%		
Other	25%	8	3%
<i>Sustainable engineering and passive design services</i>	8%		
<i>Green Star AP Interiors</i>	8%		
<i>Peer Reviewer</i>	8%		
Total		166	

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

K.2 Green Star Specific Findings

This part of the questionnaire was focussed on obtaining insight from the targeted industry professionals on the first-hand knowledge they have acquired because of participating in, and/or driving a Green Star certification process.

Table K10: Indication of Green Star Certification Target Setting Up-front

Upfront Identification of Certification Target	% of Respondents
Yes	92%
No	8%

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

Table K11: Determining Factor on Green Star Certification Target Setting

Respondent	Determining Factor
A	(No) It is a cost exercise, they first want to see which rating they can firstly afford and if the initiatives can be implemented, projects always have limitations and constraints when it comes to Green Star
B	Yes, although they tend to change it during the project to a higher Green Star

Respondent	Determining Factor
C	They set the minimum requirement upfront. Sometimes this changes along the way
D	Clients generally have an idea of the star rating to be targeted
E	No explanation provided
F	There is usually a directive from the client as to which level of rating is to be achieved. A Green Star workshops is held with the project team near the beginning of the project to determine which credits can be achieved and if a higher rating can be achieved without too much additional cost.
G	The project opportunities and limitation are discussed, the sustainability consultant puts forward a strategy that is again discussed with the project team and in this way a certification level is decided upon
H	The start would be after an initial workshop, where after first inventarisat ¹²⁷ a goal is set
I	It is set at the beginning or early stages of the project as a whole
J	Client determines desired GS ¹²⁸ level but sometimes level is increased as client realises that the project is quite close to the higher level
K	We define the Green building strategies, the interventions, the cost associated therewith for budgeting purposes and the number of points we are targeting. We give the client the tools to assess the cost-benefit relationship between 4, 5 and 6 stars – if you don't identify at concept stage what rating you are targeting then the solutions are not integrated with the design of the building well, and one has to implement tech solutions which are often expensive. It's almost impossible to achieve a 6-star rating if you have not set out to do so from project inception.
L	Normally Clients/Developers have a budget set aside for achieving a certain level of certification. In many of the cases, there is a contractual obligation on the developer to achieve a certain level of certification, which the project owner has aspirations and resources for. In some instances, it is possible with minor interventions to take a project to the next level of certification, but these are project dependent and exceptions rather than the norm.

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

Table K12: Consideration of Local Policies and/or By-laws Related to Water Issues

Local Policies/By-laws considered	% of Respondents
Yes	75%
No	17%
No response	8%

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

Table K13: Team Member Responsible for Policy and/or By-law Consideration

Responsible Team Member	% of Respondents
Civil Engineers	42%
Wet Services Engineer	33%
Town Planners	8%
Architect	8%
Green Building Consultant	8%

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

Table K14: Types of Local Policies and/or By-laws Related Considered

Type of Local Policies/By-laws Considered	% of Respondents
Water use licenses	8%
Storm water management	50%

¹²⁷ Although this does not seem to be a recognised word in the English language, it is understood to refer to an assessment of possible credits to be achieved. It refers to the creation of an inventory of possible credits that can be achieved.

¹²⁸ Green Star

Sewer	17%
Storage requirements	17%
Water outages	8%
Use of non-potable water source	25%
Fire Water	8%
Building permit	8%
Rainfall and weather data	8%
Rainwater harvesting and filtration to drinking quality	8%

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

Table K15: Local Policies and/or By-laws Fed Back to Team

Policy/By-law assessment findings fed into project	% of Respondents
Yes	67%
No	33%

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

Table K16: Explanation on Treatment of Local Policies and/or By-laws in Green Star process

