

**“Clean Water for All, But at What Cost?” A Choice Experiment Analysis in Mining
Affected Communities**

Chiedza Siobhan Chimuka: 2380829

Supervisor: Andrew Thatcher



A research project submitted in partial fulfilment of the requirements for the degree of MA
(Organisational Psychology) in the Faculty of Humanities, University of the Witwatersrand,
Johannesburg, February 2025.

Abstract

The mining industry has been responsible for boosting economies by creating jobs and commodifying minerals resulting in foreign trade. However, members of mining-affected communities experience many consequences because of these mining activities, one such major consequence is the exacerbation of water scarcity. This research aims to study how members of mining-affected communities make decisions about access to water in conditions of water scarcity. These decisions will be analysed through the lens of Utility Theory, to understand what trade-offs members are willing to make to achieve utility maximisation. The current research will empirically identify the most and least influential attributes in decisions about water provision, between water quality, availability, source, capacity limit, distance to water, and the price community members are willing to pay. A quantitative, cross-sectional descriptive study was conducted on 684 households in 3 different mining-affected communities using a discrete choice experiment manually distributed to them by volunteers of the non-governmental organisation, Mining-affected Communities United in Action (MACUA). The discrete choice experiment results were analysed using RStudio and the results showed that there was a positive utility for quality, and availability while distance and price had significant disutility. Ground water was perceived to be the most utility maximising of the three sources and the capacity limit was non-significant.

Key words: mining-affected communities; water scarcity; utility theory; discrete choice experiments; South African communities; mining activity.

Declaration

I, Chiedza Siobhan Chimuka, declare that this research report is my own, unaided work. It is submitted for the Masters of Arts in Organisational Psychology degree of the University of the Witwatersrand, Johannesburg. It has not been submitted before for any other degree or examination at this or any other university.

Signed:

A handwritten signature in black ink, appearing to read 'Chiedza Siobhan Chimuka', followed by a colon.

Date: 28/02/2025

Acknowledgements

Jesus Christ, my pillar, my strength, my compass. The one who saw all this before I did. Thank you for granting me with the spirit of endurance and perseverance.

To my mother, we did it. Thank you for sharing joy and frustration, peace and anxiety, happiness and pain. We did it all, and though not pleasant, we did it together.

To my father, you have changed so much over the years, but no matter who you are, you will always be my hero.

To my sisters, you kept me sane throughout the journey. Though there are borders between us, thank you for all the laughter and support. Thank you for never letting me feel alone on this journey.

To my supervisor, Andrew Thatcher, thank you for your guidance and for making what seemed like a daunting project, one of the most adventure-filled, eye-opening experiences of my educational career.

To the other members of the research team, Thomas Lundhede, Marie Lautrap, Prof. Eric Mungatana, Innocent Pangapanga, Craig Sheridan and Peter Holm, thank you for creating room for me on this project and for teaching me new skills along the way.

Thank you to the Danish International Development Agency (DANIDA) for the research grant that enabled data collection, to Mining-Affected Communities United in Action (MACUA) for providing access to the sample, and to Canon Collins Trust (CCT) for the scholarship to pursue my Master's degree.

Finally, to my classmates, we came, we conquered, and we beat the edge once again!

To anybody I did not mention, thank you!

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Chapter 1: Literature Review

1.1 Introduction

This chapter reviews the literature on water conditions in mining-affected communities, providing a background for understanding the context of the study. It will explore utility theory, detailing its historical development and relevance as a theoretical framework. The concept of discrete choice experiments will be introduced, establishing connections among the three sections of the literature review to illustrate how they relate and their significance to accomplishing the research objectives. Lastly, the aims and rationale will be explored followed by the proposed research questions.

1.2 Water in Mining Towns

The Global South is plagued with issues of resource scarcity, one such resource is water. Water is essential for our everyday activities. We use water for a lot of things - to drink, to water our plants, to cook, to clean, and to bath, amongst many other activities (Adam, 2020). The United Nations Human Rights Office of the High Commissioner deemed access to safe drinking water and sanitation a human right, yet some people wake up with the daily struggle of having to plan how they will access water for their day's activities (Palmer et al., 2018). In the context of South Africa (SA), this agenda is said to be a key focus of the government. The National Development Plan (NDP) is the document that defines a national agenda to reduce or entirely eradicate poverty and inequality in South Africa (NPC, 2011). It defines a list of objectives and under the fourth objective that deals with the economic infrastructure, the government states goals relating to the improvement of the water situation in the country (NPC, 2011). The most important aspect of this document as it relates to the current research is the bold claim that "before 2030, all South Africans will have affordable, reliable access to sufficient safe water and hygienic sanitation" (NPC, 2011, p. 178). Achieving this goal would not only be a leap in the right direction, but it would restore the dignity of many who have become disadvantaged by the government's inability to provide this basic need. Van der Vyver (2016) states that South Africa has a water crisis, due to poorly governed national water management systems that have led to poor pollution control. Other reasons have contributed too, such as its naturally semi-arid climate which promotes less rainfall and this rainfall is unevenly dispersed, aged water infrastructure such as leaking pipes, and corruption that has led to insufficient funding to fix such problems (Bischoff-Mattson et al., 2020; Matlakala & Von Kallon, 2021; Lee & Schwab, 2005). So while water scarcity is a challenge across the globe (Okolo et al., 2018), this is an all

too familiar story for South Africans, but more specifically for South African populations in mining-affected communities.

Members of mining-affected communities experience a unique set of circumstances as it relates to access to clean water. Before unpacking this, it is necessary to define the term mining-affected communities. For this research, the phrase mine-affected communities will be used synonymously with mining-affected communities. This refers to people who live near mining activities and as a result, their livelihoods are impacted directly by these activities. Some of these impacts include air pollution where mining emits toxic gases and particulates into the air, violence which results from the inequality in these areas, illegal mining often resulting from poverty, and the subject of this study, inadequate clean water access (Antwi et al., 2017; Mensah et al., 2015; Unruh et al., 2011). In Cole and Broadhurst's (2020) study on the mapping and classification of mining host communities, they identified 84 locations that hosted or supported mining activities. These ranged from cities and towns to village clusters and most of them had been operational for at least ten years. Many of these locations experienced the positive effects of mining, namely economic growth such that they developed other industries from which they became reliant. The number of people in these areas paints a picture of just how many citizens of South Africa are affected, positively and negatively, by mining activity. Their study reported a total of 2.3 million people occupying these areas (Cole & Broadhurst, 2020). This study was conducted in 2020, and since then, the situation has significantly changed. Furthermore, it was based on only 84 areas of mining activity with 175 mines. According to Africa Mining IQ (Mines in South Africa | Africa Mining IQ, n.d.), South Africa is home to 552 mines, which would more than double the number of people facing the challenges of living in a mining town daily.

1.3 South Africa's Mining Towns & Informal Settlements

Mining activities often result in the development of the area. According to Marais et al. (2018), mining made up 6-7% of South Africa's GDP and was about one-third of the market capitalisation of the Johannesburg Stock Exchange (JSE). South Africa's history was strongly influenced by the establishment of mining activity. The reality is, that mining towns today are a product of the exploitative formation of the mining industry in its early beginnings. Historically, minerals were discovered at several points in South Africa, some of the earliest were the discovery of diamonds in Kimberly in 1867 and the discovery of gold in the Witwatersrand in 1886 (Marais et al., 2018; Pretorius et al., 1986; Wentzel & Tlabela, 2006; Wilson, 2001). This discovery prompted a surge of migration towards these mining areas from

other parts of South Africa and neighbouring countries. At the time of establishment, mines were new businesses that were eager to hire employees, and they understood that mineworkers came from far distances. To make life easier for them and the mineworkers they hired, they established barracks and hostels for their workers. These were single-sex living environments, which meant that mine workers stayed on the premises, away from their families. Furthermore, mines were businesses that operated for profit, so they focused more on what would result in productivity rather than holistically catering to their largely migrant workforce. This meant that they provided enough to accommodate the workers but never intended to bring mineworkers' families closer by building accommodation for families (Pelders & Nelson, 2019; Wilson, 2001).

Throughout this process, many indigenous communities were displaced and some were destroyed. Much of this was supported by the colonial and apartheid governments, so the impacts on the black labour force were the least of their concern. This became a system that is still adopted today, mineworkers came from rural areas and worked on contract in mines, they would stay on-site for a while and return home when it was over. This resulted in fragmented communities and it disrupted the black family structure. This all slightly changed when the demand for work outweighed the available housing (Wentzel & Tlabela, 2006; Pelders & Nelson, 2019). Black South Africans came from far away because they were not permitted to live in urban areas under apartheid, this meant one had to travel from the rural areas daily to make it to work in the mines. This was not feasible for many, so the establishment of informal settlements began in areas around the mines. When apartheid ended, mines were not supported by the government the way they had been before. This resulted in many mines dismantling the housing system they had initially established. Informal settlements grew even more in response to this dismantling, as most mine workers could not make the commute over such long distances (Wentzel & Tlabela, 2006; Pelders & Nelson, 2019; Marais et al., 2018). This is how mining-affected areas like Emalahleni, Phola, and the Dannhauser Local Municipality arose.

Marais and Lenka's (2022) study supported the claim that informal settlements develop in response to the employment opportunities created by mining activity. They stated that these settlements put pressure on municipal resources and cause rapid growth of new neighbourhoods that have not been mapped out by the government for resource provision. In their study, Marais and Lenka (2022) reported that 16% of miners in Emalahleni and 25% of miners in Rustenburg lived in informal housing. Such a situation means that these residents are often subjected to the worst conditions of living, they are the closest to the mines, and the most

vulnerable to issues of access to quality water (Marais et al., 2018; Cole & Broadhurst, 2022; Mujere, 2020). Since clean water in these environments is not always available, residents have become accustomed to having multiple different sources, such as community centres, petrol stations, and neighbours at a cost, amongst other options. Not only are these sources limited, but they are also often unreliable. As a result, members of these communities are plagued with several decisions that they must make about how to access water, when it is available, and which water supply system has the water most appropriate for its intended use (Cole & Broadhurst, 2022).

These settlements and their issues would not exist if mining activity had not drawn community members to these areas. Mining activity has affected and continues to affect the water supply, quality, and access for the people in mining-affected areas. For example, in a qualitative study done in Rustenburg, Barnwell et al. (2020) found that eight out of ten participants reported an exacerbation of water scarcity resulting from mining activities. Participants reported dams and rivers that dried up quickly because of having to share this water with the mines. However, in South Africa, one of the largest factors affecting these community members' access to clean water is the issue of contamination. Mine-affected communities are victims of water contamination as various toxic substances from mining activities seep into drinking water in rivers and streams (Barnwell et al., 2020; Mativenga & Marnewick, 2018; Sandlos & Keeling, 2016). While it is true that mining activities create competition for access to water supply in an area, significantly reducing the amount available for community members, the belief that the mining industry consumes the largest proportion of water in South Africa is not true. (Askham & Van der Poll, 2017). Rather, the most significant effect of mining is its contamination of water sources. If water is contaminated, there is less water available for drinking, leading back to the issue of water scarcity. Acid mine drainage (AMD) from coal mines is one of the most damaging contaminants in SA (McCarthy, 2011). AMD is defined as highly acidic water draining from active, dormant, or abandoned mines and reclaimed areas. The water has higher acidity than alkalinity which is damaging to human physical health (Archaya & Kharel, 2020). The simplest way to explain this is when active mines use water during drilling and for dust control, this water then flows as runoff which seeps into rivers and dams nearby often used for drinking by locals. This runoff contains metals and toxic chemicals that are not appropriate for human consumption (Askham & Van der Poll, 2017; Ochieng et al., 2010; Tomiyama & Igarashi, 2022). This type of contamination is harmful because it affects the water sources available to such communities, including both surface water and ground water (Li et al., 2016).

As reported by Ochieng et al. (2010), 70% of the water used in rural and urban areas comes from surface water sources such as rivers, streams, lakes, and ponds. They defined water as being “mining's most common casualty” (Ochieng et al., 2010, 3351). Mining activity comes with water seepage and as long as it is in operation, seepage into surface water occurs (Wolkersdorf & Mugova, 2022). Ground water is also affected over time, as mines become deeper and deeper and continuously come into contact with this source. Wastewater containing toxic particulates can seep into groundwater, which ultimately results in the occurrence of AMD, contaminating ground water sources (Jhariya et al., 2016; Li et al., 2016). Water sources are essential for drinking but also for agricultural purposes and adverse effects result from watering plants with contaminated water. These sources do not support the healthy and safe growth of plants and thus they affect the food supply of people in these regions. Li et al. (2016) supported Ochieng et al.'s (2010) findings in their study on the environmental impacts of mining in China. They stated that water contamination, air pollution, noise pollution, and ground collapse resulting from mining activity disrupted ecosystems and created harsh conditions for both workers and residents (Li et al., 2016). Such carelessness with water creates breeding grounds for diseases like cholera and typhoid fever. Ochieng et al. (2010) stated that reduced quality and quantity of water due to mining activities resulted in the death of 30000 people globally due to poor sanitation, and most of these people were infants. Noise pollution and water contamination reduce the presence of vital animal populations required for normal environmental processes such as the provision of manure to plants. In addition, if water is heavily contaminated it can kill animals and such dead fauna may not even be healthy to eat (Li et al., 2016; Ochieng et al., 2010; Wolkersdorf & Mugova, 2022; Jhariya et al., 2016).

1.4 Existing Research on Water in Mining Towns

Water in mining towns has been studied with a focus on several areas. There have been studies focused on groundwater mining (Custodio et al., 2016), mining effects on water quality (Howladar et al., 2018), water contamination and pollution resulting from mining activities (Abraham & Susan, 2017), health risks of mining activities (Edokpavi et al., 2018; Stewart, 2020; Hadzi et al., 2018), corporate social responsibility (Frederiksen, 2019), and sustainability (Barlow & Clarke, 2017; Monteiro et al., 2019). There are also social and cultural aspects around mining such as the feminisation of mining (Lahiri-Dutt, 2015), mining identities (Skeard, 2015), and mining site connections to ancestral and indigenous heritage (Horowitz et al., 2024). However, the current study focuses on water in mining towns, particularly access to water, its quality, and availability. Since water contamination affects access to water in mining

towns, the focus is on research that assesses this along with emphasizing some of the health risks and alternative sources available for the community members.

Water contamination resulting from mining activity has been widely studied across the globe, with studies conducted in India, China, Pakistan, Nigeria, and Turkey. Almost all countries in the world have some kind of mining activity, so the issue of water contamination is a global one (Ali et al., 2016; Li et al., 2021; Okolo et al., 2018). Various chemicals can seep into water and render it inappropriate for human consumption. In a study conducted by Ali et al. (2016), fluoride contamination of water was regarded as a global issue causing dental and skeletal fluorosis and this was partly a result of mining activity. They reported that multiple sources of fluoride result in water contamination, geogenic sources, (fluoride found in rocks, in soil, and coal), and fluoride transmitted through air pollution, contributed heavily to the contamination of water. Other sources such as fertilisers, glass, clay, food items (like dates and some kinds of tea), lakes, and rivers further exacerbate the problem. They reported that each source had varying levels of fluoride found per country. South Asia was labelled the epicentre of fluoride contamination, with most countries experiencing regular fluoride contamination-related health issues. In East Asia, China was the most affected, and in Africa, Ethiopia was the most affected. South Africa, though not the highest, reported 803 sites in which fluorosis was prevalent. Some developed countries were included in this study too, such as Canada, Germany, and the United States of America (USA) (Ali et al., 2016).

Ali et al.'s (2016) study did an exceptional job of reviewing existing literature on fluoride contamination and its effects globally, highlighting that though we need fluoride for enamel and bone development, too much can be a bad thing. The reason this study is included in the current research is to show that contamination affects physical health, so in essence, human wellbeing is negatively impacted by this activity. Another important finding drawn from Ali et al.'s (2018) study is that these negative effects do not necessarily result from bad chemicals but rather from the consumption of larger quantities of certain chemicals. If this is the effect of mining activity on mining-communities, more of a spotlight should be placed on access to clean water to ensure that community members are not being exposed to large quantities of particulates that result in ill health. While Ali et al.'s (2018) study painted a picture of the water contamination issue, it focused on fluoride contamination. There are other forms of water contamination. Furthermore, it did not exhaustively focus on South Africa as there were other countries in which fluoride contamination was prevalent. Lastly, it did not put as much weight on mining activities' contributions to the contamination as is necessary for the current research.

The disruption of clean water access due to mining activities has become a major concern for millions of South Africans, emphasizing the ethical and environmental responsibilities that the mining industry must be held accountable for.

A more appropriate study was Okolo et al.'s (2018) study on the threat of open-cast mining activity on water quality in the rural Nigerian community of Enyigba. Nigeria faces population and climate pressures which have been the reason for the increasing water insecurity. Open-cast mining is a process whereby vegetation and other obstructions are removed from the ground to access minerals believed to be present. The ground is dug up until there is a large pit, exposing the minerals. Once these minerals are visible, heavy extraction machinery is used to extract them from the ground. As is common practice in mining, once the minerals are extracted, the pit is abandoned and left open which results in land degradation, and pollution as it often becomes a waste dump site. Water contamination occurs when heavy metals (for example, arsenic, silver, and lead) come into contact with air and water. The process can be referred to as acid rock drainage, where the sulphides in rocks are exposed to air and water, or when mineral pyrite in rock, compounds with oxygenated water. When this happens as a result of mining activity, it is then called acid mine drainage. This contaminated water is then washed away from the mining site with rainwater or water drainage and contaminates the rivers, dams, and groundwater used as sources of water for Enyigba community members (Okolo et al., 2018). The World Health Organisation (WHO) has reported that drinking water contaminated by heavy metals can damage the kidney and bones, it can cause lung cancer, affects the neurobehavioral development of foetuses and young children, and can further impact blood pressure (Chemical Safety and Health Unit (CHE), 2007). This is backed up by Okolo et al. (2018) who reported that heavy metal contamination was a cause of death, not only in Nigeria but globally. They tested the pH levels of three different water bodies, the top stream, middle stream, and bottom stream, and compared their pH level to that of the level deemed permissible by the WHO (between 6.5 and 8.5). Their study revealed that the surface water in active pits was 5.5, while abandoned pits had a 6.9 pH. The low result found in the active pits surface water, though permissible, revealed that acid mine drainage (AMD) had been produced.

This study is essential as it expands on Ali et al.'s (2016) study by indicating that fluoride contamination is not the only form of water contamination affecting mining-affected communities. It brought into question the effects of AMD, which are prevalent in the South African context. The study conducted by Okolo et al. (2018) took the case of a mining-affected community, and scientific tests were conducted to derive reliable and valid results showing the

damage caused by mining. However, the small rural town of Enyigba may not be the best and most representative sample to compare to South African mining towns. With a population of eight thousand residents, it hardly compares to Phola which is home to above thirty-one thousand people (Phola - Population Statistics, n.d.), and Emalahleni which is home to over four hundred thousand people (Emalahleni Local Municipality - Demographic, n.d.). Not only that, but Okolo et al. (2018) used quantitative measurement which made conclusions based on testing the actual water, not on the lived experiences or self-reported challenges faced by community members. This made the process very much removed from the experiences of people. Though the researchers acknowledged the need for cleaner water, the scientific conclusions were that only in active mining pits is there a risk of water contamination. However, the reality is, that water in this area was not consumed once, it was consumed daily, and this meant that though pH levels may be okay in some water bodies, accumulated consumption of such water could have still led to health problems, it would just take more time. Furthermore, those living with the consequences of the actions of the mines were not consulted, community engagement is essential to further validate the results derived from the samples taken.

A study that attempts to address some of these critiques was conducted by Cole and Broadhurst (2022) in the West Wits Goldfield area in South Africa, found in the Witwatersrand Basin which at the time of publication, was facing closure. This basin contained gold deposits and mining activity began there as early as 1886. This is the largest goldfield in the world and the West Wits goldfield has the deepest mines. AMD was prevalent in this area along with air pollution from all the dust that resulted from mining activity. Their study aimed to look at communities in the area and to measure their well-being as it relates to the nearby mines, using sustainable development goal (SDG) indicators. Some examples of these SDG indicators included access to clean water, sanitation, and electricity access. This gave them an idea about some of the implications of being a resident in those areas. This study was more centred on the self-reported lived-experiences of the members of mining-affected communities – addressing one of the biggest drawbacks of the previous study. The focus of this critique will be based on the aspect related to water as the other aspects do not necessarily fall within the scope of this research. The study was conducted on a South African sample, which is ideal as the current research focuses on the same sample so similarities can further strengthen the conclusions.

Cole and Broadhurst (2022) identified forty-seven communities and thirteen SDG indicators which they used to measure the levels of well-being. Their results revealed that piped water

and sanitation, that is water coming out of taps for drinking and other purposes and water for toilets and bathing, were available to those who resided in towns, which in this study meant those living in townships and mining villages. Those who lived in smaller communities such as rural areas or informal settlements had little to no access to basic sanitation and piped water. This was a crucial finding that linked back to the fact that the closest communities to mines are often people who built informal settlements to be closer to work (or potential work) at the mines. The study painted a picture of the situation in South Africa, access to clean water for communities in South Africa is guided by history. The poorest communities are affected by mining activity the most, even though they are not the only communities near it. Cole and Broadhurst (2022) also had poverty as an SDG indicator, and this corresponded with the water access results discussed above. The poorest people did not have access to water and were expected to find alternative sources, some of which may have involved purchasing it. If a community member could not afford this, they would have no choice but to make do with potentially contaminated sources. Cole and Broadhurst (2022) did not focus excessively on the aspect of water contamination as Okolo et al. (2018) and Ali et al. (2016) did, what was important in their study was that it painted a picture of access inequality among those in poor mining-affected communities.

Based on the above discussion, it becomes increasingly important for organisations and communities to explore collaboration ways of improving access to clean water in mine-affected communities. With issues such as AMD and other types of water contamination leaving the population's health at risk, sustainable interventions beyond corporate social responsibility are necessary to address how such groups can be afforded the opportunity to gain access to clean water on their own terms. As clean water in these environments is not always available, such communities have become accustomed to having multiple different sources and as established above, not only are these sources limited, but they are often unreliable. As an added layer, the poorest mining-affected communities are the ones most at risk and some of the alternatives to water access require that they pay for drinking water which they cannot always afford. Due to the various ways in which this group is disadvantaged when devising how alternative clean water systems can be put into place, it is necessary to consult with these communities as they live with the daily challenge of deciding where, how, and when to get the water they need. Alternatives provided to them could reduce their reliance on piped municipal water, which is not always available, but they would have to make multiple decisions before clean water alternatives can be made accessible to them. They would have to consider alternatives with

varying water quality, capacity limits, cost, distance, and availability, to find the solution that best works for them, making the process plagued with trade-offs. To understand how people go about making difficult decisions under such conditions of scarcity, it is necessary to refer to the psychological processes used in decision-making. When faced with these trade-off-ridden alternatives, how does an individual make a decision that suits their unique circumstances and, in this case, gives them the best possible access to clean water?