Respondent	Explanation
A	It comes into the EMI-02 and EMI-06 credits, if it is a requirement of the project (i.e. only when there is a watercourse), only then is EMI-05 usually targeted
B	Explanation for choosing No to first part of question: I have not had a project where policies were fed through. Maybe the only one was Nedbank (where we had to apply for Black water treatment in JHB) and Pretoria (green building by-laws)
C	Sometimes. The bylaws can also be rationalised out. Unfortunately, this frequently happens. However, when design attenuation ponds, the requirements usually cover the minimum Green Star requirements.
D	Not Applicable
E	The design of the water systems is based on this information. The Green Star strategy then ascertains the point-impact.
F	Explanation for choosing No to first part of question: It did not affect the Green Star Strategy
G	Explanation for choosing No to first part of question: The client and professional team will essentially be held accountable by council, so it is their responsibility to follow necessary regulations. I would hope that the project team take any relevant by-laws into account and that this informs their approach. Local regulations around stormwater (sic) and fire water consumption were mentioned
H	In the submission report
I	Informed us that we could use treated effluent as a source for irrigation and toilets (with proper treatment)
J	We run Green Star Strategy workshops with the full project team in which all relevant water related (or any other particular requirement) is included
K	These questions are difficult to answer because the GS standard rewards water performance incrementally for reducing reliance on potable water consumption. The bi-laws (sic) that may be relevant relate to black-water treatment systems as municipalities sometimes place conditions on approval of the installations of a blackwater (sic) treatment plant
L	Explanation for choosing Yes to first part of question: Specifically, for projects within a 100m of a natural watercourse (meeting eligibility requirements whilst complying with local authority requirements, or projects that are targeting EMI-05 credit as part of strategy Explanation for choosing No to first part of question: Green Star does not require evidence of approval by local authority on rainwater harvesting and filtration systems to be implemented. However, it is generally accepted that the civil engineer would have included the catchment areas and basic design for attenuation in the SDP and that the wet services engineer has designed the

Respondent	Explanation
	downstream end (reticulation of rain water into the building) in compliance to the applicable local authority requirements.

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

Table K17: Main Factor Driving Decision on Credit Targeting Strategy

Decision Driving Factor	WAT-01: Occupant Amenity Water	WAT-02: Water Meters	WAT-03: Landscape Irrigation	WAT-04: Heat Rejection Water	Wat-05: Fire System Water Consumption
Ease of achieving available points	75%	42%	33%	25%	33%
Client instruction	25%	25%	8%	0%	0%
Prohibitive cost	25%	0%	0%	8%	0%
Cost to achieve credit outweighed by benefit	17%	17%	25%	25%	17%
Anticipated financial savings	8%	17%	8%	0%	0%
Duplication of previous certification outcomes	0%	0%	8%	8%	8%
Informed through research	0%	17%	8%	0%	0%
Pressure from team members	17%	25%	17%	0%	8%
Design	33%	25%	33%	58%	50%
Availability of appropriate technology	25%	17%	17%	0%	8%
Unsure	0%	0%	0%	0%	0%
Location-based policy (please specify)	0%	0%	0%	0%	0%

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

Respondent F made the following additional notes as part of their response under WAT-4:

- Location based policy is not an issue in Gauteng as most projects use air-chillers;
- WAT-04 can also vary purely by who the mechanical engineer is and what system they are used to working with.

Respondent I made the following additional notes as part of their response under WAT-5:

- More that it is technically onerous, also many project (sic) do not have sprinkler systems.

Respondent K made the following additional notes as part of their response:

- WAT-01: Easy of achieving available points for the first two points; never influenced by anticipated financial savings – water is too cheap.
- WAT-03: Is there landscaping or not.
- WAT-04: Design – most frequently achieved by installing air-cooled chillers.
- WAT-05: Design – most frequently achieved through rational fire design route where no sprinklers are installed – but there are also normally tanks around for the rainwater harvesting and then an extra tank is put in the row for the fire draw down as a stand-alone system, or sometimes it is integrated with the greywater (sic) recycling system.

Table K18: Likelihood of Targeting Specific Credits

Water Credit	Least Likely	Unlikely	Neutral	Likely	Most Likely
WAT-01: Occupant Amenity Water	0%	0%	8%	8%	83%
WAT-02: Water Meters	0%	0%	0%	33%	67%
WAT-03: Landscape Irrigation	8%	0%	0%	33%	50%
WAT-04: Heat Rejection Water	0%	0%	42%	33%	17%
WAT-05: Fire System Water Consumption	0%	25%	0%	25%	50%

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

The following table provides an overview of the motivation assigned by respondents to the choices made relating to credit Least Likely and Most Likely to pursue. Where possible, the credits the statement relates to is identified at the start of the comment in brackets.

Table K19: Explanation for Credit Targeting Strategies Identified Less Likely and Most Likely

Respondent	Least Likely	Most Likely
A	No response provided	(Landscape Irrigation) RWH ¹²⁹ for irrigation is cheaper than the system required for flushing toilets, however the tank is oversized and cost prohibitive in terms of WAT-01
B	Fire systems or irrigation – just if they don't have a sprinkler system or that they don't have landscaping	WAT-01 for 2 points – that is common place Same for WAT-04 – if air cooled chiller than these 4 points are given (recommend to take these 4 points out, too easy)
C	Rainwater / grey water / black water treatment for reuse in building Rainwater – often selected but rejected for the following reasons: - space implications for storage tanks, - cost associated with double piping Grey water seldom has the volumes required in an office building to make it viable. Black water considered too high risk for clients.	(WAT-01, WAT-02, WAT -04, WAT -05): Water efficient sanitary fittings. Extensive metering and automated monitoring. Smart irrigation. Air-cooled chillers. Recirculation of test water for fire protection pumps.
D	No response provided	(WAT-01, WAT-02, WAT -04, WAT -05): Easy to achieve is air-cooled chillers used heat rejection achieved automatically. Generally fire systems cover Green Star requirements. Water meter requirement not too far from what is generally provided for, no major additional cost. Efficient sanitary ware generally easy to motivate.
E	No response provided	(WAT-01, WAT-02, WAT -03, WAT -05) 1) Water points are valuable in the Green Star tools and entry-level points can be achieved in all these credits quite easily at little cost.

¹²⁹ Rainwater harvesting

Respondent	Least Likely	Most Likely
		2) Water shortage is a significant risk to commercial property owners and a large environmental concern in our country, thus motivation for entry-level initiatives is not challenging. Only expensive initiatives such as water harvesting/recycling are a challenge to motivate as the ROI ¹³⁰ never really stacks up on its own.
F	There is usually very little support for rainwater collection systems due to perceived cost and complication to help achieve this credit most clients want lush gardens so xeriscaping isn't popular either. Also, some projects are in urban areas and don't have much landscaping.	(Occupant Amenity Water) This is quite an easy credit to achieve as it simply means specifying fittings with the required flow rates, so there is no additional cost
G	Heat rejection, depends on the mechanical design, which requires a team decision, but it is relatively likely	The rest of the credits are all relatively easily targeted. Not all points under each credit was targeted though.
H	No response provided	(WAT-01, WAT-02, WAT -05) Almost common practice now and highly feasible financially and technologically.
I	Fire system water – no sprinkler system on many projects thus N/A ¹³¹ ; else it is relatively easy if there is a water re-use strategy (i.e. tanks) going in as well. Where no reuse happening, no fire water either.	(WAT-01, WAT-02, WAT -03, WAT -04) Easy to achieve and becoming standard practice.
J	No response provided	(WAT-01, WAT-02, WAT -05) Relatively cheap initiative to implement. Also, project teams are becoming more aware of (sic) water crises in SA and the need to address it in building design.
K	Fire water is the least likely to be targeted because it has a low reward in terms of number of points and it is not always pragmatic to integrate it with the system.	(Occupant Amenity Water) All green projects are fitted with efficient taps and showers, which gives you at least one point.
L	No response provided	(WAT-01, WAT-02, WAT -03) These credits has (sic) been targeted on all projects that I have worked on, in many instances with max points. Some projects target less than the max available points due to practicalities/budget restrictions.

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

Table K20: Team Member Responsible for Specifying Fittings and Fixtures

Responsible Team Member	% of Respondents
Architect	91%
Wet Services Engineer	66%
Green Building Consultant	42%
Interior Designer	8%

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

¹³⁰ Return on Investment

¹³¹ Not Applicable

Table K21: Indicate Insight into Identification of Fittings and Fixtures

Insight into process	% of Respondents
Yes	83%
No	17%

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

Table K22: Insight into the Identification of Fittings and Fixtures

Respondent	Insight into Fittings and Fixtures
A	Low flow requirements are sent to suppliers, they provide a list of options with compliant or better flow rate performance.
B	Yes, we check flow rates to ensure the points are targeted.
C	First on price and aesthetics, then on performance. If the chosen sanitary item does not perform then the architect is encouraged to look for an alternative.
D	No explanation provided.
E	AP advises on required flowrates (sic). Architect then consults manufacturer catalogues, which they are well familiar with.
F	The GSSAAP gives the architect the required flow rates and then the fittings are chosen based on the aesthetics and then if they also meet the Green Star requirements.
G	No explanation provided.
H	Specs to achieve savings.
I	Architects find the performance info and select fittings. They use the flow rates from catalogues and choose within the performance requirements per Green Star, e.g. 6l/s flow rate.
J	Usually Architects preference (and in some cases clients' requirements based on previous experience) but the AP ensures that the fittings meet the GS low flow requirements.
K	Aesthetic, price, quality guarantees and water efficiency performance are all considered.
L	Based on water performances/flows.