1.5 Utility Theory

The average human being makes several decisions daily. Some decisions are easier to make than others. When we choose to take one option over another, we are choosing to pick the most preferred alternative in that time or situation (Bliemer & Rose, 2014; Hensher et al., 2005; Lunenburg, 2010). This idea was the premise of the current research. Mine-affected community members were tasked with making choices about the most suitable alternatives concerning their access to clean water. The current research studied this behaviour by administering a choice experiment and asking people to make decisions. These decisions helped provide insight into the most and least preferred alternatives and what aspects were considered when making these decisions. Before discussing choice experiments, it is important to discuss the theory behind decision-making. The current research will explain these processes through the lens of Utility Theory.

Utility Theory is a multidisciplinary theory that aims to develop an understanding of the decision-making process (Tversky, 1975). It originated in 1738 when Daniel Bernoulli began writing about its development. His writings were from a mathematical background. Many authors from other disciplines went on to expand on his research in their disciplinary context and the theory began to grow (Hensher et al., 2005). Today utility theory is studied in economics, mathematics, and psychology. It forms the foundation of the understanding behind how we arrive at the decisions we make (Bliemer & Rose, 2014). Various types of utility are used to explain the choices people make, but the accumulation of ideas has created holistic methods of analysing people's decision-making processes.

1.6 Types of Utility

To begin, it is necessary to define utility. This is referred to as the value of a particular alternative or attribute or the amount of satisfaction a person derives from an attribute or alternative (Hensher et al., 2005). So, utility theory can be looked at as value theory; a theory in which the values of options are studied, weighed, ranked, or used as determinants of a

particular outcome. It is this value in comparison to the value of other attributes that determines the choice a person will make. Bernoulli identified two types of utility – cardinal and ordinal utility (Tversky, 1975). Cardinal utility can be seen as a quantifiable measure of utility, in which the value of an attribute can be expressed numerically and its value carries meaning. These values were named utils and they were used to understand the amount of value one attribute has over another. In this context, a person who assigned 0 to an alternative would ultimately be expressing a total absence of preference (Hensher et al., 2005). This method is based on a quantified level of preference, but how does one measure preference? By nature, utils were invented to be able to measure something you cannot count, so it was decided that one util is one unit of value or satisfaction (Hensher et al., 2005). These are not a real thing; they were a value system devised by a scientist. This means that people must engage in self-report to quantify how much they like one thing over another. This is not an easy task, nor is it a reliable measure. A person would have to possess all the information about a particular attribute, quantify all its characteristics, and total this to report a final util. This would take a lot of time and effort, and most likely delay every decision a person makes.

Thus this type of utility can be very difficult to work with. It is still very valuable, but people cannot always assess all the information required to quantify a choice. A second type of utility can be used instead. Like cardinal utility, ordinal utility sees people making choices based on preference, but it is based more on rankings of preferred alternatives. In this way, it combats the inaccuracies that could result from having to quantify preference. In ordinal utility, values assigned to alternatives are meaningless, they cannot be interpreted as ratios because they are ordinal (Hensher et al., 2005; Bliemer & Rose, 2014). A person could report liking an alternative ‘way more’ than another, using ordinal utility. This would be very useful because we would have enough information to know that we can rank this preference over the other. Out of the two theories mentioned, this is the one most associated with the discrete choice experiments because in choice experiments, values assigned to alternatives are ordinal, they do not have an absolute 0 (Batley, 2008). It is necessary to discuss one more type of utility because it helped researchers explain the decision-making processes of individuals specifically in behavioural science. It is known as random utility maximisation.

Marchak (1956) devised the theory of random utility maximization (RUM). Since he operated in the discipline of economics, his research interests were largely about understanding demand. This theory was specifically devised to understand the choices made by individuals in these contexts. RUM follows the assumption that people will make decisions based on the option

that maximises utility (Hensher et al., 2005; Batley, 2008; Azari et al., 2012). People make decisions based on the option that most increases value, the option that provides them with the most benefits, or with the highest level of satisfaction. Since analysts cannot determine the exact level of utility for each of the options, a probability is devised to reflect the varying levels of utility for all alternatives. This theory helped explain human choice behaviour and demonstrates the reasoning behind a person selecting a particular alternative (Azari et al., 2012). There are many types of utility theories, and these are not the only ones that can be found in the literature, but they shed some light on some of the explanations behind people's decision-making processes. Two other types popularly found in the literature are expected utility theory, where people compare the expected utility value of each alternative, and prospect theory where people weigh the potential gains and losses derived from each alternative and choose the best one (Hensher et al., 2005).

1.7 Utility Theory in Literature

Previous research on utility theory can be found in multiple contexts, such as mathematics which looks at the quantification of decision-making through mathematical models that represent utility in numerical form (Miyamoto, 1988; Liebendörfer & Schukajlow, 2020; Kauder, 2015). In economics, the focus is on understanding consumer patterns and demand curves with the hope of improving anticipation of consumer preferences and choices (Stigler, 1950; Coto-Millán, 2012; Ganguly & Tasoff, 2017; Witt, 2016). In psychology, it is largely about understanding why people make the choices they do and the resulting consequential behaviour (Edwards, 1954; Brandstätter et al., 2006; Hulleman et al., 2010). What makes the current research unique is the specialised sample and their distinctive circumstances. Research on the application of utility theory on mining-affected communities ranges in content, but it is evident that there is very little research focused on linking the two. Perdeli Demirkan et al. (2022) conducted a study in Colorado, USA, on a mine closure. As discussed in Okolo et al.'s (2018) study on open cast mining in the previous section, mine closure often leaves the areas vulnerable to land degradation, with abandoned mines contributing to environmental consequences such as AMD and water contamination. In Perdeli Demirkan et al.'s (2022) study the aim was to ensure that the mining site was closed in a way that did not compromise environmental and social well-being and at the same time did not result in a large financial cost to the business. They used the multi-attribute utility theory to determine which repurposing alternative between the three was the most economically, socially, and environmentally sustainable alternative. This method was highly statistical, and the alternative analysed to be

the most preferred was chosen because the student sample reported that this was the best possible alternative among the three. When comparing it to the current research, one of the most obvious differences in Perdeli Demirkan et al.'s (2022) study was of course the Western sample which would not be a good representation of the South African population sampled in the current research. In addition to this, the study was based on the repurposing of mining areas after activities had concluded, it did not focus directly on water access and provision. Furthermore, the alternatives devised were selected by students who engaged with the local community and assessed the social environment to be able to make more informed decisions. Although some of these students may have formed part of the community that would be affected by the mine closure they would still be considered a specialised sample and not fully representative of all members of that mining-affected community. Out of all the studies in this area, Perdeli Demirkan et al. (2022) seemed like they had a study that was relatively similar to that of the current research, however, using a South African sample, where water access and provision in mining-affected areas remain ongoing issues, would contribute more directly to understanding the challenges faced by these specific communities.

Other related studies have used the term utility-oriented or utility-based mining to report on a guided strategy for sustainable and profitable mining (Narrei & Ataee-pour, 2021; Gan et al., 2019; Shen et al., 2002). These studies were more about the success of the mines and how to achieve this. They considered the most environmentally and socially friendly ways to go about it, but mine-affected communities did not benefit from much of this research. In the South African context, much of the research has focused on the impact of mining activities on these communities, the need for sustainable mining activities, displacement, the conflict resulting from mining activities, and issues with service provision (Muhirwa et al., 2023; Farrell et al., 2012; Roche et al., 2021; Simpson et al., 2019). In terms of water provision, there is research in the area of water provision to mine-affected communities, however, the focus is on what the current state of water access looks like (Mativenga & Marnewick, 2018; Pretty & Odeku, 2017; Munyai et al., 2021), how to provide water to these populations (Adam, 2020; Tarras-Wahlberg, 2017), and what challenges occur or could potentially occur, that relate to clean water access (Turton, 2010; Askham & Van der Poll, 2017). While these studies looked at water provision in mining-affected communities, none of this research was investigated through a utility theory lens, so alternatives and the utility of alternatives cannot be inferred. In the current research, this is essential because it is necessary to understand what options are most valuable to the communities.

The previous studies do a good job of stressing the importance of utility theory in the context of this study. It was very difficult to find studies that highlight and study the connection between mine-affected communities and utility theory as these two variables have barely been assessed in the way that the current research hopes to do. Much of the literature on utility theory is based on Western samples and research must bridge the gap between the Global North and the Global South. Mining-affected communities and utility theory have barely been studied, and when they have, it was largely studies that took the angle of the mine and assessed variables that could produce results most likely for the benefit of the organisations that mine for materials and not necessarily for the members of communities in those areas impacted by mining activity. The current study attempts to use mining-affected community members' preferences as a guide to understand their decisions and infer what is most important to these individuals in the provision of clean water. It hopes to empower community members by allowing them to voice what alternatives suit them best.

Up until this point, this literature review has addressed mining-affected communities and their needs, as well as the processes of decision-making that will most likely be used to decide which water provision alternative suits them best. It was necessary to understand choice experiments as they were the instrument used to assess the preferences reported by members of these mining-affected communities. Choice experiments were essentially the data collection tool used to assess utility.

1.8 Choice Experiments

Thurstone's 1927 Law of Comparative Judgement introduced the idea of choice analysis. He proposed that when people make choices, these choices are always determined by a comparison between at least two alternatives. These alternatives can also be referred to as affective states. This is precisely what builds the rationale behind the idea of choice experiments (Hensher et al., 2005). The concept was derived from an economic perspective that resources are scarce, so people cannot have access to everything. As a result, a choice of the most preferred alternative must be made instead. When it comes to choice, however, humans are not always as clear about choices as they think they are. Multiple alternatives to choose from can either make the idea of making a choice easier or, if there are too many options, it can make it more difficult. There is a lot to consider and often when making a choice, people make it based on limited information. A choice experiment is used to measure these preferences. These preferences are divided into two, stated preferences and revealed preferences. In reality, people do not always know for sure

if the choice they make in a hypothetical scenario would be the choice they would make in a real-life situation. Therefore, there is a differentiation between what people choose in the actual situation and what people think they would choose (Shang & Chandra, 2023).

Choice experiments therefore measure stated preferences. That is, they measure what people pick as their potential preference under experimental conditions. Alternatively, revealed preferences are what people did (or will go on to do) in reality. This can differ because reporting on what one would do in a hypothetical situation does not always truly represent what happens in real life. This goes back to the aspect of making decisions based on limited information. By nature, hypothetical bias occurs in these situations, where we make a choice and often overestimate or underestimate our preferences (Shang & Chandra, 2023). Furthermore, the reality is that humans want to look good in front of other humans. In a stated choice situation, people are often affected by social desirability bias which leads them to make choices based on what would be the most socially acceptable answer. When the choice becomes a real-world decision, people have to commit to the stated preference. The stated preference may reveal that at times people just want to look good and that is the only reason they answered the way they did, not necessarily because it is genuinely the choice they would make (Shang & Chandra, 2023; Entem et al., 2022; Gschwandtner & Burton, 2020). The hypothetical situation provided can also influence a person's stated preference. Aspects such as wording, the presence or absence of incentives, and familiarity with the scenario can lead to a certain response. In addition to this, cognitive biases like framing and anchoring can elicit certain responses. Framing refers to how information is presented, if it sounds like it is positively framed, it could affect responses differently than if it sounds negatively framed (Smith et al., 2022; Furnham & Boo, 2011). In anchoring, the person relies heavily on the first information they receive, if that information is interpreted to be negative in some way, it affects the responses they provide in the scenarios given (Furnham & Boo, 2011).

Choice experiments are also referred to as stated choice surveys or choice-based conjoint. The first application of a choice experiment was also made in collaboration between a psychologist and an economist, namely Jordan Louviere and David Hensher (Louviere & Hensher, 1982). They were designed to offer individuals a hypothetical scenario in which they get two or more alternatives to choose from to report their preference. Choice experiments make estimations about the economic value (or other "values") of different attributes of a particular variable to understand what is the most valuable or the most influential attribute as it relates to that variable (Holmes et al., 2017). It sounds more complicated than it is; to simplify it, it would be helpful

to explain it in the context of this study. In this study water is the variable. It's value is therefore estimated using an understanding of various attributes that determine a person's access to water, some attributes may be more influential than others, but these help to paint a picture of just how much people are willing to pay (not just in the monetary sense) for access to this variable.

Choice experiments are instruments used to measure choice or utility. In the economic sense, they measure willingness to pay (WTP). To contextualise this, this can be seen as how far individuals are willing to walk for water, or how much they are willing to pay for water (Hensher et al., 2005; Bliemer & Rose, 2014). Choice experiments can be discrete or continuous. Discrete choice experiments measure preference at an individual level while continuous choice experiments operate at an economic or sectoral level. The current research administered one survey to each person, so will be using discrete choice models (Hensher et al., 2005). The choice setting is the environment from which the choice task is being tested. In the context of this research, the choice setting is the mining-affected communities' water situation. The choice experiment part of the survey is referred to as a choice task, a choice set, or a choice card (Mariel et al., 2021). This is the section of the survey where choice makers find the choice scenario. The choice scenario is the hypothetical situation that choice makers are being asked about. In the context of this research, the choice scenario will be presented after the introduction questions in Appendix A, explaining the different parts of the choice experiment and all its levels from which choice makers will be asked to pick. The attributes are the different options found in the choice set that people will use to make their decisions about which alternative they will pick (Bliemer & Rose, 2014; Mariel et al., 2021). The aim of these experiments is that the results across the sample show a lot of variability. Variability is more representative of the reality of how people make choices. When the results are extremely heterogeneous, it is seen as a fallacy and may represent what the respondents think the researchers want to hear. When an analyst accepts this, it is seen as avoiding the complexity of choice. This is not to say that homogeneity is not possible. When people select the status quo alternatives they are choosing to select the alternatives that conform to the social standard to avoid being different or standing out (Hensher et al., 2005).

1.9 The Formular & Structure of Choice Experiments

The choice experiment method is founded on two elements of economic theory. The first is Lancasters' consumer theory which says, all goods and services have characteristics, and these

can have levels (Lancaster, 1966). These are what are called the attributes. The utility (U) of a given good or service can be described as:

$$U=U(X_1...X_m)$$

Where X symbolising different characteristics, such as quality, that can take different levels, such as very high quality, high quality, etc. This is a statistical way of describing a utility function. However, as with all statistical measurements, some degree of error needs to be accounted for. This is where the second element of economic theory comes in, namely the random utility theory. McFadden (1973) distinguished between an observable part (V) and an error part e . Therefore, we would write the utility function as:

$$U=V(X_1...X_m) + e(X_1...X_m)$$

Since choice experiments are experimental, people make a probabilistic choice. If asked to compare projects, g and h, and an individual chooses project g we can write it as:

$$P[(V_g+e_g) > (V_h+e_h)]$$

This means that the fact that g was chosen must mean that the utility (V) is higher for g than for h. This can be re-written as:

$$P[(V_g-V_h) > (e_h-e_g)]$$

This says that the individual will choose g over h if the difference in the observable part (V) of their utilities exceeds the difference in the error parts (e). Assuming this distribution implies that the probability of choosing g over h can be expressed in terms of a logistic distribution, also known as a conditional logit model, it can be written as:

$$\Pr(U_g > U_h) = \frac{\exp(\beta X_g)}{\exp(\beta X_g) + \exp(\beta X_h)}$$

Using a maximum likelihood technique, we can use this conditional logit model to find the beta values that satisfy the above equation. The beta-values are an estimate of the utility (McFadden, 1973).

In terms of structure, choice experiments can either be labelled or unlabelled (Shang & Chandra, 2023). A labelled choice experiment provides different alternatives, each labelled according to an overarching common group. For example, if a person was asked to complete a labelled choice experiment on technology brands, the alternatives could be Apple, Samsung,

and Huawei. These labels can be very influential as people often have a known preference between the alternatives. With this type of choice experiment, the respondent would only be expected to pick one of the three options. This type of choice experiment measures the preference between the provided alternatives. At times choice experiments can be labelled using terms like “Hospital 1, 2, and 3” where the individual will look at what the conditions are under each, but they will still be independent of each other, that is, different hospitals and the individual will have to choose which is their preferred option (Bliemer & Rose, 2014; Shang & Chandra, 2023). The second structure is the unlabelled choice experiment. In this type of choice experiment, usually, one variable is valued based on its various attributes. There are no labels per se, but the attributes are well-defined. The current research is based on this type of unlabelled choice experiment. This is the format used in the choice experiment devised for this study (Appendix A).

1.1.1 Choice Experiments in Research

Previous research on discrete choice experiments shows their application in various research settings such as healthcare (Wange et al., 2021), education (Ahmed et al., 2022), engineering (Cha et al., 2017), psychology (McGrady et al., 2021), environmental economics and sustainability (Doherty et al., 2021; Caputo et al., 2023; Byun et al., 2018; Ghosh et al., 2021), transportation (Baek et al., 2021), technology (Van Rijnsoever et al., 2015; Yang & Hobbs, 2020) and tourism (Boto-Garcia et al., 2022). McFadden used “revealed preferences”, in previous transport studies, to predict the demand for the [Bay Area Rapid Transit](#) (BART) system, a transit system built in San Francisco. Alternatively, Luce and Marley spent many years testing random utility theory in stated preference studies involving psychology students (Luce, 1959; Marley, 1968). This barely scrapes the surface because, from a quick search, it is clear that discrete choice experiments (DCEs) have been used in almost all areas of study. In mining, Que et al., (2023) used a DCE design on case studies of the community’s acceptance of mining projects. In these case studies, they used DCEs to guide them in the process of achieving two objectives. Firstly, they wanted to find the best way of identifying the correct number of factors or attributes to consider when designing a DCE of this nature. The second objective was they wanted to design and validate the DCE that would come out of this process. The first case study began as a focus group session in which they had to fill in a focus group survey. The group was made up of twenty-five individuals but only twenty-two took part in the end. They were given a survey with a demographics section first and then a choice experiment section. Three design choices were shown based on a scenario about the most preferred choice if a new mine was to

open in their area. They were tasked with selecting one, their most preferred alternative out of the three presented to them. Following this they were asked to rate the level of difficulty in answering the survey using a 7-point Likert-type rating scale. The second case study was more technical and used to devise the most appropriate number of factors. This was because in the first case study, participants reported that the more factors they had to assess when making a decision the more complex and mentally draining it became. If anything, this is the key take away from this study. The sample used was small, but it was appropriate for the type of focus group data collection methods they used. Furthermore, the analysis was conducted using statistical software that analysed the level of difficulty and effort. However, as is clear in this study, although the analysis was on mining activity, it was not necessarily directly about the conditions on the ground. The study also may have used a DCE design, but it was largely conducted to analyse and study the process of coming up with the most appropriate DCE. Although it aligns with the intentions of this research in terms of DCE analysis in mining towns, the focus of this study was however only on trying to design the most appropriate DCE and not necessarily on measuring any kind of utility.

In a previous study, Que et al., (2015) used DCEs to measure the mining project characteristics and demographics that influence acceptance of mining projects. Once again, this study located choice experiments in the mining industry, but it is not focused on the same aspects the current research aimed to study. Research of this sort benefits the mine owner who would like to engage in mining projects in the area as they have more information about the local populations' acceptance levels and what determines their acceptance levels. Unlike the focus of the current research, their study was not necessarily to the benefit of the mine-affected community, but to those people who aim to conduct mining activity in a particular area. In Narrei and Ataee-pour's (2021) study, they used DCEs to measure mine-affected community members' preferred social impacts of mining. They tried to measure what people ranked as the best social benefits of mining activity for mining-affected communities. They identified that the social benefits best suited were: the creation of entertainment and new jobs; social well-being; increased amenities; mine life; and income. They then proceeded to use DCEs to identify which of the following would be the one ranked as the most preferred social benefit of mining activity. This was only referring to the positive impacts of mining, so issues related to clean water access were not covered by this study. Yet another study by Que et al. (2019) used DCEs to assess the importance of mine acceptance determinants. Clean water was a part of this study, but not a focus. Furthermore, this was conducted on a sample of individuals from mining communities

in the United States, Turkey, and China. The South African sample in the current research would not be well represented in this study. This is not to say that no research has been done in South Africa on the state of water resources in mining communities. Some research has been done (Verlicchi & Grillini, 2020; Agboola et al., 2020; Barnwell et al., 2020), but no research has specifically used DCEs to investigate preference levels of access to clean water. This is important as it further stresses the importance of conducting this research and building on the existing literature about choice experiments.

1.1.2 The Process of Designing a Choice Set

Choice sets are designed from scratch because they are designed to suit the scenario the researchers aim to measure (Bliemer & Rose, 2014; Atkinson, 2018). The choice experiment designed for the current research contained information specific to water access for mining-affected communities. There is a standard process used to design a choice experiment with several stages that researchers must go through to accurately capture the most important aspects and produce a choice experiment that is well representative of the variable in question. The first stage is to identify the variable that is being measured (Bliemer & Rose, 2014; Atkinson, 2018). This is straightforward and often easy because it is the variable being measured in the study. In this case, water is the variable. The second stage involves some kind of review of literature or experiences that would allow the variables' attributes to be revealed. Some variables only require that the researcher conduct a review of existing literature while others, like in the case of this research, would require a thorough understanding of the experiences of the target population with this variable. This would be necessary so that the researchers understand its various attributes based on how the target population experiences it (Bliemer & Rose, 2014; Atkinson, 2018). For example, the current research identified six key attributes, water quality, water source, water supply frequency, water capacity limit, price, and distance from their home. These are the factors that were revealed to be the most important attributes that influenced community members' decisions as they related to water access. It is usually preferred that one of the attributes be of monetary value such as cost or price. This makes the process of analysis much easier as the willingness to pay estimation can be calculated using this value (Atkinson, 2018). Researchers can often go back and forth between varying numbers of attributes as it not only has to be a valuable attribute for the community but also a valuable attribute for the study. In most cases, it takes a few tries before researchers land on the exact number of attributes they need to fully analyse the variable of the study (Atkinson, 2018).