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

Table K23: Overview of Whether Fittings and Fixtures are Ever Incorrectly Specified

Non-Conformity Issues	% of Respondents
Yes	67%
No	33%

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

Table K24: Motivations to Team to Rectify Incorrectly Specified Fittings and Fixtures

Respondent	Motivation to Team
A	We first check the water calculator to see the effect and identify the problem fittings that need to change in order to achieve the full 3 points for efficient fittings and fixtures.
B	Motivation: to get the points.
C	It doesn't make green star requirements and it is against the green specifications already agreed to by the team.
D	No explanation provided.
E	One uses the 'Green Star Points' as leverage.
F	It was explained that the chosen fittings would compromise the Green Star Rating that the client wants, so they need to be changed or modified.
G	No explanation provided.
H	Only in EB too, never in Office, New Construction.

Respondent	Motivation to Team
I	Ask them to change it, to select another. Never a big deal.
J	In the Strategy Workshop we have identified that we (the project team) would target the WAT-01 credit. Thus, we needed to ensure that the credit criteria were included in the design documentation.
K	The motivation is established by our appointment to the team to deliver a Green Star certified building. We are contractually obliged. If the sanware (sic) schedule is not compliant – we literally mark it up with comments and notes and send back suggestions for alternatives, which we may work out in consultation with the brand supplier.
L	By explaining what is the right approach to selecting fittings, which at the end results in achieving points.

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

Table K25: Previous Direct Contact with Manufacturers to Improve Products

Previous Green Star Related Contact with Manufacturers	% of Respondents
Yes	42%
No	58%

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

Table K26: Contact with Manufacturers – Products Improvement Outcomes

Respondent	Manufacturer Contact Outcomes
A	Answered No.
B	No – lead to improved documentation and data sheets.
C	Yes, inline flow restrictors are now readily available from Cobra. More work needs to be done on shower flow rates.
D	Answered No.
E	Answered No.
F	Not sure, it mostly involved selecting another fixture or adding aerators, reprogramming the flow rates.
G	Answered No.
H	Never water related, but with paints and cleaning products.
I	Have not needed to, there is plenty of compliant fittings on the market; for offices anyhow.
J	No not really just a better understanding by the product supplier of what is important from a GS perspective – e.g. flow restrictors that are fitted in the factory rather than hand tightened on site.
K	I helped a chemist at Midas understand the VOC limits they needed to comply with and they committed to ensuring their entire range of paints was compliant.
L	Answered No.

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

Table K27: Satisfaction with Current Stringency of Benchmarks

Insight into benchmarks	% of Respondents
Yes	75%
No	25%

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

Table K28: Insight into Recommended Changes to Benchmarks

Respondent	Explanation
A	Performance of the fittings in terms of flow rates also depends on what the system is pressurized to. This is difficult to change as it depends on municipal supply, i.e. the performance of a fitting depends on the system pressure and can have better performance if pressure is adjusted but this is controlled by municipal requirements and capability of the entire system.

Respondent	Explanation
B	Too easy – 2 points are a given
C	It is difficult to use lower flush rates in toilets, as incorrect design and placement of the waste water (sic) piping may result in system blockages. It is possible to access a 4/3 flush, and all the way to a 1 litre vacuum flushes (sic), but the infrastructure may not be able to carry waste on such low flows. It may be necessary to get certification on toilet bowl flushing minimums – some bowls will not clear on a lower flush and will result in multiple flushing to do the trick.
D	Most hand basin flow rates should be lowered. LEED makes use of much more stringent flow rates for these fittings.
E	In the office tool this is appropriate as they can be sourced in the market and are still at a functional level (no point in a toilet that does not flush). In the PED v1 rating tool however, benchmarks are too high for toilets.
F	They have never really been very difficult to achieve.
G	Green Star could require lower flow rates on bathroom taps. But otherwise stringent enough.
H	Through self-testing, have determined that if more stringent you wash your hands with air, etc.
I	No explanation provided.
J	There is growing concern in some countries that not enough water is being produced to properly flush sewer drainage systems. Thus, we need to be careful not to create the situation where the sewerage system doesn't work properly due to targeting and rewarding less water usage.
K	There are up to 12 points available for reduction in potable water use. Efficiency is only one strategy. It is possible to install waterless urinals and composting toilets if you have kind of project where it is suitable intervention for building typology. Most new build projects are AA grade buildings, so waterless urinals are unpopular, but we deal with this by recycling grey water and collection of rainwater etc.
L	We still see projects using fittings with much higher flow rates.