Once this stage is completed, the attributes are assigned varying levels. This is informed by the data gathered at the previous stage. Any information that can assist in setting the appropriate levels is used, focusing entirely on the context. In the choice experiment used for this study, the varying levels of price came about from gathering information about the highest and lowest prices often paid for water, prices of water of the same quantity in grocery stores in South Africa, and the prices locals said they would pay from different vendors. This led to the conclusion that the levels would be R30/5L, R15/5L, R5/5L, and R1/5L, as these levels best represented the price range most likely expected. The next stage involves the use of statistical design theory to organise the levels of attributes into different scenarios, this is done using statistical software. The products of this stage result in the choice sets constructed in the next stage. These are organised such that the individual sees different scenarios for comparison (Bliemer & Rose, 2014; Atkinson, 2018). These are then presented to the individual and they must compare one scenario with the other(s) provided and decide the one they prefer the most. After several different scenarios have been presented and compared, this allows the researchers to infer what is important to the responders. These responses are recorded and used for analysis. Data collection and data analysis are the final stages. Econometric analysis is used to analyse the data, producing values that are then interpreted.

The current research identified six attributes that are often considered when community members think about access to alternative sources of water.

Quality of Water

This attribute was found to be essential to any research on water services. In Latinopoulos's (2014) study titled 'Using a choice experiment to estimate the social benefits from improved water supply services', water quality was the first attribute assigned due to its perceived importance to the sample population. This demonstrated the need to include it in the current research for the same reason. It was assigned four levels ranging from very high (fit for human consumption, drinkable directly from collection point), high (fit for drinking and cooking only after boiling), medium (neither fit for drinking nor cooking, but can be used for laundry and bathing) and to low (not fit for any domestic use – only for watering gardens or livestock use). It was necessary to state what each level of water can be used for because the quality of water could vary depending on what it will be used for. Furthermore, the monetary attribute, price, would be closely linked to this meaning that most people would prefer to spend less if they do not need the highest quality water.

Water Sources

All the water in the hypothetical scenario would be treated. However, people often have reasons why they would prefer their water source to come from one place over the other. The three levels identified were treated mining wastewater, treated surface water, and treated groundwater. Studies containing a DCE that used this attribute and these levels were not found, however, studies mentioned in the previous sections (Wolkersdorf & Mugova, 2022; Ochieng et al., 2010; Jhariya et al., 2016; Li et al., 2016) do a good job demonstrating that these are the main sources of water in a mining town. The challenges faced by the mines could affect community members' choice as to whether they would prefer treated mining wastewater, furthermore, surface water and groundwater are both prone to contamination and this could cause suspicion about how likely the water can be expected to be clean and safe for drinking.

Water Supply Frequency (availability)

Latinopoulos' (2014) study included the frequency of supply interruptions (availability) as an attribute to understanding the current water situation. Once this was known, as in the current research, changes could be suggested or made in the improved situation that tackles this issue. This refers to how often the community members would be able to collect from the alternative water source. There were six levels of variation under this variable and they ranged from on-demand all the time, once a day, three times a week, two times a week, once a week, and twice a month. This is unfortunately very similar to the reality in the South African context, as highlighted in Cole and Broadhurst's (2022) study on the water conditions in mining towns, especially the poorest ones.

Capacity Limit

This attribute represented the varying amounts each household was allowed to collect. Considering the differences in household composition, it is expected that some would prefer and need more water than others as some households would be accommodating three people while others could have five to seven people. The levels range from no capacity limit, a maximum of 25 litres per person, a maximum of 10 litres per person, to a maximum 5 litres per person. This aims to accommodate larger families and is by nature guided by the cost with lower limits costing more and high limits costing less.

Price

A monetary value was essential as this is commonly found in a choice experiment. It assists analysts to derive estimates that can be used when making cost-benefit analysis (Holmes et al.,

2017). This is the value that helps to measure willingness to pay and it is found in almost all DCE's. Alcon et al. (2014) used it in their study 'Adoption of irrigation water policies to guarantee water supply: A choice experiment' to measure a change in preference in response to a change in price, Dauda et al. (2014) used it in their study on 'Household's willingness to pay for heterogeneous attributes of drinking water quality and services improvement: an application of choice experiment' as the water bill price and Li et al. (2024) used it in their study 'Assessing the impact of farmers willingness to pay on different cultivated land attribute levels in China: an empirical analysis using the choice experiment method' as payment method. In this study, that value was the price of water which ranged from R30 per 5 litres, R15 per 5 litres, R5 per 5 litres to R1 per 5 litres.

Distance

This is necessary as in these situations the alternative water source may not always be central to all in the community, and walking some distance would be another factor that could potentially influence a person's final decision. Hanley et al. (1998) conducted a study titled 'Using choice experiments to value the environment.', in which they used distance as an attribute labelled distance from home to the hunting area. They knew this was essential in the study as it possessed the potential to influence decisions, in the same way distance did in the current study. The levels are in or just outside your home, up to 200 meters away, up to 400 meters away, up to 1 kilometre away, up to 2,5 kilometres away, and lastly up to 5 kilometres away. These make up the attributes that were decided to be the most influential when it comes to the final choices made by the members of the mining-affected communities in this study.

Therefore, although there is research on utility theory, discrete choice experiments, mining-affected communities, and clean water access, and there are studies that combine some of these into one, a study that combines these four aspects has not yet been conducted. The state of water in mining towns is detrimental to health and researchers must continue to shed light on the issue. There is an element of agency that is robbed from members of such communities when their water sources must be shared with large organisations designed for profit, or when the activities of these organisations result in the contamination of the community members' water. This is unfair and sets the country back as a whole. A more just approach would involve giving these individuals agency to choose which water alternatives best meet their needs. The mining industry in South Africa is a billion-dollar industry, and it has been the reason for the development in a lot of countries including South Africa, so it would be naïve to think that sustainability and health challenges would affect them so much that they would stop all

operations (Statistics South Africa, 2022). This is precisely why this study aims to assess choice and provide a means through which mining-affected community members' challenges can be voiced. This study will take a participant-centered approach in that the focus will be on their preferences for their benefit. Going back to the South African government's National Development Plan (NDP) (NPC, 2011), if such a water system was put into place, it would be entirely centred on the community members and their preferences for water access and it would serve the needs of those who are having to make do with conditions that are opposite to what was promised to them.

1.1.3 Aims

The aim of the current research was therefore to empirically identify the most and least valuable attributes in water access as reported by members of mining-affected communities using a discrete choice experiment.

1.1.4 Rationale

As established members of mining-affected communities are continuously subjected to changes in their water quality, and accessibility issues as water is not always available, they often must travel to find clean water, and at times these alternative sources come with an additional cost. This is unfair to them and affects their quality of life. If clean water alternatives can be devised for these communities, providers must develop an understanding of which attributes are most influential in determining what community members are willing to pay to access these alternatives. This research was important because it used utility theory and choice experiments which helped to understand the value of each of the attributes of water. They assisted in demonstrating these preferences as reported by the individuals of mining-affected communities, who live with the daily experience of inaccessibility to clean water.

1.1.5 Research Questions

The following research questions were addressed:

1. What was the most preferred level for each attribute?
2. Which attribute had the highest level of variability?
3. Was water quality the most significant attribute in each community?
4. Was water quality perceived as more important than water availability?

Chapter 2: Methods

2.1 Introduction

This chapter provides a detailed description of the methods employed in this study. It begins with the research design, followed by the procedure, which details the data collection process. The sample and the sampling strategy will be discussed along with the instrument used to collect data. Finally, the key ethical considerations relating to this research will be addressed and an analysis section will provide insight into how the results were derived.

2.2 Research Design

The research design employed was a quantitative descriptive correlational design. It used a descriptive design to analyse the preferences reported in the choice experiments. This situates it in the positivist paradigm as the study made use of measurements and observations (Pawar, 2020; Rahi, 2017). The research reported patterns and frequencies. This was best suited to provide statistically reliable results that helped to achieve the objectives and answer the research questions as well as to be able to make conclusions that demonstrated the theory in practice (Pawar, 2020). It was a cross-sectional design because there was only one administration of the survey for each participant. This method could be limiting in that the analysis was affected by the passage of time. Furthermore, cross-sectional studies cannot accurately infer causality, but it was the most practical considering this quantitative research aimed to get as many participants as possible and not necessarily to identify causal relationships (Pawar, 2020; Rahi, 2017).

The independent variables in this research were the six attributes used to describe water, namely; water quality, water availability, water sources, capacity limit, distance, and price. These were independent variables because they varied across each choice scenario provided to the participants. The dependent variable in this study was the choice outcome, this was the final choice made after comparing the different scenarios in each choice set. These were considered the dependent variables because they were influenced by the level of the independent variables, that is, the attributes presented in each choice set determined the choice that was made (Marudhar, 2019). In terms of causal claims, the attributes were presented to participants first, then they made a choice based on these, so it is safe to say that temporal precedence was established. Covariation was also achieved based on this because there is a clear correlation between the varying attributes presented and the choices participants made. Manipulation occurred because each of the choice scenarios was intentionally altered. Each choice set

differed to make observing the influence of attributes easier. However, there was no control group which is another way of establishing covariation. Furthermore, because all participants formed part of the experimental group, there was therefore no random assignment. As a result, the current research had a weaker level of covariation than a true experimental design and no comparison group, so it can therefore be seen as a non-experimental design (Stern, 2021; Marudhar, 2019). This conclusion was not necessarily a limitation because the current research simply aimed to describe the most and least influential attributes, as well as observe correlations between demographic statistics and the choices made.

2.3 Procedure

The attributes used in the DCE were derived from three focus group discussions with 30 participants in total who were members of mining-affected communities. This focus group data was collected in a prior study. Focus group participants consented to be a part of the discussions as they understood that they had a better understanding of what aspects to consider when designing a survey about water access and provision in mining-affected communities. The research team deliberated over the most important aspects to include as it relates to water eventually deciding on the previously mentioned six attributes. Further deliberation occurred in these focus group discussions and in conversations among the research team to decide on the most representative levels of each attribute. The idea was that each attribute had to contain levels that mimicked the reality of the situation on the ground. Once the attributes and levels were decided on, the researchers went about creating icons for the three attributes, water quality, water sources, and water availability. These were generated using AI technology, with colours to demonstrate the water quality levels. The images were also designed to remind the participant of how that level can be used. For example, the blue icon showed a child drinking the water, demonstrating that this level was clean enough for drinking.

After this stage, the DCE was designed, and to be as thorough as possible, another focus group discussion was organised. This time, the focus group was arranged with experts in mining-affected communities, to determine whether the final draft of the survey would be understandable, did not contain any contextual bias, and addressed the water challenges accurately. This focus group discussion was conducted with six senior members of the NGO Mining-affected Communities United in Action (MACUA). MACUA is a non-profit organisation that works to build solidarity among those affected by mining activities, by collectively giving them a voice to advocate for their rights which are often infringed on by mining activity (Mining Affected Communities United in Action [MACUA], n.d.). They

provided insights into changes that needed to be made along with information on how members from these communities would understand some of the questions to be posed. They stressed a need to remain respectful of communities and their members, to remain as clear as possible about the fact that these choice scenarios were hypothetical and this study would not immediately result in the implementation of an alternative water system, and the need to be learners as community members living with these water struggles daily and knew more than the researchers. After a lengthy discussion, the survey was emailed to MACUA for final contributions and the changes they identified were addressed.

Before the distribution of the surveys could commence, it was necessary to once again receive community members' input and approval. This was done during the training of the enumerators who would assist with data collection. For clarity, the reason this study approached MACUA is because volunteers were required to distribute the surveys. MACUA worked with mining-affected communities, so they had access to a network of volunteers and branches in each of the mining communities included in this study. These volunteers were members of these communities, and they would require training for them to understand how to administer the survey to members in their communities. Once ethics approval was granted, the first day of training occurred in the community of Phola. MACUA assigned enumerators to assist in the collection of surveys in this community, and they also became the pilot test samples during these training sessions. The training sessions would begin with formal introductions of every person in the room, followed by a detailed explanation about the purpose of the study and what the survey aimed to investigate. It was required, as advised by MACUA, that the enumerators understood that this was a university research study with no political affiliations or agendas. The survey was explained in detail to assist the enumerators in understanding what they would be required to do. Simultaneously, they provided their responses to each question which formed the data for the pilot test. This training occurred on a Monday from 10 am to 3 pm in their communities. This was the same process that was followed in the two other data collection sites in Emalahleni and the Dannhauser Local Municipality (DLM).

Once training was complete the enumerators conducted a 3-day data collection process going from door to door in their communities. There were 25 enumerators in Phola, 22 in Emalahleni, and 28 in DLM. MACUA divided the communities based on coverage and feasibility (i.e., whether there were enumerators who were familiar with the area). Phola was divided into four quarters and enumerators were distributed between these. Emalahleni was split into two sections and these sections had wards and enumerators were further divided based on these.

Those who lived in those wards were encouraged to collect in areas where they lived to ensure familiarity approaching members' homes. DLM was also split between the area names and the same process as Emalahleni was employed for safety and familiarity. They went door to door and collected responses from community members. They were encouraged to randomise the choice sets they had, to make the data more reliable; they were also encouraged to stress that participation was voluntary, and they had to ensure to go in pairs in the interests of safety.

A few changes had to be made after the pilot test in Phola, mainly some wording and a few adjustments to the DCE design. As is evident in the results chapter, some additional questions were asked in the last two communities. Other than that, these participants were asked to complete all sections of the survey, and data collection stopped after three days. Once this was achieved, the data collection process in the communities was concluded. The surveys were collected from MACUA's offices and all hard-copy surveys were transported to a private residence. This was a secure location that was locked when left unattended, no unauthorised personnel gained access to the data. It was immediately converted to a digital version which was kept in a secure and locked private laptop, and distributed only to members of the research team for analysis to be conducted on the data. A feedback session was conducted in each community to confirm the results that came up in the analysis. Furthermore, each feedback session resulted in the collection of a sample of water from regularly accessed sources. This was then sent to a lab for testing to assess its quality and if it contained any contaminants. The results of these tests were positive, and the water was reported to be clean enough for drinking. This information was communicated to MACUA who were responsible for informing the communities.

2.4 Sampling Strategy

The sampling strategies used were non-probability purposive sampling as well as convenience sampling. Non-probability sampling comes with the potential for selection bias, thus there was an attempt to collect from different communities (Turner, 2020). Furthermore, a stratified sampling approach was proposed by MACUA as a randomising technique for data collection. The sampling areas were divided, and the enumerators were distributed according to this division. A purposive strategy was used as participants were selected because they resided in these mining-affected communities. By nature, this method was biased toward certain groups which was the reason for its use as this research relied on those who resided in the three mining-affected communities. The fact that they lived in mining-affected communities made them

experts on the challenges of water provision in these settings and therefore they were better able to make decisions based on lived experience (Turner, 2020).

A convenience sampling strategy was applied as participation was voluntary and based on which community members were available, accessible, and willing to participate at the time of data collection. This could also result in selection bias as those who have jobs were likely not available at the time. This was a possible non-response bias because working individuals who were not home were excluded from the study (Turner, 2020). Access to the sample was acquired through MACUA's close contact with the members of these mining-affected communities. They provided 25 enumerators in Phola, 21 in Emalahleni, and 27 in DLM who were responsible for the administration and collection of surveys. A potential bias here could be that there is no way of knowing if the enumerators did not fill in some surveys on their own to get it over and done with. Response bias could have occurred, perhaps the enumerators could have implied some of their views while asking the questions, which may have swayed the answer in the same direction (Kundu et al., 2021; Turner, 2020).

2.5 Sample/Participants

The sample consisted of adult members of mining-affected communities. More specifically, individuals who resided in the mining towns of Phola, Emalahleni, and DLM. Verbal consent was provided, and participants were informed that participation was voluntary, and they could withdraw at any point. The inclusion criterion was that participants had to live in one of the three mining-affected communities. Exclusion criteria were therefore the opposite of this because the aim was to acquire an expert sample that had a lived experience in these communities. The aim was to get as large a sample as possible because quantitative research allows for the analysis of large sums of data (Pawar, 2020; Rahi, 2017). From Phola, 208 surveys were collected but 13 were excluded, therefore 195 survey responses were collected. From Emalahleni 233 surveys were collected but 16 were excluded due to missing data therefore, 217 responses were collected, and from DLM 279 surveys were collected but only 272 included valid data. Initially, the idea had been to achieve 200 to 300 participants which was surpassed as the total was 684 surveys. Thirty-six were invalid responses that were excluded from the data since less than 50% of the questions in the survey were answered.

The demographics of the sample differed from community to community. In Phola, there was an uneven gender distribution with a large sample of women and much fewer men. There were 70 male respondents and 121 female respondents. The remaining 4 participants did not indicate

their gender. As for age, the participants from this mining-affected community reported a range of between 21 years old and 75 years old. This is shown in table 1:

Table 1

Demographic Characteristics of Phola Sample

Characteristic	Descriptive Statistics
Sample size	195
Age Range	21 Years Old – 75 Years Old
Gender	
Male	70 (36.6%)
Female	121 (63.4%)
Number Of Adults Per Household (Range)	1 – 13
Number Of Children Per Household (Range)	2 – 10
Number Of Years Living in Phola	1 year – 72 years

In Emalahleni, the sample had a similar gender distribution with 100 women and 103 men, but 14 people did not indicate their gender. They ranged in age between 18 years old to 85 years old and most of the respondents resided in households occupied by at least two people. Table 2 shows this:

Table 2*Demographic Characteristics of Emalahleni Sample*

Characteristics	Descriptive Statistics
Sample size	217
Age Range	18 Years Old – 85 Years Old
Gender	
Male	103 (50.7%)
Female	100 (49.3%)
Number Of Adults Per Household (Range)	1 – 14
Number Of Children Per Household (Range)	0 – 11
Number Of Years Living in Phola	1 year – 60 years

In DLM, there were 109 males and 153 females, meaning more women were sampled than men. 10 participants did not report their gender. The age ranged from 18 to 76 years of age and some residents have lived in this community for over 50 years. Table 3 shows these details and more, below:

Table 3*Demographic Characteristics of Dannhauser Local Municipality Sample*

Characteristics	Descriptive Statistics
Sample size	272
Age Range	18 Years Old – 76 Years Old
Gender	
Male	109 (41.6%)
Female	153 (53.4%)
Number Of Adults Per Household (Range)	1 – 23
Number Of Children Per Household (Range)	0 – 46
Number Of Years Living in Phola	1 year – 66 years

Phola's population reported a lower educational level than Emalahleni as it had an educational distribution of 3 higher certificates and 1 diploma, with the rest of the individuals falling below this. Whereas this differed in Emalahleni and DLM, as shown in table 4:

Table 4*Highest Qualification Obtained*

Qualification	DLM	Phola	Emalahleni
Grade 9 & below	49	9	78
Grade 10	36	54	37
Grade 11	54	78	28
Grade 12	87	156	49
Higher Certificate	23	6	7
Diploma	8	4	2
Undergraduate degree	3	0	1
Postgraduate degree	4	0	0

In terms of employment status, about 47% of the responses indicated that participants in Phola were never employed, the remaining responses were distributed between almost never, a few times and month, almost every day, and every day. Only 10% of the responses indicated having a job every day. In Emalahleni, the number of unemployed participants was ever greater. Of a sample of 205 responses to this question, 118 reported never having a job and only 14 reported having a job daily. In DLM 254 responses were provided and of these 128, which is 50%, reported never having a job. These responses are shown in table 5:

Table 5*Employment Status*

Employment Status	DLM	Phola	Emalahleni
Everyday	44	21	14
Almost everyday	23	17	5
A few times a month	41	26	41
Almost never	18	38	27
Never	128	92	118

2.6 Instruments

One survey was administered as the instrument for this research. It was designed by the researchers for this study as there was no existing version of this instrument. It will be referred to as the Water Survey. The survey measures four different aspects. Firstly, it sought to understand the current situation about water in a mining-affected community by asking who was responsible for water collection and how much water was consumed daily. It also asked questions about current water availability, secondary and primary water sources, distance, and quality of the water. Secondly, it presented participants with hypothetical alternative water systems in a choice experiment to explore the changes in participants' choice outcomes when the six water variables were manipulated. Six different scenarios were shown to each participant out of a possible 12 scenarios. This is shown in the second section of the survey in appendix A an extract from the survey is provided below for illustration purposes:

Please consider the choice as a new situation independent from the previous choice.

Attributes	Project 1	Project 2	Current situation
Quality of the water	Low 	Medium 	
Availability	Available once a day 	Available less than once a week 	
Source of water	Treated groundwater 	Treated surface water 	
Quota	max 25 liters	max 5 liters	
Distance from your home	Less than 1 km	Less than 400m	
Price	R 0/5L	R 15/5L	
Mark the preferred option (x)			

Figure 1: Survey extract from Appendix A

The respondents were shown different scenarios in which they had to choose between project 1, project 2, or an alternative 3 for the current situation. Project 1 and 2 displayed varying levels across each attribute as shown in Appendix A, while the “current situation” referred to the answers they provided in the introduction questions, in other words, the water situation currently in their communities. This was done to provide them with hypothetical examples of alternative water situations for them to pick their most preferred option. The water survey also asked questions about survey difficulty and assessed the participant’s beliefs about the agency to run an alternative system, trust in their capabilities, and preferred sources and providers of water. The last section was the demographic section which asked questions about age, gender, and employment status among other things.

Structurally, it was divided into sections: the introduction questions; the choice experiment; the debriefing section; and the demographic section. The introduction questions were in a short answer, self-report format with questions that gave background information about the participants. Some example questions included “how much water do you use per week?” and “how does your current primary water look/taste/smell?”. The choice experiment contained two projects and a current situation box. Each project presented contained the six attributes of water, that is, quality, sources, availability, distance, capacity limit, and price, but they varied in each project. Participants would indicate which project they chose between projects 1, and 2 and the current situation (which was the state of water in their community), by ticking a box on the answer sheet. This section of the survey was a close-ended and self-report (Rahi, 2017). For each of these variables, specific levels were devised beginning with the quality of water which gave participants a choice ranging from the ‘best (for human consumption, directly drinkable)’ to the ‘worst (watering plants, feeding livestock)’. The second attribute was availability which had five levels ranging from ‘available on demand all the time’ to ‘available less than once a week’. Sources of water ranged from ‘treated mining wastewater’ to ‘treated ground water’. The limit, which represented the capacity limit, ranged from ‘no limit’ to ‘maximum 5 litres per person when collecting’. The fifth attribute was price which ranged from ‘R30/5 litres’ to ‘R1/5 litres’. Finally, distance from your home was assessed and this ranged from ‘in or just outside your home’ to ‘less than 5 kilometres’.