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

Table K29: Rainwater, Grey Water and Black Water Systems – Main Drivers

Type of System	Yes	Decision Driver	% of Respondents
Rainwater system	92%	Water security (water is cheap so it's more about security)	8%
		Water use reduction	16%
		Client	42%
		Design team guidance	42%
		Green Star AP	16%
		Cost/benefit	8%
Greywater system	67%	Water security – done in addition to RWH and usually done if there is excessive water that can be captured from showers	8%
		Availability of grey water (gym)	16%
		Design team guidance	16%
		Team experience and cost	16%
		Client	8%
		Green Star AP	16%
Black water system	42%	Too expensive	8%
		Water use reduction	8%
		Client	25%
		Team experience and cost	8%
		Sustainability consultant	16%
		Architect	8%

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

Table K30: Installation Potential of Water Meters with no Green Star Points

Water Meters Without Green Star Points	% of Respondents
Yes	67%
No	25%
No response	8%

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

Table K31: Water Meter Approaches

Respondent	Explanation of Approaches to Water Meters
A	The benefits outweighs (sic) the cost during the life cycle of a building. For example, I worked on a project that missed installing water meters in a borehole, there was a massive leak that went undetected and as a result they blew their annual water budget in just one month.
B	Probably ye! As it is the easiest things to do to meter and manage.
C	Takes effort and cost to link points to BMS. Clients are reluctant to spend too much money on water, as there is no direct payback. However once one explains the benefit of tracking consumption over time and how that may reveal exceptional consumption indicating a leak, clients become more interested.
D	Metering generally provided to the level required. The linking to automated system is the over and above, which is generally easily motivated.
E	Water is cheap, so project to (sic) not monitor water usage at a very granular level outside of Green Star.
F	Most would add water meters purely for billing of tenants, but I am fairly certain that almost none would like it to a BMS.
G	Perhaps not necessarily the link to BMS, but at least a link to a monitoring and metering company or other system, in the cases I dealt with this was for monitoring of tenant consumption mainly.
H	Should be normal practice. Low cost, high rate of return.
I	It is a really good idea and not very expensive for access to this information for empowering better usage. Would be a general 'green building' goal regardless of Green Star pursuit.
J	Not sure – some would (i.e. those larger clients who monitor building performance (e.g. property funds). Clients building speculative buildings would probably not install water meters if not rewarded by GS. Ultimately the tenant gets the benefit but the owner pays the capital – thus owner-occupiers would still install meters but less of the speculative owners could.
K	Maybe – in multi-tenanted buildings this would be the norm. But it has been something we have had to motivate for as part of a green strategy. If the building is not trying to be green, they might not do it.
L	Yes and no. Some clients are more water conscious and will meter the major water uses as well as tenancies for billing purposes. Clients, however, will report to only a single meter and will apportion the use between tenants.

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

Table K32: Likelihood of Specific Landscape Irrigation Strategies to be Used

Route	Least Likely	Unlikely	Neutral	Likely	Most Likely
Water-wise planting	0%	0%	8%	17%	67%
Water efficient irrigation system	0%	0%	0%	33%	67%
Xeriscaping planting	17%	8%	17%	42%	0%
Moisture sensors	0%	17%	17%	50%	17%
Other (please specify)	0%	8%	0%	8%	17%
<i>Solenoid rain sensors and timers</i>					X
<i>Not/Applicable targeted</i>					X

Route	Least Likely	Unlikely	Neutral	Likely	Most Likely
Reducing Landscaping area					X
Weather stations (occasionally)					X
Mulch					X

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

Table K33: Respondents Previous Involvement with Projects Pursuing WAT-04: Heat Rejection Water credit points

Previous Involvement with WAT-04 Credit	% of Respondents
Yes	92%
No	8%

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

Table K34: Heat Rejection Reduction Strategies Used

Respondent	Strategy Insight
A	All the projects I have worked that targeted this point had no water-based heat rejection systems installed.
B	More efficient cooling towers – I think this was Nedbank as well – not reuse of water, but we got 2 points demonstrating the cooling towers were using less water than the base case.
C	We used air-cooled chillers.
D	Points targeted, but for the full points due to air-cooled chillers.
E	Simply by not using water-based heat rejection. This is usually a function of other reasons (e.g. energy efficiency, cost of plant, maintenance, etc. The point is thus usually achieved as a consequence of plant choice.
F	The projects used air-cooled systems, no water was used.
G	By installing no water based heat rejection systems, points were achieved.
H	Sensors to re-use cooling water for more cycles. Grey water usage.
I	Achievement was always via avoidance of water-cooled HVAC, thus never involved in reducing the water consumption.
J	Easiest and most common way is to specify an air-cooled chiller. Some projects use rainwater harvesting to reduce potable water for chillers.
K	We used treated effluent from the municipal sewerage treatment plant.
L	Normally, this credit is targeted on projects with air-cooled chillers. On a specific project, we do have a combination of water cooled and air cooled chillers and so the project aim to demonstrate 60% reduction of potable water use for heat rejection.