The debriefing survey was the second last section of the survey. It contained debriefing questions that could capture more about the motivations behind the choices made in the choice experiment. Some example questions included “How likely do you think it is, that the community will improve your access to water through the proposed project?” and “Did you

find it difficult to make choices between the different schemes?”. Initially, there were seven of these but after data collection in Phola, two more questions were added. The final version of the survey contained nine questions and they were a combination of short answers and closed-ended answers. Some questions in the debriefing section ranged from 4, 5-, 6-, 7-, and 13-point Likert-type response formats. The high scores and low scores varied in meaning for each question because they all measured different aspects and some were answered by putting an ‘x’ or a tick in the box, so this could not be inferred. As mentioned before, there was a short demographic section to conclude. This section asked questions like “How often do you have a job?” and “How old are you (years)?”. There were seven questions in this section and four required short answers while the remaining three provided boxes to tick or mark with an ‘x’. A version of this survey can be seen under the Appendices (appendix A).

The Water Survey was a new instrument that did not have any established reliability or validity scores. However, this instrument was designed based on contextual information from members of mining-affected communities and from MACUA, an organisation that regularly designs surveys for these communities. These groups can both be regarded as experts and so they helped to infer validity by making sure that there was clear consistency and relevance of items. This also ensured that the instrument remained culturally relevant because the survey was designed for the South African population group that resided in these communities. In terms of validity, face and content validity could be inferred by looking at the items in each section of the survey, they were all aligned logically with the sample and study. While these steps were taken to infer reliability and validity, statistical measures would still be a stronger indication, this will be discussed in the limitations section of the current research (Taherdoost, 2016).

2.7 Ethical Considerations

The data collected in this research came from a human participant sample. As a result, an ethics form was filled in and submitted to the school of the Human and Community Development Ethics Committee constituted under the University Human Research Ethics Committee for approval. This was approved with the protocol number MAORG-24-01 (Appendix B). This sample was not classified as a vulnerable group and the risk level was set to minimal risk. They did not encounter any form of psychological, physical, or emotional triggers from participation in this study (Roberts & Allen, 2015; Chenneville, & Schwartz-Mette, 2020). Informed consent was acquired at all necessary points in this research. Respect for each participant was observed as voluntary participation was stressed in the participation information sheet. Enumerators were encouraged to not force anyone to take part in the survey if they did not want to (Roberts

& Allen, 2015; Chenneville, & Schwartz-Mette, 2020). There was no harm brought to the participants from this study, and there were no immediate benefits.

The current research project involved conducting a survey that could have raised certain expectations among participants about the implementation of an alternative water system in their communities. However, no water system would be implemented at this stage of the project, and this was explicitly communicated to the participants. It was asked that they communicate this to the community members during the door-to-door process of data collection, and during feedback to the community, this was reiterated. Anonymity was observed because, although the choice experiment was administered in person, this was done by the enumerators. MACUA enumerators were responsible for the process of data collection, so no member of the research team knew who answered each survey. Confidentiality was observed as there was no participant identifying information, such as identification numbers or names and surnames, only the enumerators' name was placed on each survey to track the number of surveys they completed (Roberts & Allen, 2015; Chenneville, & Schwartz-Mette, 2020). Survey numbers were used to track every participant's response. These were then manually captured onto a private laptop which was password protected and access to this data was limited to only the members of the research team. Only group data were reported so no individual response could be identified.

It is necessary to speak about comprehension considering the survey was content-heavy. Since the survey was administered in person, any questions and clarifications on things the participants did not understand were answered by the trained MACUA enumerators. It was emphasised that any questions that could not be answered by enumerators were brought to the researchers so that they did not affect the data to be collected. Luckily, no questions of this sort came up and the data collection went smoothly. In addition, the cultural diversity of the volunteers from MACUA allowed for language accommodations in these areas where the majority of the people spoke a South African language other than English (Roberts & Allen, 2015; Chenneville, & Schwartz-Mette, 2020).

2.8 Data Analysis

The research employed quantitative techniques, analysing discrete choice experiments using RStudio, a statistical software program (Hensher et al., 2005). Data was collected through hard-copy surveys and manually transcribed into a Microsoft Excel spreadsheet for digital storage and analysis. The initial process involved cleaning the data by removing any participants who

did not provide at least 50% of the information required. For the choice experiment data, custom scripts were designed, and functions were used to assign values to the different attributes in the study. This allowed for estimates to be generated that showed how different levels were perceived by participants as utility maximising or not. To compare the preferences at each level of the attributes, dummy variables were used, as a comparison baseline (Hensher et al., 2005). Statistical significance was assessed using t-ratios, with a threshold of 1.96 for significance at the 95% confidence level. In the results generated from these analyses, the signs of the attribute estimates were indicators of perceived utility with positive signs (no sign) reflecting increased utility and negative signs (minus sign) reflecting decreased utility (Edwards, 1962). These results were generated into tables, which will be explained in the next chapter.

Chapter 3: Results

3.1 Introduction

In this chapter, results after analysis of the surveys are provided. This section is separated into each part of the survey to effectively report the results found. It will begin with the introduction section, followed by the choice experiment analysis, and lastly, the debriefing questions. In each section, all three communities, Phola, Emalahleni, and Dannhauser Local Municipality, were compared, and significant results will be reported. This comparison was made bearing in mind that they may have all been coal mining towns, but their water access conditions differed as did their populations and their geographical locations.

3.2 Introduction Questions

The results of the survey were analysed in three different sections. The first analysis was conducted on the introductory questions section of the survey by simply summarising this data. The first introduction question aimed to gauge how much water community members used and had access to daily. A summary of the results found in all three communities on the Total Water Usage question, **“How much water does your household use per day on a normal day? (in litres)”** was provided.

These figures were calculated using a range to show the maximum and the minimum amounts reported per community, the mode showed the most popular answer given and the mean showed the average amount of water consumed daily in each community. A final column was provided with some outliers found in the data, as some communities reported abnormally high or low amounts, these were separated to avoid distorting the average and these will be accounted for in the next chapter. Table 6 is detailed below:

Table 6*Total Water Usage per day (in litres)*

Community	Maximum	Minimum	Mode	Mean	Outliers (excluded)
How much water does your household use per day on a normal day? (in litres)					
Phola	1500	15	80	119	4 10000
Emalahleni	225	10	80	79	5 (3)
Dannhauser Local Municipality	2000	10	80	108	8000 (3) 10000

DLM had the highest water usage daily, with a maximum of 2000 litres, this was also accompanied by three reports of 8000 litres used daily and one of 10000 litres. Phola followed with a maximum of 1500 litres and two outliers, one of 4 litres and another of 10000 litres. Emalahleni reported the lowest usage with a maximum of 225 and the outliers were only low amounts, with three participants reporting using 5 litres daily. Some of these highest outliers can be interpreted as coming from clinics or schools that were sampled by the enumerators. Removing them was essential to avoid distorting the mean, but also because organisations were not necessarily part of the target sample, and this will be addressed further in the limitations chapter.

As established, piped water was not always accessible in these communities, so the next question assessed who was responsible for water collection. This included gauging who had the primary responsibility and when they were absent, who had the secondary responsibility.

Table 7 shows the top five most popular answers provided in each instance:

Table 7*Water Collection Responsibility*

Community	Responsibility	Frequencies
Who is responsible for making sure the household has water?		
Primary		
Phola	Mothers, fathers, sons, everyone & grandmothers.	86%
Emalahleni	Mothers, myself, fathers, everyone & sons.	85%
Dannhauser Local Municipality	Mothers, everyone, children, fathers & brothers.	88%
Secondary		
Phola	Mothers, fathers, sons, daughters & sisters.	100%
Emalahleni	Mothers, fathers, brothers, daughters & myself.	92%
Dannhauser Local Municipality	Children, mothers, brothers & daughters.	100%

Note: Frequencies represent the percentage of respondents within each community who selected the five most common individuals responsible for household water collection.

Mothers were reported to be primarily responsible for water collection in both primary and secondary cases. It was often an adult's responsibility to collect water for the household but when they were not available, children would be required to assist. In DLM, the secondary responsibility was on children first. Some elderly residents also had to collect water as seen in the primary group for Phola, grandmothers were the fifth most popular answer reported by the participants. It was necessary to understand where community members got their water from. Table 8 shows the top 3 main primary and secondary sources reported to be used by members of all three mining towns. The percentages do not total 100% because they are based on the three most popular answers, meaning the remaining percentage of the sample chose other sources.

Phola and DLM reported the tap/hose outside the house as the main primary source, with 69% responses in DLM and 49% in Phola. However, Emalahleni displayed a different picture, they were the community that struggled the most as their most popular primary source according to 35% of the responses from this community was the truck that would come with water for the community or a water tank. These are traditionally secondary sources, but a large percentage of this community relied on them as primary sources. Granted, the second most popular source was the communal tap with a 1% difference, however, it is still not a traditional primary source like the tap inside the house or the tap just outside the house. An important element to note is that none of these communities reported the tap inside the house as a reliable source of water. This would typically be the first source of water in Phola and DLM.

Table 8*Primary and Secondary Water Sources*

Community	Main Sources of Water	Sample Percentage (%)
What are your primary/secondary sources of water?		
Primary		
Phola	Tap/Hose Outside the House	49%
	Tap Inside the House	42%
	Communal Tap	4%
Emalahleni	Other (truck/water bowser)	35%
	Communal Tap	34%
	Tap/Hose Outside the House	16%
Dannhauser Local Municipality	Tap/Hose outside the House	69%
	Communal Tap	15%
	Tap Inside the House	12%
Secondary		
Phola	Neighbour(s) (without cost)	29%
	Other (tank)	16%
	River/Dam	13%
Emalahleni	Communal Tap	33%
	Other (tank)	17%
	River/Dam	13%
Dannhauser Local Municipality	Communal Tap	38%
	Neighbour(s) (without cost)	30%
	Other (truck/tank)	11%

In terms of the secondary sources, 29% of the participants in Phola reported accessing water from their neighbours without any additional cost, while 33% of the participants in Emalahleni and 38% of those in DLM reported the communal tap as the most popular secondary source.

Seeing as the tap inside the house was not a reliable source, distance became a factor in the study. A question was posed about the distance participants had to travel to gain access to the

primary and secondary sources of water. The question “**How far is the primary/secondary water source?**” was posed.

As in Table 8, various options were provided, but table 9 shows the top three highest reported distances.

Table 9

Distance to Water Sources

Community	Distance	Sample Percentage (%)
How far is the primary/secondary water source?		
Primary		
Phola	Just Outside the House	54%
	Inside the House	22%
	500 meters away	11%
Emalahleni	Within a few 100 meters	27%
	500 meters away	24%
	Just Outside the House	20%
Dannhauser Local Municipality	Just Outside the House	56%
	Within a few 100 meters	22%
	1 kilometer away	7%
Secondary		
Phola	Within a few 100 meters	45%
	500 meters away	13%
	Other	13%
Emalahleni	1 kilometer away	27%
	500 meters away	21%
	More than 2 kilometers away	16%
Dannhauser Local Municipality	500 meters away	23%
	Within a few 100 meters	19%
	1 kilometer away	15%

The results displayed here are consistent with those reported in table 8. In Phola and DLM, the most reported distance was just outside the house, 54% and 56% respectively. This makes sense

considering the most common primary source was the tap/hose outside the house. The same goes for Emalahleni where 27% of the participants reported the source being within a few 100 meters. This seems consistent with the fact that this source is a truck, tank, or communal tap. In terms of secondary sources, all three communities reported different distances, 45% of the Phola participants reported that their secondary source was within 100 meters of them, 27% of Emalahleni participants reported that their secondary source was 1 kilometre away from them and 23% of DLM participants reported that their secondary source was 500 meters away from them.

The next question asked was “**How often do you have access to the primary/secondary water source?**”. It was important to ask questions about the availability of water from primary and secondary sources.

Table 10 presents this information for the three communities:

Table 10

Access Level to Primary and Secondary Sources

Access Level	Phola	Emalahleni	Dannhauser Municipality	Local
How often do you have access to the primary/secondary water source?				
Primary Sources				
All the time	23%	3%	18%	
Every day but not all the time	36%	3%	45%	
A few times per week	32%	29%	17%	
Every second day	2%	7%	2%	
Once a week	3%	56%	11%	
Less than once a week	4%	2%	7%	
Secondary Sources				
All the time	28%	13%	18%	
Every day but not all the time	29%	14%	29%	
A few times per week	14%	40%	14%	
Every second day	6%	1%	3%	
Once a week	17%	23%	14%	
Less than once a week	6%	9%	22%	

In this section, each of the three communities differed in their reported water availability levels. For the participants from Phola, water from primary water sources was reported to be available every day but not all the time for 36% of the respondents. 32% of the responses indicated that the water from primary sources would be available a few times per week. However, in Emalahleni, 56% of the respondents indicated that the water from these sources was only available once a week, and in DLM, 45% of the respondents described the water from these sources as available every day but not all the time.

In terms of the secondary sources, Phola participants reported that in 29% of the cases, water was available every day but not all the time. It was interesting to note that the next most popular response was all the time, which was reported by 28% of the Phola participants on this question. Their secondary sources seemed to be more reliable than Emalahleni where 40% of the participants reported the secondary water sources as only available a few times a week and the next best option was the 23% reported as once a week. DLM was in a slightly better position but not as good as Phola with 29% of the responses indicating the secondary water source availability as every day but not all the time, however, 22% reported that the water was available less than once a week. Once the water frequency was assessed, the distance and availability were established, as well as who was responsible for water collection, the quality was assessed. To do this, participants were asked to describe the look, taste, and smell of primary water sources. There were more unfavourable responses than favourable ones.

Table 11 summarises all responses provided across all communities for both primary and secondary sources of water. The three communities provided similar responses, so these responses were combined in the table. Each section shows the negative responses and the positive responses. There were no differences across the communities, most negative responses ranged from dirty, to bad, to a colour like red, brown, or green to dusty or rusty. Positive responses were also the same, clean, good, normal, no taste or smell, pure, still, or fresh. These differences were the same across communities and primary and secondary sources in each community.

Table 11*Primary/Secondary Water Look, Taste & Smell Descriptions in Phola, Emalahleni and DLM*

Community	Descriptions
How does the primary/secondary water source look, taste and smell?	
Primary	
Look	Negative: Brown, yellow, dirty, muddy, white, bad, jik, worms, cloudy, grey, red, black, milky, dusty, rusty, dark, creamy, poor. Positive: Clean, good, normal.
Taste	Negative: Bitter, dusty, bad, salty, muddy, sour, undrinkable, jik, rusty, aftertaste, fishy, milky, chlorine, sewage, chemical, dirty, soapy, abnormal, sour, rusty, bitter. Positive: No taste, normal, good, clean.
Smell	Negative: Jik, bad, muddy, lake, fishy, sewage, dusty, chemical, rusty, salty, soil, oil. Positive: No smell, good, pure, clean, normal.
Secondary	
Look	Negative: Brownish, yellowish, bad, dirty, reddish, dusty, urine, jik, green apple, muddy, dark, terrible, coffee, white, gold, milky, creamy, chemicals. Positive: Good, normal, still, clean, clear
Taste	Negative: Dusty, bitter, bad, salty, muddy, fishy, jik, acidic, rusty, sewage, sour, chlorine, soapy, chemical, rusty, chemicals, milky. Positive: No taste, good, normal, fresh, nice.
Smell	Negative: Jik, bad, fishy, chemicals, dusty, muddy, grassy, sour, salty, sewage, rusty, smells after storage, copper, chemicals, dirty, oil, coal, rusty. Positive: No smell, good, normal, clean, fresh.

This was the final question in the introductory section of the survey, following was the choice experiment which will be explained in more detail in the next section.

3.3 Choice Experiment

Quantitative analysis using the Apollo package written for R was conducted in the choice experiment section of the survey. The sample was asked to answer the choice experiment which was the second section of the survey, and the results can be seen in Tables 12, 13, and 14.

R generated final tables with the estimates and the t ratios. If an item was statically significant it had to have a t ratio value above 1.96. Estimates reflected either positive (no sign) or negative (minus sign), these implied an increase or a decrease in perceived utility, respectively.

The following table shows the results of the choice experiments collected in Phola.

Table 12

Choice Analysis of Preferences in Phola

Estimates					
	Estimate	s.e	t. ratio	rob. s.e	rob. t. ratio
Current Situation	2.51	0.29	8.75	0.35	7.19
Water Quality	0.64	0.06	10.73	0.07	9.20
Ground Water	0.27	0.16	1.68	0.15	1.84
Mine Water	0.35	0.15	2.38	0.13	2.77
Availability	0.16	0.04	3.81	0.04	3.76
Capacity Limit	-0.00	0.00	-0.94	0.00	-0.89
Distance	-7.39	4.30	-1.72	4.15	-1.82
Price	-0.04	0.01	-5.20	0.01	-5.07

The estimated model includes an alternative specific constant (asc), that takes the value 1 for the current situation. It is labelled the current situation as it represents the utility of the current situation with an estimate of 2.51 and a t ratio of 8.75. This figure was significant large and positive, which communicates that participants had a significant positive utility for the current situation. The variable describing the quality of water ranges from 1 (low, can be used for irrigation and livestock) to 4 (very high, directly drinkable). The parameter water quality is an estimate of the utility related to water quality and is estimated at 0.64 with a t. ratio of 10.73. This indicated the significant positive utility of every quality step.

The source of water could vary between groundwater, mine water, and surface water, all treated for the right purpose. The values for ground water and mine water are parameters for the utility related to the source and were analysed in comparison to surface water as all were

coded as dummy variables to compare the three source levels. The estimates for ground water and mine water were both positive at 0.27 and 0.35 respectively and their t ratios indicated significance, at 1.68 and 3.39, respectively. The estimate values showed a preference for mine water over ground water as this had a higher estimate value. Availability was positive and significant at an estimate of 0.16 and a t ratio of 3.81. The higher the level of availability of water the higher positive utility was perceived.

However, the capacity limit differed. When analysed the capacity limit came up as negative and non-significant at a t ratio of -0.94 and an estimate of -0.00. This meant that an increase in the capacity limit resulted in an increased negative utility. The lack of significance meant that this utility estimate could not be estimated significantly different from zero which may mean that it did not matter to participants.

The last two attributes came up as negative too. This was expected, unlike the capacity limit. The distance and price were reported as, a distance estimate of -7.39 with a significant t ratio of -1.72 and a price estimate of -0.04 with a significant t ratio of -5.20. This implies that respondents experience a disutility of walking further for water and a disutility of paying higher prices for water which is in line with our initial expectations.

Table 13 details the results of the choice experiments conducted in Emalahleni.

Table 13

Choice Analysis of Preferences in Emalahleni

Estimates					
	Estimate	s.e	t. ratio	Rob. s.e	Rob. T. Ratio
Current Situation	2.90	0.14	20.72	0.14	20.43
Water Quality	1.61	0.10	15.95	0.14	11.76
Ground Water	1.65	0.14	11.46	0.19	8.57
Mine Water	0.33	0.13	2.50	0.15	2.16
Availability	0.54	0.04	13.64	0.05	10.52
Capacity Limit	-0.00	0.00	-1.61	0.00	-1.28
Distance	-1.27	3.11	-4.10	3.96	-3.20
Price	-0.04	0.00	-6.37	0.00	-4.66

Once again, the current situation was significant, large, and positive. The estimate was 2.90 with a t ratio of 20.75. This communicated that participants had a significant positive utility for

the current situation in Emalahleni as well. Water quality was significant and positive just like in Phola. The results for ground water and mine water were similar to Phola in that both showed significant and positive results, however, there was a preference for ground water, unlike in Phola. Availability came up positive and significant as was the case in Phola.

However, the capacity limit still came up as negative. The negative utility was perceived the more it increased. Price and distance analysis were the same as with Phola, negative and significant as expected.

Table 14 reports the results of the choice experiments collected in the community of DLM.

Table 14

Choice Analysis of Preferences in DLM

Estimates					
	Estimate	s.e	t. ratio	Rob. s.e	Rob. T. Ratio
Current Situation	-0.01	0.15	-0.20	0.20	-0.16
Water Quality					
Very High - Drinkable	1.12	0.14	7.89	0.15	7.64
High - Cooking/Drinking after Boiling	0.60	0.16	3.86	0.15	4.23
Medium – Washing	0.20	0.20	1.02	0.14	1.14
Water Sources					
Ground Water	0.03	0.10	0.30	0.10	0.26
Surface Water	0.24	0.09	2.68	0.10	2.58
Availability	0.10	0.02	3.37	0.03	3.60
Capacity Limit	-0.00	0.00	-0.82	0.00	-0.82
Distance	-1.59	2.11	-0.75	1.88	-0.84
Price	-0.00	0.00	0.50	0.00	0.57

In DLM, community members reported a non-significant disutility for the current situation. This was evident as the analysis reported an estimate figure of -0.01 which was very low, and a t ratio of -0.20, non-significant because it fell below the threshold required for significance (1.96).

The DLM analysis was more detailed. As shown in table 13 water quality was split into its four categories. Regardless, the results were similar to the other two communities with the highest estimate reported corresponding to the highest level of water quality. Very high drinking water had an estimate of 1.12 and a t ratio of 7.89, making it a large, significant, and positive result.

Water sources were compared and unexpectedly, ground water came up non-significant with a t ratio of 0.30 and a very small estimate of 0.03. Surface water was the most referred with an estimate of 0.24 and a significant t ratio of 2.68. Availability was significant and positive much like in Phola and Emalahleni.

Also like the other two communities, there was a disutility towards a capacity limit, distance, and price. However, unlike in the other communities, each of these was non-significant in DLM.

3.4 Debriefing Questions

The next section of the survey investigated how participants found the choice experiment in terms of the level of difficulty. They were asked to report on what they felt was the most important attribute, what their perceptions were of those in charge of water provision, and how they felt about their abilities to successfully operate the alternative water system hypothetically.

In terms of the survey difficulty levels, the line chart shows how each community reported their experience answering the survey in terms of the difficult or ease they experienced in doing so. The question **“Did you find it difficult to make choices between the different choice sets?”** was posed to investigate this. In DLM, 62 participants found it very easy while 56 participants found it somewhat difficult. Similarly, in Phola, residents reported 62 cases in which the survey was said to be very easy, with much fewer reports on all other anchors. The lowest was 20 people who found it very difficult. Lastly, Emalahleni reported the highest number of participants who found it very easy. 105 participants picked this option, with only 15 people finding it very difficult.

This is shown in Figure 2:

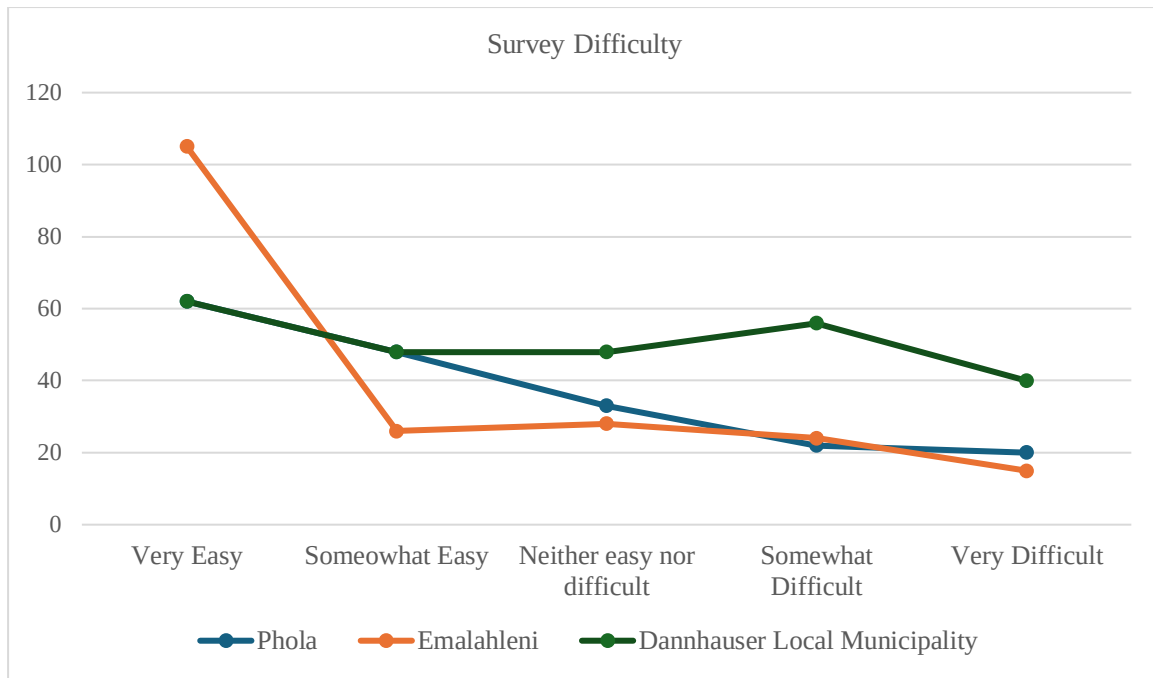


Figure 2: Survey Difficulty

Based on the answers to the choice experiment, the next 2 questions aimed to find out why a person would choose to remain with the current situation in all scenarios, or why they would choose a project which contained an amount they would be willing to pay in every case. The questions were “**Why did you choose not to pay for any of the cases?**” and “**Why did you choose to pay in all cases?**”.

In Phola, no one selected the “current situation” every time, so community members did not have to answer the first question, however, 5 households picked the projects only, so they answered the second question.

The reasons given are detailed in the bullet points below:

- 4 felt that this would be a good deal for them in their current situation
- 1 felt obligated to do so for the sake of their community regardless of their preferences.

In Emalahleni 44 households chose ‘current situation’ every time, so they had to answer the first question, and their reasons are outlined below:

- 30 stated that they would do so because they do not have the stated amounts to pay for the projects
- 6 felt the companies that caused the pollution should pay for it
- 5 felt the community would not use the money from the project as intended

- 1 felt there were bigger problems than the issues with water.

58 households picked the projects in all their responses, and their answers to the second question are shown below:

- 37 stating that they felt it was a good deal for them in their current situation
- 14 thought it was a good idea, and they wanted to contribute
- 7 stating that they felt obligated to do so for the sake of their community regardless of their preferences.

In the Dannhauser Local Municipality, 16 households selected the “current situation” every time, so they had to answer the first question, these were their reasons why:

- 11 did not trust the mines.
- 1 felt they would not use the money as intended.
- 1 felt the companies that caused the pollution should pay.
- 1 felt that they did not have the stated amounts.
- 1 felt the government should pay for it instead.
- 1 did not think the community could run the project.

168 households picked the projects only and their answers to the second question are detailed below:

- 78 felt that this would be a good deal for them in their current situation.
- 58 thought it was a good idea, and they wanted to contribute.
- 22 felt obligated to do so for the sake of their community regardless of their preferences.
- 5 households picked other but did not state their reasons.

Another important aspect to investigate was how participants made the choices they did. This would inform their thought process and help to ensure their responses provided reliable and valid conclusions. The question “**How did you make your choices?**” was posed and participants had 6 options to pick from.

Figure 3 shows how participants in each community reported making their choices:

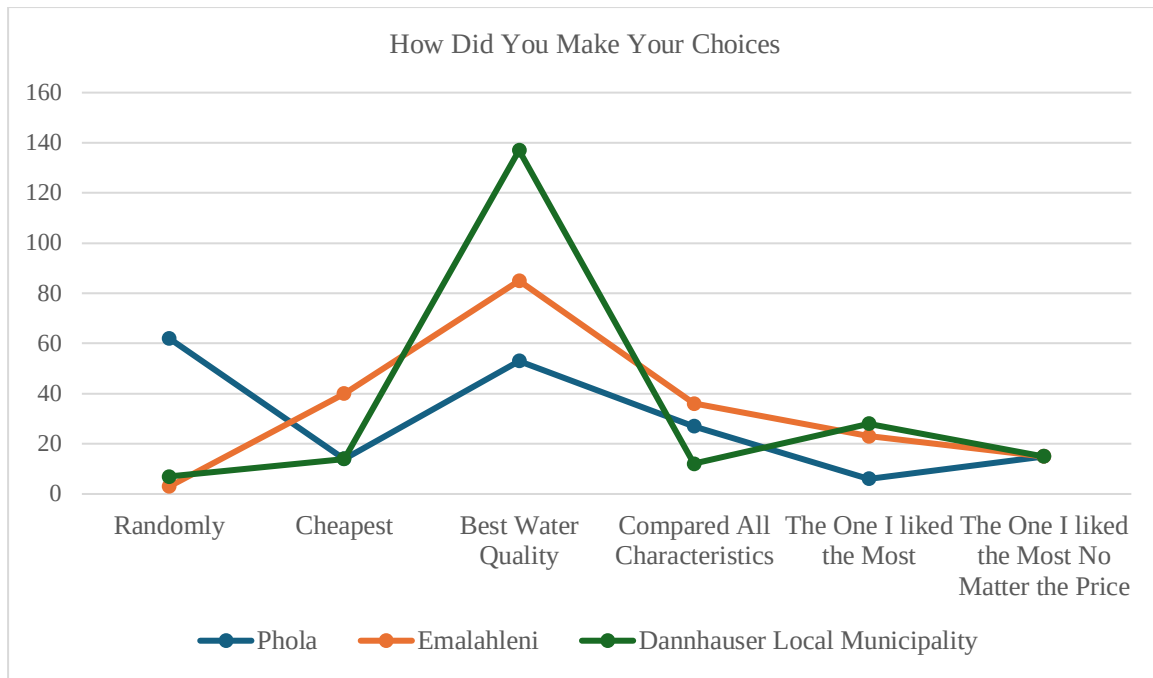


Figure 3: *How Participants made their Choices*

This chart, along with the one on survey difficulty (figure 1) helps to inform the reliability of the answers found in the choice experiment section. As stated earlier, in Emalahleni, a high number of participants found the survey easy. Figure 2 shows that this group mainly made choices based on the options with the best water quality. Only 7 participants made their choices randomly, which means they were taking the time to analyse the attributes and made informed decisions. However, this is not the case with the Phola community where 62 participants made their choices randomly, while the remainder of the participants choice the other options. These 62 participants' choices would impact the reliability of the results of the choice experiment. In Emalahleni, only 3 participants were picked randomly and the remainder of the sample made choices based on the other characteristics.

The purpose of the choice experiment was to be able to statistically analyse participants' choices and make conclusions about what seemed to be the most influential attributes when making choices, and how a change in the level of an attribute would either increase or decrease utility. However, it was necessary to hear from the participants themselves, what they felt the most influential attribute was. In the next question, participants were asked **“Which of the project elements had the greatest influence on your choice? Please rank from highest to lowest (with 1 for lowest and 5 for highest)”**.

This was one of the questions some participants found to be confusing, especially in the Phola community. The participants in Phola gave a 1 to the most influential attribute and a 5 to the

least, so this community's results were separated from Emalahleni and DLM where participants understood the preferred ranking order.

Table 14 shows the ranking order of the attributes in the community of Phola where 1 was the most influential and 5 was the least:

Table 14

Ranking of Attributes from Most Influential to Least Influential in Phola

Attribute	Most Popular Response	Number Of Households
Quality	1	73 households
Availability	1	48 households
Price	2	42 households
Distance	3	69 households
Source	5	79 households

This table shows that in the community of Phola, the most influential attribute was quality followed by availability. They cared about gaining access to the cleanest possible water as often as possible. These two attributes affected their decision-making the most as they carried the most utility according to the participants.

Table 15 shows the results for the communities of Emalahleni and Dannhauser Local Municipality. In Emalahleni, quality was the most influential attribute in decision making while source was the least influential. In Dannhauser, unexpected results came up where participants reported availability to be the most influential attribute and price as the least.

Table 15

Ranking of Attributes from Most Influential to Least Influential in Emalahleni and Dannhauser Local Municipality

Attribute	Most Popular Response	Number Of Households
Emalahleni		
Quality	5	75 households
Availability	4	66 households
Distance	2	69 households
Price	1	65 households
Source	1	88 households
Dannhauser Local Municipality		
Availability	5	94 households
Quality	4	79 households
Source	3	73 households
Distance	2	82 households
Price	1	118 households

The next section posed debriefing questions about the community's belief in their abilities to improve the water situation as they would oversee this system in the hypothetical condition. The question **“How likely do you think the community will actually improve your water access through the proposed project?”** was asked.

The three community's responses are plotted in figure 4 below:

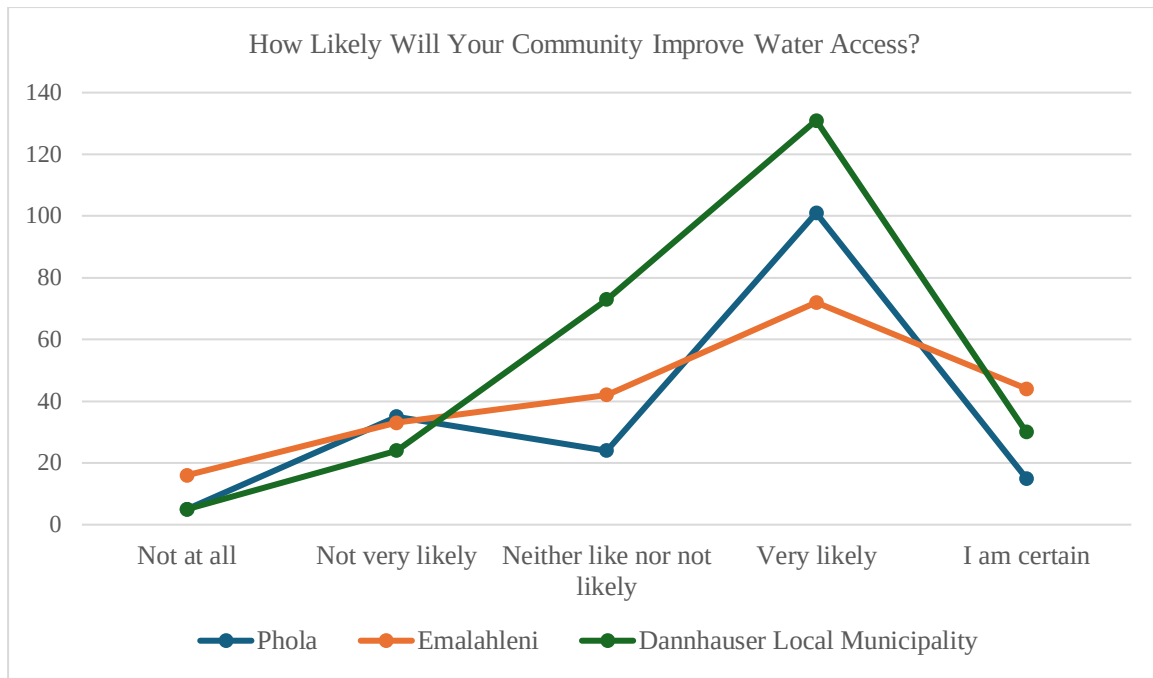


Figure 4: *How Likely will the Community Improve Water Access?*

All three communities reported that it was very likely that they could improve their water access: 131 participants in DLM, 101 in Phola, and 72 in Emalahleni. Several participants voted not at all, roughly less than 20 in each of the three communities.

Following this was a question about trust, **“To what extent do you trust the institution (the community) that will provide water in the improved situation?”**.

The community’s responses are shown in figure 5:

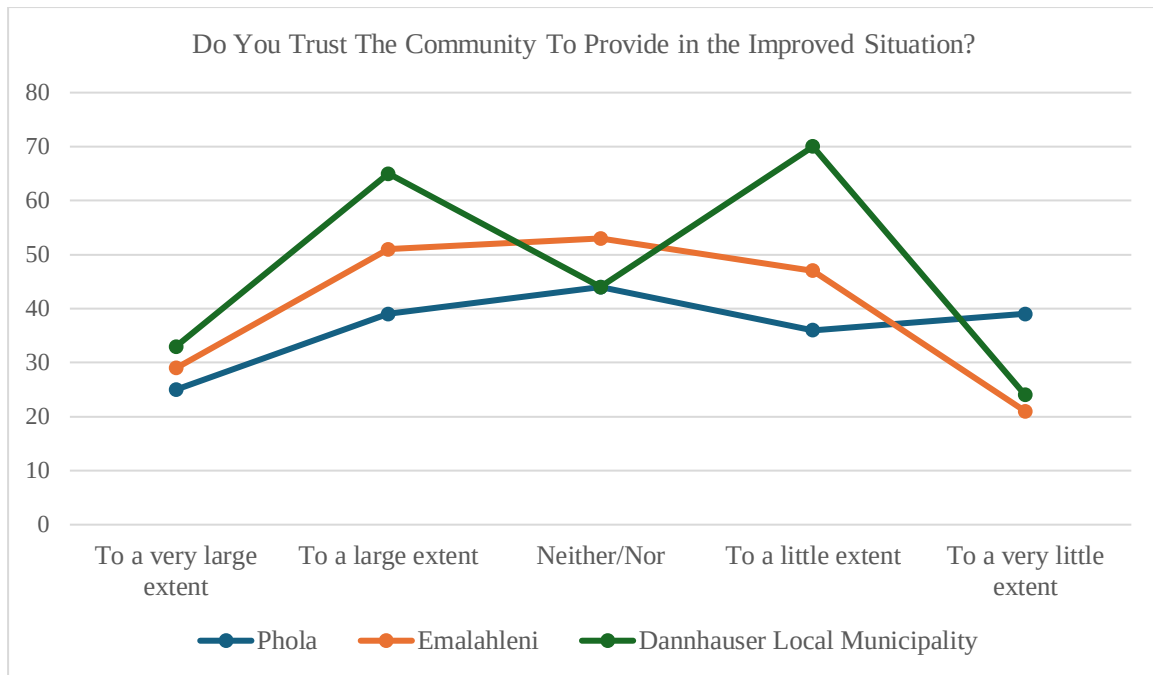


Figure 5: *To What Extent Do You Trust the Community to Provide in the Improved Situation?*

High levels of distrust were seen in DLM, with 70 participants believing they could trust the community to a little extent, while 65 believed they could largely trust the community. In Phola, participants were unsure, with the highest votes going to the option neither/nor (44). However, 25 participants did believe they could trust the community to a very large extent, but this was coupled with 39 participants who felt they could only do so to a very little extent. In the final community of Emalahleni, 53 participants voted neither/nor so a high level of uncertainty was seen in this community too.

The final two questions were only posed to the community of Emalahleni and DLM. The survey in Phola did not contain these two questions because they came up after having conducted data analysis on the Phola data. It was necessary to further investigate participants' preferences for water sources (for the treated water) because this was ranked lowest, but it came up as a crucial aspect of concern in conversations with the enumerators on the day of training.

Participants were asked, **“Please rank the following sources of water according to what you would prefer most (with 1 for most and 3 for least preferred)”**.

Table 16 shows the results:

Table 16*Ranking of Water Sources (households)*

Water Sources	1	2	3
Emalahleni			
Surface water	20 households	139 households	41 households
Mine water	55 households	42 households	104 households
Ground water	133 households	15 households	60 households
Dannhauser Local Municipality			
Surface water	81 households	137 households	36 households
Mine water	98 households	21 households	119 households
Ground water	90 households	72 households	86 households

In Emalahleni, the results were very straightforward with ground water being the most preferred by most households and mine water being the least preferred of the households that answered this question. In DLM however, the highest number of households preferred mine water as a source of water to be treated, while mine water was also the least preferred source of water. This could have been a mistake in the interpretation of the ranking order. This is an issue that will be discussed under the limitations section of the research.

The second additional question was drawn from the high level of distrust towards the community's abilities to provide water in the improved situation in Phola. This led to a question about who the community would trust to do so, if not themselves. The question posed was **"Who would you trust the most as a water provider?"**.

In Emalahleni, 153 participants reported trusting the municipality to provide water for them, only 1 person reported trusting the mines, and 5 reported none. 78 participants trusted the community as a provider of water. In DLM, 129 participants trusted the community as a provider with only 26 participants reporting that they trusted the municipality. 11 participants voted none, and 15 chose the mines as a provider. In both communities, 27 participants felt the government would be a good provider of water for their communities.

This is shown in figure 6 below:

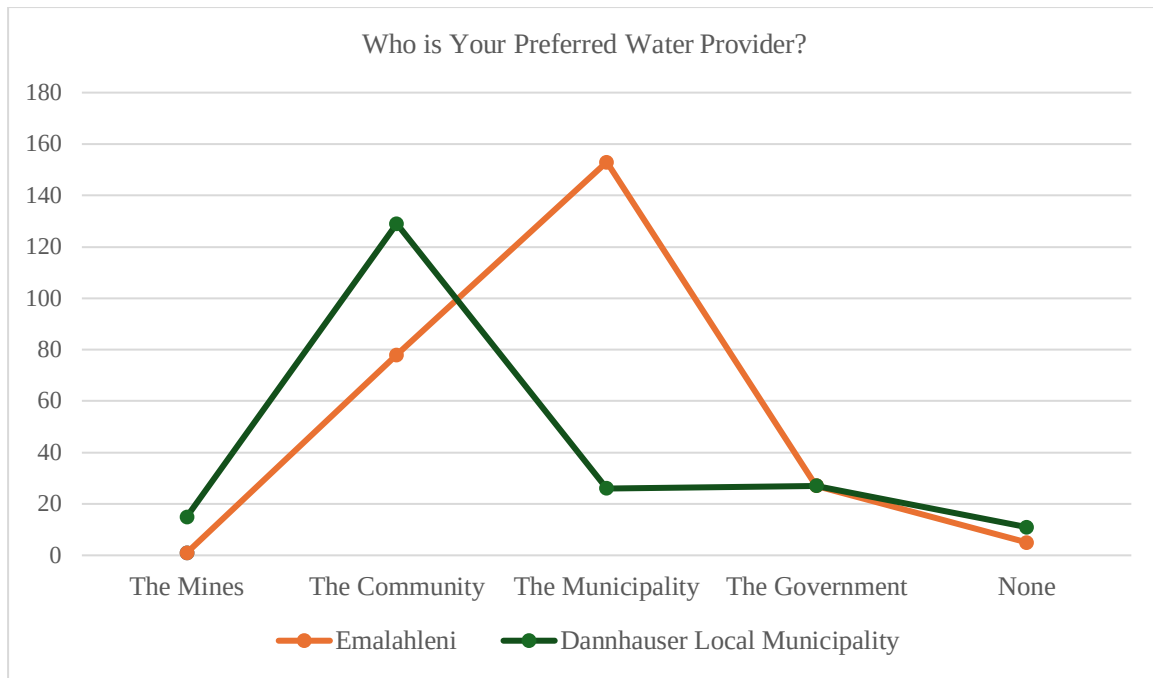


Figure 6: *Preferred Water Provider*

This was the last part of the debriefing section of the survey. It is necessary to interpret them and discuss the implications of the results outlined in this chapter. Relating this to utility theory and understanding what implications can be revealed will be done in the following chapter.

Chapter 4: Discussion

4.1 Introduction

This chapter discusses the implications of the results found in the previous chapter. It will examine these and make comparisons with existing literature. Furthermore, it will link them to the broader theoretical framework. The research questions posed in the methods section will be answered and conclusions will be made based on the results about the preferences reported by participants in the three communities.

4.2 Introduction Questions

The results in this section were similar across all three communities, so they will be discussed together. Members of mining-affected communities live with a daily problem of water scarcity that robs them of a normal, hassle-free life. All three communities confirmed the water crisis as highlighted by Van der Vyver (2016), Bischoff-Mattson et al. (2020), Matlakala and Von Kallon (2021), and Lee and Schwab (2005) in the literature. The most common answer provided about the water consumed daily was 80 litres, in households of more than 2 two people, from this it is clear that community members in Phola, Emalahleni, and DLM were living below the global minimum, and this can have massive health implications. According to the WHO, at minimum, every person should have access to at least 50 litres of water per day (United Nations, n.d.). However, it goes beyond health as it impacts the general lifestyle of the people. The three communities sampled in this research reported having multiple sources of water, and these were all within some distance for the majority of the sample. It would be preferred that if a household had a tap in the bathroom or the kitchen, they could gain access to water from it. However, this was not reported as the most likely primary source of water. This demonstrated just how unreliable this source was and introduced another layer to the issue – distance.

Since the water was not directly accessed through the taps in the house, distance became an expected part of participants' lives as they often had to travel to find clean water. The most likely primary sources were not too far away, the main one being outside the house. However, when the primary sources were not accessible, participants reported having to walk far distances for water. The biggest issue with this was most people in these communities were of lower socioeconomic status. This was shown in the high percentage of unemployed individuals or those who relied on contract work. As Marais et al. (2018) stated in the literature, this type of work was precisely the kind available to mineworkers who had migrated to live closer to

work. Furthermore, some of the secondary sources came at a cost, in a low-income area, every cent counts. Having to pay inflated prices for bottled water or a neighbour's water could impact their ability to pay for other necessary expenses.