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

Table K35: Use of Water Reduction Strategies Beyond Green Star

Respondents previous involvement with strategies beyond Green Star	% of Respondents
Yes	33%
No	58%
No response	8%

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

Table K36: Heat Rejection Reduction Strategies Used

Respondent	Heat Reduction Strategy Feedback
A	Answered No.
B	Answered No.
C	Answered No.
D	Answered No.

Respondent	Heat Reduction Strategy Feedback
E	Often projects harvest condensate from air conditioning. We are also working on an existing building project that is harvesting 'fog' from the air to generate water for the building.
F	On one project groundwater was a big problem and large amounts were being pumped out of the basement on a daily basis. It was investigated whether this could be used for landscaping.
G	Answered No.
H	Answered No.
I	Chevron CORE project designed to send excess rainwater to the Virgin Active gym next door resulting in an annual average of water neutral for the building. Ultimately the strategy fell through for a variety of reasons and was not implemented fully.
J	Not beyond the credits provided, but we have worked on projects where HVAC condensation is collected and recycled (via rainwater harvesting tank) and also where stormwater (sic) is reused on site, or attenuated and infiltrated resulting in no stormwater (sic) leaving the site in municipal stormwater (sic) system.
K	Moisture harvesting would be viewed similarly to rainwater collection – it is classified as an alternative sustainable source of water. This supplements the municipal potable water consumption and points (sic) are rewarded for reduction in potable water use however that is achieved.
L	Yes – filtering of rainwater to drinking quality. Rainwater from first cycle of filtration was used for WC flushing, and second cycle of filtration for use in taps. This was claimed as an innovation. The Client provided all filtration and pumping equipment and the system is used to showcase the performance of the equipment.

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

Table K37: Relevance of Including Alternative Strategies in Green Star

Additional Strategy Consideration	% of Respondents
Yes	42%
No	33%
No response	25%

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016

Table K38: Alternative Strategies Identified for Consideration

Respondent	Alternative Strategies
A	I truly believe the WAT-01 calculator is flawed. It needs to be resized so that realistically sized RWH tanks can be specified to achieve full points under WAT-01 so that the benefit outweighs the cost!
B	I don't think there are many more alternative strategies – these could be innovation points as well. But the system could reward recycling water more, so that it becomes more attractive.
C	(Moisture harvesting) is an innovative approach and cannot be applied fairly across the country due to different climatic conditions.
D	Question left completely unanswered.
E	I think there are other initiatives that can be undertaken, but the latest rating tools (e.g. PEB v1) actually already account for them. Some areas are not accounted for though: - some proper research on the use of boreholes and well points in Green Star. - Operational initiatives relating to behaviour changes in water usage.
F	A credit like the LEED Process Water Reduction can be added to address the water used in canteens in larger offices as this is currently not taken into account.
G	WAT-03 could have a clearer path to compliance. The improvement over the baseline allows the credit to be interpreted differently, but there is not enough research to back up claims that are being made. Perhaps I am saying that I am more concerned about the reliable industry information around irrigation technology. If this was available it would close some of the seeming loopholes, and allow project initiative to be assessed according to approved standards. If the standard was clearer, then this credit could be taken more seriously.

Respondent	Alternative Strategies
	I would like to see more project, perhaps on new precincts, target blackwater(sic) and greywater treatment (so essentially the existing strategies). But these seem somewhat inaccessible in the market to date.
H	More water saving the better.
I	Leave it up to the teams to innovate.
J	The restriction is normally cost of storage. The incentive for project teams to implement other strategies (e.g. moisture harvesting) is still available via the Innovation points.
K	Moisture harvesting is already included. What is excluded is borehole / groundwater harvesting with some controversy.
L	Many buildings have car wash facilities where potable water is used and disposed to sewer. Filtering and recycling of this water could be a potential strategy.

Source: Adrie Fourie - Green Star and Water Conservation Survey Feedback, 2016