In addition to this, some of the people responsible for water collection were children and grandmothers. Pelders and Nelson (2019) and Wilson (2001) highlight the disruption of the family structure and link the father's or men's absence in the daily lives of their families to contract work that, in mines that still have hostels and barracks, keeps them on site. One community reported grandmothers as one of the top five individuals responsible for water collection. Perhaps these grandmothers were younger than what could be assumed, however, the three communities reported elderly participants ages 75, 76, and 85. If one of these individuals was part of the group regularly practising heavy lifting and walking far distances, this could impact their health negatively over time. Furthermore, mothers made up a large percentage of those who collected water and they too could have been above 65 and so they would have fallen into the elderly category. Even when a person is fit enough to collect water for the household, an excessive repetitive habit of heavy lifting and walking distances could cause a lot of stress and strain. The same goes for the children, having to get up early to collect heavy buckets of water and return on time to make it to school was a very laborious lifestyle.

Water quality was also examined in the introduction questions, participants reported mostly negative explanations of the look, taste, and smell of water as shown in table 10. The contamination of water sources in mining-affected areas was highlighted in the literature by Barnwell et al. (2020), Mativenga and Marnewick (2018), and Sandlos and Keeling (2016). The results of the current study reiterated their findings. There were reports of water discoloration resulting from mining activity. Reddish, yellowish, and brownish colours could have simply been rust; however, AMD does result in the same type of discoloration. The acidic or chemical tastes reported by participants could also indicate that AMD had occurred. This process lowers the pH of water and results in an acidic taste. Furthermore, reports of a black, dark, coffee water colour could be a result of coal dust or other dark-coloured minerals finding their way into water sources. Lastly, creamy, white, or cloudy water could also be a result of silicates released during mining activity (Centre for Environmental Rights, n.d.). These findings were important because they confirmed the water conditions reported and further supported authors such as Ochieng et al. (2010) and Tomiyama and Igarashi (2022) who claimed that such water was not appropriate for human consumption. The absence of functioning piped water in towns closest to the mines was explored by Cole and Broadhurst

(2022) in the literature and the results of the current study helped to demonstrate this and further stress how this impacted the members of mining-affected communities.

4.2 Choice Experiments

The significance of all attributes in the choice experiment, except capacity limit, communicated that all of them influenced the decisions participants made during the choice experiment. This would help to address the research questions and understand what was most important to participants. The first research question posed in the methods sections asked **“What was the most preferred level for each attribute?”**. The results of each community differed, so they will be discussed separately.

Phola

The capacity limit should be addressed first as it was the one attribute that, in Phola, was non-significant and resulted in disutility. This was unexpected because it would be assumed that participants would prefer not to be limited in terms of the amount of water they could collect. With diversity in terms of the size of each household, it was expected that larger households would most likely need more water and so this attribute would influence their choices. Perhaps the community did not care about this attribute as much as expected or they felt no matter the limit, they could manage it for drinking and cooking, while using their usual sources for other household needs such as bathing, flushing the toilet, and landscape and animal upkeep. Only assumptions can be made as to why this was the case, further investigations would have been required to fully understand how participants felt. To reiterate Palmer et al.’s (2018) position on these issues, water is a human right and it is evident that each community is in dire need of clean water.

In terms of water quality, the results indicated that there was a high positive utility perceived from higher levels of quality. This means the choice scenarios that displayed options of high or very high-quality water were the most preferred. This was expected because while water in these communities was available sometimes, it was not always clean. To go back to Unruh et al.’s (2017) study, one of the biggest impacts of mining is the resulting inadequate supply of clean water. Participants often had to boil the water to ensure that their families could drink it, and while this may work with some particulates in water, not all contaminants are removed by boiling. Li et al., (2016) reported water sources containing contaminants easily carried by the wind that settle on the surface of open water bodies. Not all of these materials dissolve when boiled.

Another attribute that participants responded to was supply frequency or availability. The high positive utility reported by the analysis indicated that the higher the availability level the more utility maximising an option was. This made sense because the communities reported that water was not available all the time with some participants reporting its availability as less than once a week. This corresponds with Cole and Broadhurst's (2022) study which went into detail about the conditions of mining settlements including mentioning the fact that water sources are often limited and unreliable. Based on this, it would be expected that the most preferred level of availability was the option that indicated that clean water was always available.

To address the issue of water sources, the three different water sources were compared during the analysis. Participants reported a higher positive utility for ground water and mine water as a source when compared to surface water. The explanations around this came up during the training sessions with the enumerators who were members of the mining-affected communities too. They reported that surface water was easily contaminated and as a result, was a less attractive alternative. Wolkersdorf and Mugova (2022) reported that as long as a mine is active, seepage occurs through surface run-off and other processes. Water was expected to be drawn from one of the three sources and treated in the alternative water system, however, even though this was the case community members still did not find surface water to be an attractive water source. Going further into the analysis, in Phola, of the two preferred sources, ground and mine water, a higher utility was perceived in scenarios that had mine water over those with groundwater as a source.

Distance and price had a high negative utility, meaning that utility was raised the lower the level was, so distance in or just outside your house is expected to be the most preferred and for price R1 is expected to be the most preferred. Far distances were less preferred because often water is needed immediately, and it involves a lot of heavy lifting. Carrying heavy buckets over far distances is unfavourable to all, especially considering those responsible for water collection. Expensive water was less preferred perhaps because of the income groups under which these communities fall. Not everyone can afford R30 for 5 litres, it would be perceived as unreasonable. This further demonstrated Azari et al.'s (2012) statement that people's decisions are driven by what maximises utility and benefits them the most.

Emalahleni

In Emalahleni, the capacity limit was also non-significant and reflected disutility. As explained in the case of Phola, this was an unexpected result. It communicated that participants were perhaps not concerned about the amount of water they were limited to, as much as the other attributes. Once again, it was expected that different household sizes would be affected by capacity limits differently, so this seemed like a key issue. However, members of this community shared the same sentiments as those in Phola based on the results of the analysis.

In terms of water quality, similar to Phola, Emalahleni community members indicated that the preferred level of water quality was the highest possible, which in this choice experiment was very high-quality drinking water. This was expected for the same reasons expressed in Phola, the environment they were used to often came with water that could be contaminated with toxic materials from mining activity, so it was expected that they would prefer the highest possible quality they could get. Cole and Broadhurst (2022) reported that the poorer the community, the poorer the piping and sanitation infrastructure. As most of these participants lived in informal housing, they were as Marai and Lenka (2022) put it, living in the worst conditions of poverty. Therefore it did not come as a shock that the highest level of water quality was the most preferred.

Like the other two attributes, results on supply frequency or availability in Emalahleni were similar to those in Phola. The high positive utility meant that the higher the availability level the more utility maximising an option was. This was expected due to the inconsistencies reported about the water availability, but also, the fact that Emalahleni reported the lowest level of water availability 'all the time' for both primary and secondary sources. This reality helped to bring Okolo et al.'s (2018) claims into focus. A participant reporting that water was unavailable all the time reflected their reports on the global water crisis, that in this day and age water scarcity was exacerbated by modern activities and mostly affected the poorest communities.

As for water sources, ground water was the most preferred because community members felt it was the water source that was the least compromised. Like in Phola, surface water was the least preferred source. The results for mine water were unexpected. Participants reported it as an option over surface water, but in conversation with the enumerators, this was the least preferred option. They did not trust the mines and felt that if surface water was contaminated by the mining activity from a distance, mining water would be even worse than the surface

water. In further analysis of the two preferred sources, community members in Emalahleni, preferred ground water as a source of water over mine water, which was expected.

Distance and price were perceived to have high negative utility or disutility which was expected. So just like with the community of Phola, it meant that the further away the water was, the less utility maximising the choice scenario was, and the more expensive the water was, the less utility maximising the choice scenario was. It would become more of a cost to the individual and so those options felt less attractive.

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In DLM, the capacity limit showed the same pattern as in Phola and Emalahleni. Once again, further analysis of this was required to fully understand the reasoning behind the results shown. Like in the other two communities, the results showed that participants may have not been too concerned about the capacity limit. This went against the expected outcome, as it was assumed that the amount of water community members were restricted to, would affect each family differently based on their needs. Utility maximisation was expected to be seen in scenarios that had no capacity limit, as these would align with Azari et al. (2012) and Hensher et al.'s (2005) descriptions of the theory however, these results indicated a perception of unimportance or disregard for this attribute entirely.

The results for water quality, like in the last two communities, indicated that the higher the level of water quality, the more a scenario was perceived to be utility maximising. Community members preferred the highest level of quality and the lower this got, the lower the significance level got too. This indicated that lower levels of quality resulted in uninterest towards the attribute. As shown in the results (table 13), the medium category for water quality was non-significant. Perhaps the idea that water from the system would only be appropriate for washing and bathing felt slightly pointless to participants. As mentioned in Antwi et al. (2017), Mensah et al. (2015), and Cole and Broadhurst's (2022) studies these communities struggle with clean water for drinking, therefore, in making their decisions, participants prioritised what they needed the most. Of the water sources provided, surface water was the most utility maximising. This was an unexpected result as in the other communities, members claimed that this source was often easily compromised. This was also backed up by Li et al., (2016) in their study on the environmental effects of mining activity. They reported that surface water was subjected to contamination through both air and land pollution. Perhaps this result came from the difference in this location, DLM was far more rural than the other communities, so perhaps their surface

water sources were not as easily compromised as with the other two communities. Availability seemed to also display similar patterns as in the other two communities, meaning a higher level of availability was more utility maximising than a lower level, so participants preferred this.

Lastly, much like in Phola and Emalahleni, distance and price were negative, so this indicated disutility. This meant that every time the distance or the price increased, the scenario became more unattractive as it was less utility maximising. This was expected because the more one had to pay or travel to get access to this water the higher the cost they had to pay. Holmes et al. (2017) stated that these attributes often allowed participants to conduct a cost-benefit analysis and as with the theory, the least costly, most beneficial option was the one often chosen. There was an unexpected element to this, however, which was that both options were non-significant. Significance indicates how important or how influential this attribute was in decision-making. A result of non-significance was not expected as it would be assumed that having to pay a lot more or travel much further would be a significant disadvantage when compared to other scenarios. However, like with the capacity limit, the reasoning behind this can only be assumed, perhaps community members were in a better position than the other two to afford this cost. According to the demographic information collected, DLM was by far the most educated community and reported the highest number of people employed daily. Perhaps this is part of the reason these two aspects were not as significantly influential as in the other communities.

The second research question was **“Which attribute had the highest level of variability?”** This was asked to understand which attribute differed the most across the three communities. It was assessed using the estimate values of each attribute compared against the same one in each community. The one with the greatest difference would be the one with the highest level of variability. As explained by Hensher et al. (2005) variability is a good thing, it shows diversity in perspectives and is a sign that most participants were being truthful about their opinions and not conforming out of the need for social desirability. However, this was not an easy question to answer. At first glance, the answer appeared to be distance. Phola participants had a very high level of disutility for distance while those in Emalahleni and DLM had a much lower level of disutility. Based on the reported distances participants walked to access water in these communities, Emalahleni residents walked further than Phola and DLM residents, and DLM sources were slightly further than Phola water sources. Therefore, it can be assumed that members of Emalahleni and DLM may have become more accustomed to walking further than the Phola participants which is why this community reported such a high negative disutility to distance. Furthermore, Phola was the community in which grandmothers were one of the top

five collectors of water. To the elderly, the distance would not be perceived as utility maximising, so this could potentially be the reason for this conclusion. For the sake of answering this question, distance would be most appropriate as the disparity across the communities could not be ignored.

However, it is important to remember that these results could not be confirmed with the community, they were only assumptions made from the data collected. Something essential to point out was that, although distance was the attribute with the largest variability, it was also reported as non-significant in Phola and DLM. This would indicate a lack of interest in the attribute when compared to others, so perhaps the attribute with the second largest variance, which was the current situation, would be the most appropriate. It did however also carry a non-significant estimate value in DLM. Further questioning within the communities would have been required to confirm this answer.

The third research question asked, **“Was water quality the most significant attribute in each community?”** Water quality was a challenge for members of such mining-affected communities as established in the literature (Van der Vyver, 2016; Cole & Broadhurst, 2022; Barnwell et al., 2020). This was expected to be the most important attribute and the data collected confirmed this. In the data analysed the significance level was inferred from the t ratios which had a cut-off point of 1.96. Significant attributes had a t ratio higher than this. Phola reported a high significance level with a t ratio of 10.73, the highest out of all the other attributes in this community. DLM reported a t ratio of 7.89 on the highest level of water quality, all other attributes fell below this. Lastly, Emalahleni reported a significance of 15.95, the highest of all three communities however, it was not the most significant attribute in the data collected from Emalahleni.

The reason for this is inferred from the data collected in other parts of the survey. The highest significance level in Emalahleni was for the current situation. It had a t ratio of 20.72 indicating that when making decisions, members of this community leaned more towards the current situation over all other attributes in the other scenarios. This was unexpected but not surprising. Emalahleni was the community with the highest votes for the current situation. The most popular reason for this decision was that participants did not have the money to pay the stated amounts. Therefore, in this community, the prices applied to each scenario resulted in such a strong perception of disutility that a high number of members of Emalahleni felt it better to remain with things as they were. In theory, this can be linked back to the anchoring effect which

Furnham and Boo (2011) posited happens when people focus heavily on the first information they receive. The fact that there was a cost tagged to each scenario may have remained in participants' minds and resulted in them making the choices they did. Furthermore, Emalahleni reported the lowest socioeconomic status with fewer people employed every day and more people who reported never having had a job compared to Phola and DLM. Therefore, to bring the argument back to the question posed, water quality was the most significant attribute in Phola and DLM but not in Emalahleni.

Finally, the question, **“Was water quality perceived as more important than water availability?”** was posed. Since members of mining-affected communities often experience cuts in water availability, it was important to find out which one was more important to them, having water more often or having the cleanest water regardless of the supply frequency. When assessing the data reported in Tables 11, 12, and 13, it was evident that water quality was always perceived as more important both in terms of the level of significance and the size of the estimated value. An assumption can be made that community members have become accustomed to having cuts in their water supply frequency, however, with the way the three sources are reported to be contaminated, there was no guarantee that any of them could truly supply clean water. AMD was a form of contamination that was shown in the literature to be a hindrance to the clean water in these communities, it seeped into groundwater through mining chemical reactions, seeped into surface water through run-off, and mine water was the primary AMD contamination site (McCarthy, 2011; Archaya & Kharel, 2020; Askham & Van der Poll, 2017). Therefore, it is clear to see why community members would find scenarios more utility maximising if they had the cleanest water regardless of what the availability level was. Based on the reported data, water quality was perceived as more important than availability.

4.3 Debriefing Questions

This section, like the previous one, varied across the three communities, so each community will be discussed separately.

Phola

To assess the reliability of the choice experiment conclusions explained above, participants were asked how easy/difficult they found the survey. This helped to assess the participants' experience making choices as this could potentially affect the choices they made. As expected, some found it to be very easy while others found it very difficult. In Phola, most people found the survey very easy. Perhaps the fact that enumerators could speak the languages spoken in

the community helped to explain the survey, this was a strength of the current research. However, participants in Phola went on to answer a question about how they made their choices.

The most popular answer was 'randomly'. There was no question to assess the reason for this, and many assumptions could be made such as that they may have been unable to give their full attention to the enumerator which would affected their understanding of the choice experiment and resulted in random choices. There is no way of knowing, which means that results in this community should be interpreted with caution because perhaps this is why they found it easy because they were choosing randomly. Granted the second most popular answer was that they chose the options with the best water quality, however, a significantly large amount of people chose randomly.

In Phola, no one selected the current situation in every choice set presented. They reported that they thought it was a good deal and some felt obligated to do it for their community. Going back to the state of water described by Li et al. (2016), Ochieng et al. (2010), and Wolkersdorf and Mugova (2022) in the literature, it became evident that life in such mining-affected communities requires that they have alternatives because the current situation is often not the best nor is it the safest. Therefore, the participants avoided this option as it was the least utility maximising. The survey required that participants rank the attributes to see what attributes participants reported as having the highest utility and influencing their decisions the most. The attribute that was regarded as having the highest ranking would be the one that most affected the choices made in the choice experiment. In Phola quality was ranked the highest. This meant that when the quality decreased, it reduced the perceived utility value of the scenario. In scenarios where quality was at its highest level participants often chose that option. This corresponded well with the results of the choice experiment analysis, as discussed in the previous section, the highest possible level of water quality was the most preferred.

The source was regarded as the least influential in Phola. This was investigated further in an attempt to understand the distribution of utility across the three sources. As this question was added to the survey after data collection in Phola, the results were only available for the Emalahleni and DLM communities. However, this was inferred from the choice experiment analysis discussed previously where Phola community members reported groundwater as the most preferred source. Again, this would be perceived as having the highest utility since participants felt it was the least compromised. This unfortunately was not accurate, though

groundwater is protected by its distance to initial mining activity, eventually seepage occurs as stated by Jhariya et al. (2016) and Li et al. (2016) in the literature.

More than half of the participants from Phola felt it was very likely that the community could improve access to water. This was necessary to investigate because decisions about the scenarios hinged on the fact that the alternative water system would be a community-run system, thus their decisions could have been influenced by their own competency beliefs. If the community believed themselves to be capable, there would be a higher chance that they would find the projects to be utility maximising. If not, this would be reflected in the answer to this question. Based on this, community members seemed to believe in their abilities. However, the last question asked if they trusted the community to improve water by running and operating this alternative water system. Their responses leaned more toward the negative. They trusted the community less than they distrusted them. What could be inferred from this is possible disutility originating from their distrust of the community to run the system. However, the need for water could outweigh this distrust, perhaps participants were willing to take a chance on it and see if it would work.

Emalahleni

Once again, like in Phola, most Emalahleni participants found the survey very easy. A larger group, than in Phola, expressed a preference for the current situation in their responses. The fact that 44 participants chose the current situation in their choice experiment answers resulted in a lot of frustration during feedback. The rest of the community felt this was going to hinder the progress toward a solution, however, with closer inspection, this was just another demonstration of utility theory at play. In Emalahleni, the 30 participants who did this wanted to avoid the cost attached to each scenario as they reported that they did not have money to pay the stated amounts. This was a reflection of the pattern often seen in existing studies, similar to Dauda et al. (2014) and Li et al. (2024) where an increase in the monetary value, if it is expected to be paid by participants, leads to a decrease in perceived positive utility because they were expected to pay more. This was also the community with the lowest socioeconomic status, and it was closest to the mine. This decision to them, was as good as having no water.

Six members of this community felt that the mines should pay for it. For them, there was more value in holding the mines accountable for their actions and perhaps they recognised that this should be a duty that the mine upholds and not their responsibility. This choice demonstrates how utility in choices is not always limited to the attributes closest to the main issue, many

issues result in the current situation and participants reflected different priorities in the choices they made. As highlighted by Hensher et al. (2005) we assign value to what matters the most to us, for this group of participants, this perhaps was most important to them. Five participants felt the community would not use the money generated from the water system as intended. This demonstrated a community trust issue. Participants may have felt the project utility would be minimised by the fact that their fellow community members would run the system, and they distrusted them. One participant felt there were bigger issues, which further demonstrated that each person made a choice based on their priorities. This individual was a part of the group that indicated that they had a job a few times a month, so perhaps they may have had other needs beyond clean water.

On the positive side, the remaining participants reported why they chose projects only. The trend in this question was that most participants picked the option that maximised utility for themselves, as opposed to the whole community. Most participants focused on their own experience with water and reported choosing the project because it was a good deal for them in their current situation. In such a situation, it would be unfair to interpret this decision as selfish because they should not have this problem in the first place. In general, people will make the decisions that reap the most benefits for themselves (Hensher et al., 2005; Batley, 2008; Azari et al., 2012). Though there were fewer, there were participants who decided with some consideration of the community as a whole. Twenty felt it was a good idea and wanted to contribute or they felt obligated to do so for their communities.

In Emalahleni, the majority of the participants reported making choices based on the scenarios with the best water quality. This corresponded well with the participants' ranking of attributes where they reported that quality was the most influential attribute. Theoretically, this meant that the higher the quality, the more participants felt the scenario was utility maximising (Hensher et al., 2005; Batley, 2008; Azari et al., 2012; Bliemer & Rose, 2014). Furthermore, this result was the same in the choice experiment analysis, which revealed a preference for the highest possible quality. Much like in Phola, the source was the least important attribute. This was investigated in the next question where participants had to rank the three sources. Emalahleni participants reported that ground water was the most preferred followed by surface water than mine water. There was a high level of distrust towards the mine in this community because they were the closest to the mines. Furthermore, surface water was often described as dirty, but it was a better alternative to mine water.

Emalahleni participants reported that they strongly believed in their abilities to improve the water situation with the hypothesised alternative water systems. Earlier in the survey, participants revealed some distrust in their decisions to choose the current situation. However, most of the community felt they trusted each other to run the project. An important part of choice experiment theory came up in the analysis. While previously, most other elements between choice experiment revealed results and stated results linked, the response given when Emalahleni participants ranked the sources differed from the ones revealed in the choice experiment analysis. As mentioned earlier, it found that Emalahleni community members preferred groundwater as a source then they preferred mine water as a source.

When asked to rank the sources, they chose groundwater then they chose surface water. This discrepancy is a demonstration of choice theory. Participants stated choices on the ranking differed from the revealed choices in the choice analysis results. As mentioned in the literature, people do not always make accurate decisions when asked what they would do. The choice experiment was an exercise that may have felt more realistic and so they made certain choices that differed from when they were just asked to rank the sources. This is precisely why studying decision-making can be tricky because there is no way of knowing which is more correct, they are just different based on the experience of how the question is asked (Hensher et al., 2005; Shang & Chandra, 2023).

A final question was posed about who was a preferred service provider between the community, the mines, the municipality, and the government, they also had the option of picking none. About 60% of the participants in Emalahleni revealed that they trusted the community the most. Trust towards the community was demonstrated in their reports that they felt it was very likely that they could improve their water access through this project and that they trusted their ability to run the system to a larger extent.

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Unlike the other two communities, a high number of participants found the survey difficult. The majority found it easy, but it is important to address the large group that did not. This result of difficulty could come from having to consider six attributes that differ in each scenario. Some people may have experienced decision fatigue or choice overload (Bliemer & Rose, 2014). However, the choice experiment was designed with as few attributes and attribute levels as possible to attempt to mitigate this. Perhaps, it was an issue of understanding the choice experiment and how it worked, if participants did not understand or did not have time to analyse

the scenarios, they could have found the survey difficult as a result. This was perhaps not the case, because when looking at how participants made their choices, they can be assumed to have been choosing consciously. After all, most participants chose the option with the best water quality. This revealed that they did analyse the scenarios and were not making random choices like participants in Phola.

In DLM, 16 participants chose the current situation in all cases, for the same reason as those in Emalahleni. However, the 16 participants had different reasons. Eleven felt they did not trust the mines. Perhaps they felt that operating a system like this in the backyard of the mine could result in sabotage. This would not be far-fetched as putting a system in place could appear as an attempt to undermine larger institutions. It would be more likely, that these institutions are the government and the municipality because they must provide these basic needs to the community. However, if the mine had any agendas that would be undermined by the alternative system, they too could organise against the community. One participant felt the government should pay, another felt the companies that caused the pollution should pay. Again, this individual prioritised the institution's roles as the fact that they would have to pay for a basic need was seen as a decision that would essentially decrease utility. One participant felt that the community was not capable of running this system, and another felt they would not use the money as intended, this reflected underlying feelings of distrust towards the community's abilities. One stated that they did not have the money to pay the stated amounts, going out of budget would not be utility maximising so this made sense.

On the flip side, like in Emalahleni, most people made a decision based on their situation and chose the project only because it would be a good deal in their current situation. However, unlike in Emalahleni, more people made a decision that considered the wide community's needs and felt obligated to do it for the whole community. Based on demographics, more people in DLM had jobs daily perhaps because this community had a higher educational level. It would not be so far-fetched to assume that perhaps these aspects afforded them the ability to think of others even if it would cost them slightly more.

When asked to rank attributes, availability was the most influential attribute, this meant when there was a higher level of availability, participants found the scenario was more utility maximising than when the water had a lower availability rate. The source was regarded as the least influential in Phola and Emalahleni but in DLM it was the third most influential. However, when compared to the result of the choice experiment analysis, although availability came up

as significant, it was not the most influential attribute as quality had a higher estimate and significance level. Perhaps this was another demonstration of the hypothetical bias where stated preferences differ from revealed preferences (Shang & Chandra, 2023). In DLM, the results were a bit confusing, mine water was ranked highest and lowest as shown in Table 15. This could be interpreted as a difference based on group preferences or the ranking of the most preferred water source was skewed perhaps because of confusion, but it does not change the fact that mine water was ranked lowest by many participants. The choice experiment data revealed that mine water was the least preferred as both groundwater and surface water reported higher positive estimates. However, the most preferred source was surface water, which was still an unexpected response as surface water contamination was often a big problem in these communities (Ochieng et al., 2010).

DLM's response here remains unclear, however, it would be interesting to understand why DLM participants did not share the same sentiments as Phola and Emalahleni residents. There is often a lot of politics that comes with living in a mining-affected community. The fact that a million-dollar company is situated next to a poor community often creates tension because of the observed inequalities. As established in the study done by Marais and Lenka (2022) these communities are often informal and grow out of the presence of employment opportunities at the mines. However, the interest of these groups often differs, and community members realise that the mines do not care about the nearby communities. It is also why, if an alternative water system was set up, sabotage could occur if the mines' interests were threatened by the system. Members of these mining-affected communities are also employees of the mines and must navigate this diverging interest (Wentzel & Tlabela, 2006; Pelders & Nelson, 2019; Marais et al., 2018). These are just some of the aspects that result in the distrust directed towards the mine.

Half the participants sampled from DLM reported believing in the community's abilities to improve the situation and 1% more people leaned towards trusting the community to run the system. This was unexpected but made sense because although participants believed they could improve the situation, they did not entirely trust the community to oversee the system. There are a lot of needs that are not being met. The system would generate money and produce clean water, perhaps the community recognised how in times of desperation, the money, the parts of the system, and the clean water could be targeted. However, in correspondence with this, DLM indicated the municipality as the most preferred water provider. This was unexpected because the other groups were not trusted. Perhaps the participants expressed distrust towards the mines

for the reasons explained above. The government was most likely an unreliable provider because members of the government often have stakes in the mines, for example, the current president of the country was once a director in Lonmin, which owns the Marikana Platinum mine (BBC News, 2012). This therefore means that when the interests of the mines and the interests of the community clash, the chances that the government would support the community would be slim considering it goes against their interests. The municipality is a local governing body, perhaps this group was shown to be more reliable and perhaps more visible to the community than the overall government body. They may have been responsible for service provision and in many cases failed to do that, but their proximity to the community could be the reason they are seen as more reliable.

4.4 Limitations

Although this research was conducted in an attempt to make it as valid and reliable as possible, there were a few limitations. The research was quantitative and although there were elements of the survey that attempted to capture as much detail as possible, there was still the disadvantage that a quantitative survey limits participants' ability to express themselves in full detail. Furthermore, being a non-experimental design meant that the research could not fully make any causal claims (Turner, 2020; Marudhar, 2019).

A second limitation can be found in the responses. Participants did not always answer every question in the survey, meaning many questions were only filled in by a portion of the whole sample. There were different sample sizes for each question. Valid surveys were those that provided at least 50% of the responses, so all those included in the results were valid, however, there were often questions left unanswered. This has implications for generalisation because this would mean that not everyone was represented in every question.

Some bias was observed in the data collection process too; selection bias to be exact. The enumerators collected data during the hours of 10 am to 3 pm on three days of the week. Perhaps the reason the sample reported such a high level of unemployment was because those were the only people who would be home during this time. This falsely represents the communities to a certain extent. South Africa does have a high unemployment rate so it cannot conclude that the communities were entirely misrepresented (Kundu et al., 2021).

In addition to this, there is no way of knowing that all the surveys were filled in by members of the mining-affected communities. The consequence of having volunteers collect data on your behalf is that, if they are for some reason not in the mood to go from door to door for five

hours, they could do it themselves. It was stressed that they had a right to back out when they wanted to, but these enumerators were volunteers of MACUA so they could have had no interest in the surveys but did not want to let MACUA down by backing out.

Another limitation was, the ranking of attributes in the debriefing question excluded the capacity limit. This would have helped to assess its value as the participants' self-reported perceptions especially since this came up as non-significant. This was still analysed during the statistical analysis of the choice experiment, but this could have been included in the ranking to further support the findings or to assess differences between stated choices and revealed choices.

The use of an entirely new instrument comes with its disadvantages. The survey was designed alongside the community and experts who regularly entered these spaces (MACUA). Regardless, there were no statistical tests conducted to assess the reliability or the validity of the instrument. While face and content validity could be assessed other kinds of validity would have to have been assessed too to confirm the validity of the instrument. In the same way, consistency was checked against community members and MACUA, so this could be interpreted as inter-rater reliability, however, internal consistency reliability would need to be statistically assessed (Taherdoost, 2016).

The sample was distorted to a certain extent as participants in some cases were reporting on the organisations they worked at. Enumerators labelled some of the surveys as coming from the clinics and schools, this was also the reason for the outliers found in Table 6 when they were asked to report daily water usage. It was not stressed enough during training that the target sample was individual households. This would allow for comparisons to be made across the different participants and for demographic statistics to represent the sample and not just who was working at the organisation on that day. The enumerators labelled these surveys so they were easy to identify, however, the exclusion of these should have been stressed during training.

The mining-affected communities in this research were specifically from coal mining sites. This could result in an unrepresentative sample because gold, platinum, chrome, and other type of mining have communities near them that were not included in this study. The demographics could differ, the health issues could differ, and the geography of the area could differ. Though the literature review considers all types of mining, the results come specifically from a coal mining site.

Lastly, it is important to bear in mind that when a person must make decisions, often they need to make that decision because it is important to them for some reason. This study was focused on this process, therefore if participants were distracted or did not care much, the results they provided could be unreliable. This was not only the case with those who reported choosing randomly, but all other responses too. This is not a major concern as no causal claims will be made but it is important to include this as a limitation of this research.

4.5 Recommendations for Future Research

Some recommendations for future studies would be to perform a mixed-methods approach. Having qualitative data could assist when making conclusions about the quantitative results. Perhaps finding a way to make the survey shorter could ensure that all questions were answered by all participants, as well as sampling more than three communities, in other types of mining environments other than coal mining. Perhaps these changes could ensure that the research is fully representative of the diversity that comes with geographical location.

To address any selection bias, future studies should attempt to diversify their methods of data collection. Sampling over the weekends could allow for the inclusion of employed participants in this study. Furthermore, a stricter emphasis on the target sample could be made during training. This would ensure that the enumerators do not sample organisations but focus more on the community members reporting on their own experiences of water in their mining-affected community.

4.6 Conclusion

The presence of mining activity places a huge burden on the individuals who live near it. Not only has such activity led to the displacement of people but it has come with a magnitude of disadvantages for members of mining-affected communities (Wentzel & Tlabela, 2006; Pelders & Nelson, 2019; Marais et al., 2018). It has led to land degradation, interfered with wildlife and vegetation, and resulted in noise pollution, but most importantly, in a water scarce country, it has only exacerbated the situation. Competition for water resources with the mines, as well as acid mine drainage and other forms of water contamination have meant that members of mining-affected communities have had no choice but to become accustomed to a life of having additional sources of water (Archaya & Kharel, 2020; Li et al., 2016; Ochieng et al., 2010). However, these sources are often unreliable or unclean. Therefore, the current research used utility theory to assess the most influential and least influential attributes or variables of water between, water quality, water sources, water supply frequency (availability), capacity limit,

distance, and the price of water. It aimed to understand how valuable each of these attributes was to community members and to hypothetically investigate the feasibility of setting up an alternative water system. Utilizing a choice experiment, participants revealed their perceptions about which combination of attributes was the most or the least utility maximising.

The findings were for the most part expected, as positive utility was perceived whenever quality and availability were at their highest level. Therefore, the highest level of quality and availability were the most preferred. The most preferred source was groundwater, as mine water was not trusted and surface water was perceived to be easily contaminated. Participants reported disutility for distance and price the higher they got, further distances and high cost were perceived to be less utility maximising as expected. The unexpected result was the capacity limit, which was non-significant, the reason for this was unclear and would require further investigation, but this indicated that perhaps this was not as important to participants as expected. Furthermore, distance was the attribute with the highest variability perhaps due to two communities becoming accustomed to walking long distances and the other not so much (Hensher et al., 2005; Batley, 2008; Azari et al., 2012).

Theoretically, the current research demonstrated utility theory by use of a choice experiment. Participants preferred scenarios that were more convenient or more favourable to them and they had very low interest in those that were perceived negatively (Hensher et al., 2005). Existing literature either provides solutions for mine owners, based on a Western sample or a smaller sample, or it did not engage the community enough to enquire about their situation. The current study remedied this issue and focused on investigating experiences with water for potential solutions to the current water crisis (Que et al., 2015; Okolo et al., 2018;). Practically, the current research provides donor organisations or NGOs with a clear indication that members of the mining-affected communities Phola, Emalahleni, and DLM need and are open to alternative systems of water which they believe themselves to be capable of running. The study also adds to the existing literature that demonstrates the damage that mining activity causes in these communities.

The study aimed for validity and reliability but faced several limitations. The quantitative design restricted participants' ability to fully express themselves, and the non-experimental approach prevented causal claims. Additionally, incomplete survey responses led to varying sample sizes for different questions, affecting generalizability. Selection bias occurred as data was collected during hours when unemployed individuals were more likely to be home,

potentially skewing the results. The survey instrument, though designed with input from the community, lacked statistical testing for reliability and validity. Distortion in the sample occurred as some participants reported on organisational data instead of individual households. The focus on coal mining communities limited the broader applicability of findings, and distractions or lack of interest from participants may have impacted the reliability of responses (Turner, 2020; Kundu et al., 2021; Taherdoost, 2016).

Future research should consider these limitations by making use of a mixed-methods approach, combining qualitative data to complement quantitative results. Shortening the survey and expanding the sample to include more communities other than coal mining communities would improve the representativeness of the research. To reduce selection bias, diversifying data collection methods, such as sampling on weekends to include employed participants, would be useful. Additionally, more emphasis should be placed during training to ensure enumerators focus on individual community members' experiences rather than organisational data, enhancing the accuracy and relevance of the sample.

In conclusion, this study provided valuable insights into the water-related challenges faced by members of mining-affected communities, providing ideas about what alternative water systems suit the community and how they came about their decisions. Though there were some limitations, further studies could build on these to enhance researchers understanding of the water-related needs of members of mining-affected communities.

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Appendices

Appendix A

Survey (draft)

Intro questions (before choice experiment):

[Read out loud]

How much water does your household use per day on a normal day?

Who is responsible for making sure the household has water? (for example mother, father etc)

Primary Sources of Water	Mentioned by participant (✓)	Secondary Sources of Water	Mentioned by participant (✓)
Tap inside the house		Tap inside the house	
Tap/hose outside the house		Tap/hose outside the house	
River/Dam		River/Dam	
Communal Tap		Communal Tap	
Rain Water Collection		Rain Water Collection	
Neighbour/s (with cost)		Neighbour/s (with cost)	

Neighbour/s (without cost)		Neighbour/s (without cost)	
Petrol Station		Petrol Station	
Community Centre		Community Centre	
Church		Church	
Public Space		Public Space	
Purchased bottled water		Purchased bottled water	
Other (please specify)		Other (please specify)	

How far is the primary water source ?		How far is the secondary water source?	
Distance	Mentioned by participant (✓)	Distance	Mentioned by participant (✓)
Inside the house		Inside the house	
Just outside the house		Just outside the house	
Within a few 100 meters		Within a few 100 meters	
500 meters (five minutes walking)		500 meters (five minutes walking)	
1 kilometer (10 minutes walking)		1 kilometer (10 minutes walking)	
1-2 kilometers (20 minutes walking)		1-2 kilometers (20 minutes walking)	
More than 2 kilometers (more than 30 minutes walking)		More than 2 kilometers (more than 30 minutes walking)	

10 minutes by car/scooter		10 minutes by car/scooter	
Other		Other	

How often do you have access to the primary water source?		How often do you have access to the secondary water source?	
Distance	Mentioned by participant (✓)	Distance	Mentioned by participant (✓)
All the time		All the time	
Every day but not all the time		Every day but not all the time	
Every second day		Every second day	
A few times per week		A few times per week	
Once a week		Once a week	
Less than once a week		Less than once a week	

How does your current primary water look/taste/smell	How does your current secondary water look/taste/smell

[Please read out loud]

We now want you to suppose that your current water supply situation can be improved. We would like to know how you prefer your improved water supply situation to look like.

Imagine that your community decides to install and operate a community owned water supply system. This system is run by a reputable member of the community who will be chosen by all members. The system will filter and treat water at a cost, which will vary with the desired water quality and water availability frequency. The water will be tested once a month to guarantee the promised quality. Since you will pay for water at the point of collection, you will only pay for what you collect. The community will not make any profit from the system – all collected funds will be used for system maintenance. Community members will be trained to keep the system secure from vandalism and damage. They will be paid a stipend for this role, which will come from water sales.

We will now present you with six situations where you can choose between different water supply alternatives. The water supply alternatives you will see, differ on a number of characteristics, which are:

Water quality: The filter system can clean the water to different levels depending on community needs. Different levels of water cleanliness will have different costs. The water cleanliness levels can vary between:

- Very high (fit for human consumption, drinkable directly from collection point),
- High (fit for drinking and cooking only after boiling),
- Medium (neither fit for drinking nor cooking, but can be used for laundry and bathing),
- Low (not fit for any domestic use – only for watering gardens or livestock use).

Water source: Input water can be obtained from different sources, which will affect treatment costs. Potential sources for input water:

- Mining wastewater.
- Surface water.
- Groundwater.

Water supply frequency: The water supply frequency can vary in the different alternatives depending on filtering capacity, which will also impact on running costs. Water can be collected either:

- On demand all the time;
- Once a day;
- Every second day;

- Once a week;
- Less than once a week.

Limit: Depending on filter system size, water supply capacity at collection can vary as below:

- No capacity limit,
- max 25 liters per person,
- max 10 liters per person,
- max 5 liters per person.

Price: The price the community can charge will depend on many factors and might thus vary between;

- R30/5L;
- R15/5L;
- R5/5L;
- 0R/5L

Distance from your home: Where the system will be located is not currently known but can be at the alternative distances from your home shown below:

- In or just outside your home;
- Less than 200m;
- Less than 400m;
- Less than 1km;
- Less than 5km

Please consider all characteristics when making a choice. If you prefer none of the alternatives shown, you can always choose the “current situation”, which implies that no changes should be made to your current water supply status and with no extra cost to you. Remember, that if you choose to spend money on water, the money cannot be spent on something else.

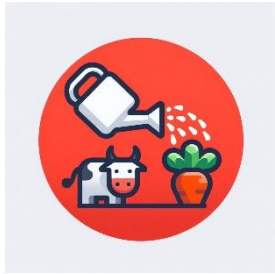
Please consider the choice as a new situation independent from previous choices.

Choiceset 1

Attributes	Project 1	Project 2	Current situation
Quality of the water	Very high 	Medium 	
Availability	Available once a week 	Available on demand all the time 	
Source of water	Water from treated mine water 	Treated surface water 	
Quota	No limit	Max 10 liters	
Distance from your home	Less than 200m	In or just outside your home	
Price	R30/5L	R5/5L	
Mark the preferred option (x)			

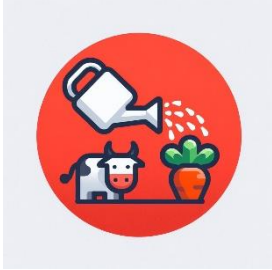
Choiceset 2

Please consider the choice as a new situation independent from the previous choice.

Attributes	Project 1	Project 2	Current situation
Quality of the water	Low 	Medium 	
Availability	Available once a day 	Available less than once a week 	
Source of water	Treated groundwater 	Treated surface water 	
Quota	max 25 liters	max 5 liters	
Distance from your home	Less than 1 km	Less than 400m	
Price	R 0/5L	R 15/5L	
Mark the preferred option (x)			

Choiceset 3

Please consider the choice as a new situation independent of the previous choice.

Attributes	Project 1	Project 2	Current situation
Quality of the water	High 	Low 	
Availability	Available every second day 	Available on demand all the time 	
Source of water	Treated groundwater 	Water from treated mine water 	
Quota	max 10 liters	No capacity limit	
Distance from your home	Less than 5km	Less than 200m	
Price	R 15/5L	R5/5L	
Mark the preferred option (x)			

Choiceset 4

Please consider the choice as a new situation independent of the previous choice.

Attributes	Project 1	Project 2	Current situation
Quality of the water	Medium 	High 	
Availability	Available every second day 	Available once a week 	
Source of water	Treated surface water 	Water from treated mine water 	
Quota	No limit	max 5 liters	
Distance from your home	In or just outside your home	Less than 400m	
Price	R 5/5L	R 0/5L	
Mark the preferred option (x)			

Debriefing question (after Choice experiment):

[read out loud]

Did you find it difficult to make choices between the different choice sets? (*please mark the selected answer with an X*)

Very difficult	Somewhat difficult	neither difficult nor easy	Somewhat easy	Very easy

[If the person chose the “current situation” option every time] Why did you choose not to pay to any for any of the cases? (*please mark the selected answer with an X*)

I do not think the project will have an effect	
I do not care about the water	
I do not have the money to pay the stated amounts	
I do not think the community will spend the money as intended	
I think the money will end up in the wrong hands	
I don't trust the municipality	
I don't trust the mines	
I don't think the project will work	
I don't think my community is capable of maintaining the system	
I think the government should pay instead	
I think the companies who caused the pollution should pay	
I think there are bigger problems than water supply	

Other (please describe)	
-------------------------	--

[If the person chooses one of the project every time]: Why did you choose to pay in all the cases? *(please mark the selected answer with an X)*

I think the presented project is a good idea and I would like to contribute	
I think the project would be a good deal for me in my current situation	
I feel obliged to join for the sake of my community, regardless of my own preferences	
Other (please describe)	

How did you make your choices? *(please mark the selected answer with an X)*

I picked randomly	
I chose the cheapest option	
I always chose the option with the best water quality	
I compared the price and the other characteristics and chose the best	
I chose the one I liked the most	
I chose the one I liked the most no matter the price	

Which of the project elements had the greatest influence on your choice? Please rank from highest to lowest *(with 1 for lowest and 5 for highest influence)*

Price	
Distance	
Quality	
Source	
Availability	

How likely do you think the community will actually improve your water access through the proposed project? (please mark the selected answer with an X)

Not at all	Not very likely	Neither like nor not likely	Very likely	I am certain

To what extent do you trust the institution that will provide water in the improved situation? (please mark the selected answer with an X)

To a very large extent	To a large extent	Neither/nor	To a little extent	To a very little extent,

Please rank the following sources of water according to what you would prefer most (with 1 for most and 3 for least preferred)

Surface water	
Mine water	
Groundwater	

Who would you trust the most as a water provider? (please mark the selected answer with an X)

The mines	The community	The municipality	The government

We will now ask you a few questions to determine whether age or gender for example, had an influence on how you made choices

How old are you?

Gender (observation by the interviewer only)

- ☐ Male
- ☐ Female

Number of other adults in your household

Number of children in you household

How long have you lived where you do now?

How often do you have a job?

- ☐ Everyday
- ☐ Almost everyday
- ☐ A few times a month
- ☐ Almost never
- ☐ Never

Highest qualification obtained

- ☐ Grade 9 and below
- ☐ Grade 10
- ☐ Grade 11
- ☐ Grade 12
- ☐ Higher Certificate
- ☐ Diploma
- ☐ Undergraduate Degree
- ☐ Postgraduate Degree

Appendix B



SCHOOL OF HUMAN AND COMMUNITY DEVELOPMENT ETHICS COMMITTEE
CONSTITUTED UNDER THE UNIVERSITY HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)

CLEARANCE CERTIFICATE

PROTOCOL NUMBER: MAORG-24-01

PROJECT TITLE:

"Clean Water for All, But at What Cost?" A Choice Experiment
Analysis in Mining Affected Communities.

INVESTIGATOR

Chimuka Chiedza

SCHOOL/DEPARTMENT OF INVESTIGATOR

SHCD/Psychology

DATE CONSIDERED

08 July 2024

DECISION OF THE COMMITTEE

Approved unconditionally

RISK LEVEL

Minimal Risk

EXPIRY DATE

31 December 2026

ISSUE DATE OF CERTIFICATE

23 July 2024

CHAIRPERSON

Aline Ferreira Correia
(Prof. Aline Ferreira Correia)

cc: Prof. Andrew Thatcher (Supervisor)

DECLARATION OF INVESTIGATOR

To be completed in duplicate and **ONE COPY** returned to the Chairperson of the School/Department ethics committee.

I/we fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure be contemplated from the research procedure as approved, I/we undertake to submit an amendment of the protocol to the Committee.



Signature

Date

26 / 07 / 2024

PLEASE QUOTE THE PROTOCOL NUMBER ON ALL ENQUIRIES

Appendix C

Participant Information Sheet

Dear Sir / Madam

My name is Chiedza Siobhan Chimuka. I am a Masters student in organisational psychology at the University of the Witwatersrand, Johannesburg. My supervisor is Prof Andrew Thatcher. I am conducting a research study about the individual preferences for access to clean water of people in mining affected communities. The study title is "Clean Water for All, But at What Cost?" A Choice Experiment Analysis of Mining Affected Communities.

I am inviting you to take part in answering the survey. If you decide to take part, your participation in this research study will last about 30 minutes. The survey will take place in person at a convenient time for you.

This data will be stored in password-protected file until the end of the project. Only the researchers will have access to the data.

During the research activity, I will need to ask for some personal information about you, including your age and highest level of education. This will only be used to describe the sample and you will not be identifiable. The survey data will be confidential. When I share the results of the research study, I will not include your name or anything else that could identify you. With your permission, other researchers may use the data collected from this research study, but your name and any personal information will not be used or passed on.

If you decide to take part in the research study, it should be because you want to volunteer. You do not have to take part. You can stop being in the study at any time. You do not have to answer any questions if you do not want to. You will not get any direct benefits if you choose to join the research study. You will not lose any services, benefits or rights you would normally have if you decide not to join. Taking part in the research study will not cost you anything. You will not be paid for being in this research study.

The risks for this research study are no more than what happens in everyday life.

This research study will be written up as a research report. The report will be available on the university library website. If you would like to receive a summary of this report, I will be happy to send it to you.

If you have any questions during or afterwards about this research study, feel free to contact me or my supervisor on the details listed below. If you have any concerns or complaints about the ethical procedures of this research study, you are welcome to contact the University Human Research Ethics Committee (Non-Medical), telephone +27(0) 11 717 1408, email hrecnon-medical@wits.ac.za.

Yours sincerely,
Chiedza Siobhan Chimuka

Researcher:
Chiedza Siobhan Chimuka, 2380829@students.wits.ac.za

Supervisor:

Andrew Thatcher, Andrew.Thatcher@wits.ac.za

Appendix D

University of the Witwatersrand, Johannesburg

Ethics Application Form for Human Research Ethics Committee (HREC Non-Medical)

(SCHOOL ETHICS COMMITTEES: Revised November 2023)

Instructions

1. This form must be completed by Honours (4th year) and Masters by Coursework and Research Report students who require ethics clearance, or for ethics clearance for coursework activities as part of a taught degree. Note that staff non-degree applications, PhD and research Masters students must complete the online form.
 2. Completed applications must be submitted to the relevant School Ethics Committee.
 3. Applications may be submitted as hard or soft (electronic) copies, but the first page of the application must contain the signatures of the student and supervisor. Final revised versions must be in soft (electronic) copy as all documentation will be archived.
 4. Incomplete or handwritten applications will **NOT** be considered, including where signatures are missing.
 5. Necessary supporting documents (e.g. *Participant Information Sheet*, *Consent Form*, copies of instruments, permission letters, etc), must be provided.
-

SECTION A

Please ensure that you have included all the relevant documents in your Ethics Application:

- Completed *Ethics Application Form*.
- Copy of the *Research Proposal*.
- Copy of proposed *Research instruments* (e.g. questionnaires/interview schedules).
- *Participant Information Sheets* (for each different sample group and/or instrument used).
- *Consent forms* (for each different sample group and/or instrument used).
- Relevant *letters requesting permission and/or letters granting permission* if required - consult the *Guidance on the use of Permission Letters* document.

Please complete the signature page below to indicate that you agree with the conditions of application:

SIGNATURES (REQUIRED)

Declaration: We, the signatories, declare that all information on this form is correct and that we will strive to maintain the highest ethical standards in this research at all times, according to disciplinary and university expectations, recognising that ethical practice in research is always a continuing process.

I as the Principal Investigator have prepared this application. I recognise that it is my responsibility to conduct my research in an ethical manner according to Guidelines of the University of the Witwatersrand, according to any laws and/or legal frameworks that may apply, and according to the norms and expectations of my discipline. In preparing this Application for Ethics Clearance form, I have consulted the ***Guidelines for Human Research Ethics Clearance Application/Non-Medical*** (available on this website <https://www.wits.ac.za/research/researcher-support/research-ethics/ethics-committees/>) and have familiarised myself with the ethical guidelines specific to my discipline. I declare that no data will be collected from human participants until ethics clearance has been obtained.

☒ Yes ☐ No

By signing this form, the researcher and supervisor of this project undertake to ensure that any revisions to this application that are required by the Human Research Ethics Committee (Non-Medical) and School Ethics Committees are made and approved before data collection with human participants commences.

	Date	Name	Signature*
Applicant	24/04/2024	Chiedza Siobhan Chimuka	
Supervisor	02/05/2023	Andrew Thatcher	

*electronic signatures are permitted but there are requirements governing this – please see *Guidelines for Applicants* document.

SECTION B

1. Summary of risk categories of this research project

1.1 Does this project involve human participants? ☒ Yes ☐ No
If NO, an ethics waiver may be appropriate. Please complete the Ethics Waiver application form

1.2 I have read and understood the risk categories table ☒ Yes ☐ No
Applicants must have read the table of risk level category definitions on the final page of this document. This table is also available on the University Ethics Committee webpage.

1.3 The applicant must tick the box for the category that best applies to this project:

Risk category	Tick the appropriate box
No risk	
Minimal risk	x
Low risk	
Medium risk	
High risk	

Medium or high risk applications must be submitted by the School Ethics Committee to the University HREC

1.4 Will human participant research involve **vulnerable categories**? ☐ Yes ☒ No

If **YES** state which ones:
 N/A

If **YES**, how will **existing vulnerabilities** among research participants be addressed?
 N/A

1.5 Does this research expose either the participant(s) or the researcher(s) to any **potential risks or harm** to which they would not otherwise be exposed? ☐ Yes ☒ No

If **YES**, describe the nature of the risk and how **potential risks or harm** will be addressed.
See the document for guidance on a distress protocol on the ethics website, if needed

N/A

NB: Vulnerability is context specific. The term 'vulnerable categories' includes, among others, children under 18, orphans, prisoners, persons with cognitive or communication disorders, people who are traumatised or currently in traumatic situations. Vulnerable categories do not necessarily include poor or marginalised communities, older people, women, people with disabilities (unless it results in diminished capacity to give informed consent). Not all research involving 'vulnerable categories' is Medium or High Risk research: here vulnerability must be considered in terms of the nature of the research and the context in which the research is carried out. Where necessary, include details of steps to be taken to facilitate data collection across language barriers (e.g. interpretation or translation).

2. Researcher's personal data

Your family name: Chimuka		Your first name: Chiedza Siobhan	
Title:	☐ Mr	☒ Ms	☐ Other : _____
School:	School of Human and Community Development		
Your student number:	2380829		
Your email:	2380829@students.wits.ac.za		
Your tel number:	0729260117		
Name of supervisor(s):	Prof. Andrew Thatcher		
Your supervisor's Wits email:	Andrew.Thatcher@wits.ac.za		
Your supervisor's Wits tel number:	X74533		

2.1 Is this application for a multi-student project (i.e. several students working on exactly the same topic under the same supervisor)?

☐ Yes ☒ No

If **YES**: List the names and student numbers of additional students working on this project:

N/A

3. Research project	
3.1 Title of research project: “Clean Water for All, But at What Cost?” A Choice Experiment Analysis in Mining Affected Communities	
3.2 Is this research for degree purposes? ☒ Yes ☐ No	
If so, for what degree? ☐ Honours ☒ Masters (research report) ☐ Other (specify) _____	
3.3 Has the proposal been approved by the relevant School or Faculty higher degrees committee or other unit? ☐ Yes ☐ No ☒ Submitted and pending	
3.4 Will any additional researchers be covered by this ethics protocol (including translators/interpreters, research assistants, etc. but not including supervisors)? ☒ Yes ☐ No If yes, please specify their names, affiliations and roles:	

Marie Lauptrup (responsible for data analysis)
Thomas Lundhede (responsible for data analysis)
Innocent Pangapanga (to assist with the write-up)
Eric Mungatana (to assist with the write-up)
Craig Sheridan (project PI)
Peter Holm (project PI)
MACUA enumerators (conducting data collection):
Hlobisile Shongwe
Nomvula Maswa
Nonhlanhla Mabuza
Thapelo Bhekane
Thulani Nkosi
Tumelo Kikane
Kholofelo Masipane
Kgotlelelo Mahlangu
Mzwandile Qwabe
Thokozane Mabuza
Mlungisi Mahlangu
Phumzila Buda
Thobani Khoza
Khethukuthula Sibiya
Clearence Lubisi
Zodwa Grace Ngubeni
Daisy Tshabangu
Sibongile Mwako
Emmah Jigane
Nomvula Mashane
Alice Mostepe

3.5 What are the aims and objectives of the research? (Please be specific)

The current research aims to empirically identify the most and least valuable attributes in water provision as reported by members of mining affected communities using a discrete choice experiment. In other words, which levels of each of the variables are seen to maximise water utility the most.

3.6 Summary or abstract of the research (100 words maximum)

Give a brief outline of the research plan such that reviewers can understand what the study is about, who the participants are (and where/how you are recruiting them), and how you will collect the data.

This study uses Utility Theory and a choice experiment to identify participants' water utility preferences, quantifying their willingness to pay in terms of financial cost, distance, water quality, availability, water limit, and water sources. It aims to empirically identify the most and least valuable attributes in water provision as reported by community members. The study will target a sample of adults living in mining-affected communities, using a purposive volunteer sample obtained through face to face surveys consisting of introduction questions, a choice experiment, debriefing questions, and a demographics section. The survey data will then be captured digitally for analysis.

3.7 Do you have any **financial or material interests or a relationship** associated with your research participants or with the organisations that you will be involved with in your research? (such as a familial relationship; lecturer/student relationship; collegial relationship; employer/employee relationship)

☐ Yes ☒ No

If yes, please **explain** this potential conflict of interest:
N/A

Also explain how you will **manage any existing or potential conflicts of interest and potential coercion** during recruitment and data collection, if applicable:

MACUA enumerators will be fairly remunerated for the data collection.

4. Formal permission

1.1 Where will the research be carried out? (Please give a specific location)

Adults in mining affected towns in Mpumalanga in the eMalahleni area.

1.2 Name all organisations or research sites where permissions are needed, if applicable:

Mining Affected Communities United In Action (MACUA)
4.3 Has appropriate formal permission been obtained from these organisations or research sites, if required? ☐ Yes (attached) ☐ Not required ☒ Pending (must be supplied before ethics clearance can be given)
NB: Obtaining permission is often necessary when conducting research <i>within the premises</i> of a particular site such as an ethnographic study of the functioning of a supermarket or a school, or the way staff interact with clients in a clinic or how members of a closed social media group interact/post on a specific topic. Permission is also required to use data from personal communication with participants or experts. Please note that any research done on Wits University campuses with employees or students of the University requires formal permission from the Registrar. Please read the <i>Guidance on the Use of Permission Letters</i> document on the Ethics website.

5. How will data on human research participants be collected (instruments, methods, procedures)?
(tick all applicable boxes) (NB: All applicable instruments must be attached to the application)

☒	Hard copy questionnaires or psychometric tests, etc.
☐	Online instruments (e.g. questionnaires, surveys)
☐	Individual interviews (e.g. structured, semi-structured, etc.)
☐	Group interviews (e.g. seminar/discussion groups, focus groups, etc.)
☐	Ethnographic observation, participant observation, other informal descriptive, and/or interactive methods (you <u>must explain</u> the ethnographic methods in the box below)
☐	Autoethnography (you are the participant in such a study, please refer to the <i>Guidelines</i> document)
☐	Community-based methods or techniques such as drama workshops, community theatre, training workshops, participant rural appraisal, rapid rural appraisal, etc. (you <u>must explain</u> in the box below)
☐	Research on/in therapeutic or counselling contexts
☐	Putting on your own exhibition / public performance
☐	Observation of public performances, and/or public behaviour observation
☐	Photography
☐	Video recording
☐	Audio recording (e.g. of interviews)
☐	Use of data from social media
☐	Other research methods or techniques (you <u>must explain</u> in the box below)

Explanation of **all research methods** specified above, and explanation of any other **research methods that are not listed** above:

A closed-ended survey will be administered which includes an introduction section, a choice experiment, a debriefing section, and lastly a demographics section.

The introduction questions will be in a short answer, self-report format with questions that give us background information about the participants. Some example questions include “how much water do you use per week?” and “how does your current primary water look/taste/smell?”.

The choice experiment will be administered next. This section will contain six attributes that make up the variables in this study. They will be represented along with their varying levels from which participants will have to choose their most preferred level for each of the attributes. Participants will indicate their preference by writing the level name in the last row of each corresponding attribute. The six attributes include quality of water, availability, source of water, limit (capacity each member can get), price, and distance from home. For each of these variables, specific levels were devised beginning with the quality of water which will give participants a choice between the ‘best (for human consumption, directly drinkable)’ to the ‘worst (watering plants, feeding livestock)’. The second attribute is availability which will have 5 levels ranging from ‘available on demand all the time’ to ‘available less than once a week’. The source of water will range from ‘water from treated mine water’ to ‘treated ground water’. The limit will range from ‘no limit’ to ‘maximum 5 litres per person when collecting’. The fifth attribute will be Price which will range from ‘R30/5 litres’ to ‘R0/5 litres’. Finally, Distance from your home will be assessed and this will range from ‘in or just outside your home’ to ‘less than 5 kilometres’.

The debriefing survey will be the last section of the survey. It will contain debriefing questions that could tell us more about the motivations behind the choices made in the choice card. Some example questions include “How likely do you think it is, that the community will actually improve your access to water through the proposed project?” and “Did you find it difficult to make choices between the different schemes?”. There will be six of these and they will be answered in short answers. Following this will be seven debriefing questions for participants to answer that range from 4, 5-, 6-, 7-, and 13-point Likert type response formats. The high scores and low scores have varied meanings for each question because they all measure different aspects, there is not one collective construct measured by the survey.

Lastly, the demographic section will include questions about the participant's age, the number of dependents in their household as well as their employment status just to mention a few (see Appendix A).

6. Who will the research participants be?

6.1 List the **different participant groups** that you will be working with in your project:

Adults in mining-affected communities

6.2 Specify the **age range** and **sample size** for **each participant group**:

200-300 people

6.3 Specify **which participant group** will be doing **which data collection activity** in your project:

All participants will be completing the survey.

7. How will informed consent be obtained?		
7.1 How will potential participants be identified in your project?		
MACUA enumerators will go to mining-affected areas and handout surveys to people who volunteer to participate in the study		
7.2 How will potential participants be approached and recruited , and by whom?		
Potential participants will be approached by the MACUA enumerators in person in their communities and invited to participate.		
7.3 How will informed consent be obtained from your participants?		
☒ Formal (Signed form)	☐ Informal (e.g. verbal)	☐ Other (e.g. online survey)
7.4 Please explain your strategy for obtaining informed consent:		
A Participant Information Sheet will be provided to participants. This will contain an explanation of the research topic, and the participants' role in the research. There will be information on what the data will be used for and how it will be stored to ensure ethical principles are upheld. Furthermore, it will stress that participation is voluntary and that once a participant agrees to participate, they can back out at any point. Some personal contact details will be provided for any follow-up questions or feedback requests from participants. A Consent Form will be provided to participants. This will allow them to read and understand that participation is voluntary and they can back out at any point. It will allow participants to formally give their consent to participate in the research study.		
7.5 Will any incentives or reimbursement of costs be offered to participants? (NB: it is NOT compulsory to offer any incentives. Please note for any curricula incentives, permission is required from the Registrar's office and DVC. Financial incentives or reimbursements are limited to R150 – see <i>Guidelines</i> document)		☐ Yes ☒ No
If YES, please explain: N/A		
NB: Attach <i>Participant Information Sheets</i> and <i>Consent Forms</i> for each participant group (please label these carefully), and/or other related materials. It is essential that participants be fully informed (irrespective of the method used) and then be able to agree on this basis to participate in the research. Refer to the <i>Guidelines for Applicants</i> document for strategies on obtaining informed consent.		
8. Protecting participant identities		
8.1 Can confidentiality of participants' responses be guaranteed throughout the data collection process?	☒ Yes	☐ No
8.2 Can anonymity be guaranteed throughout the data collection process?	☒ Yes	☐ No
8.3 Can anonymity be guaranteed in resulting research reports or publications?	☒ Yes	☐ No

Definitions: *Confidentiality*: that any information considered confidential by the participant or researcher will not be disclosed to others. *Anonymity throughout the data collection process*: that you as the researcher will not be able to identify the participant. *Anonymity in the resulting reports*: that the participant's name/identifying data will not be disclosed and that anyone reading your results will not be able to identify the participant. **NB:** While confidentiality may be desirable, it cannot be guaranteed in, for example, focus groups, or ethnographic observations. Similarly, anonymity should be preserved in questionnaires, but cannot be offered in workshop methodologies, focus group research, etc. Participants should have the right to remain anonymous in the final report and this must be respected in handling of all data relating to them. Participants need to be informed about these issues through the *Participant Information Sheet*.

9. Protection of data during and after the research

9.1 How will the data and the identities of participants be protected while the research is **in progress**?

All information will be locked away on a password-protected computer. No names or identifying information will be recorded in data collection.

9.2 What is to be done with the research data **after completion** of the project? (Please note that usage of data should be consistent with what is indicated to participants in the *Participant Information Sheet* and *Consent Form*.)

☐	Stored in archives (specify below)	☐	Stored in online public database (specify below)
☒	Stored in password protected computer / data cloud	☒	Stored in digital form with all identifying features removed
☐	Stored for future secondary analysis	☐	The data will be kept for ... years (insert numbers of years, if applicable), after which it will be destroyed.

Please specify which **archives or online databases** will be used for data storage (if applicable):
N/A

Please specify in what **format** the (deidentified) data will be stored and who will have **access** to the data:

Data will be kept in an anonymised Excel spreadsheet. Only research team members will have access to the data.

NB: 'Raw' or unprocessed data, especially **where the identity or personal data of research participants is included, must be safeguarded** and preserved from unauthorised access. Data may be destroyed after use, but **preservation in an archive or personal collection** may also be appropriate, desirable or even essential. For instance, datasets that contain **historically important information** or information that relates to **national heritage** must be preserved and should be placed in a public archive where possible and appropriate. An **online database** could include secure databases such as REDCAP, or open access databases (see loadb.org for examples). All data should be preserved in a way that **respects the nature of the original participants' consent** and aligns with POPIA. If you are unsure about the procedure of data management and storage, please contact the Data Services Librarian.

10. Summary CV of applicant ALL boxes in the following table must be completed by the applicant. Do not attach a formal CV to your application.																															
10.1 List your academic qualifications. Include dates and/or current registration status	Bachelor of Arts Degree General Majoring in Organisational Psychology & International Relations 2022 Bachelor of Arts Honours Degree in Organisational Psychology 2023 Master of Arts Degree in Organisational Psychology – currently registered																														
10.2.1 Describe any ethics <u>content</u> training* you have received in the previous 3 years (e.g. ethics short courses; online courses; ethical input as part of a research methods course).	Research Methods in Psychology 2023 where ethics was taught throughout the course SPP Program in February 2024 which was administered to all Masters in Psychology groups.																														
10.2.2 Please state the course name/course code and date attended	SPP Ethics in Research Training Date & Time: 7 th February 2024, 2pm – 5pm Lecturer: Dr. Clare Harvey																														
10.3 List of instruments or methods used in this project, as listed in Section 5 of the application form (Tick the appropriate boxes and describe these specific instruments if necessary)	<table border="1"> <tr><td>☒</td><td>Hard copy questionnaires or psychometric tests, etc.</td></tr> <tr><td>☐</td><td>Online instruments (e.g. questionnaires, surveys)</td></tr> <tr><td>☐</td><td>Individual interviews (e.g. structured, semi-structured, etc.)</td></tr> <tr><td>☐</td><td>Group interviews (e.g. seminar/discussion groups, focus groups, etc.)</td></tr> <tr><td>☐</td><td>Ethnographic observation, participant observation, other informal descriptive, and/or interactive methods (you must explain the ethnographic methods in the box below)</td></tr> <tr><td>☐</td><td>Autoethnography (you are the participant in such a study, please refer to the <i>Guidelines</i> document)</td></tr> <tr><td>☐</td><td>Community-based methods or techniques such as drama workshops, community theatre, training workshops, participant rural appraisal, rapid rural appraisal, etc. (you must explain in the box below)</td></tr> <tr><td>☐</td><td>Research on/in therapeutic or counselling contexts</td></tr> <tr><td>☐</td><td>Putting on your own exhibition / public performance</td></tr> <tr><td>☐</td><td>Observation of public performances, and/or public behaviour observation</td></tr> <tr><td>☐</td><td>Photography</td></tr> <tr><td>☐</td><td>Video</td></tr> <tr><td>☐</td><td>Audio recording (e.g. of interviews)</td></tr> <tr><td>☐</td><td>Use of data from social media</td></tr> <tr><td>☐</td><td>Other research methods or techniques (you must explain in the box below)</td></tr> </table>	☒	Hard copy questionnaires or psychometric tests, etc.	☐	Online instruments (e.g. questionnaires, surveys)	☐	Individual interviews (e.g. structured, semi-structured, etc.)	☐	Group interviews (e.g. seminar/discussion groups, focus groups, etc.)	☐	Ethnographic observation, participant observation, other informal descriptive, and/or interactive methods (you must explain the ethnographic methods in the box below)	☐	Autoethnography (you are the participant in such a study, please refer to the <i>Guidelines</i> document)	☐	Community-based methods or techniques such as drama workshops, community theatre, training workshops, participant rural appraisal, rapid rural appraisal, etc. (you must explain in the box below)	☐	Research on/in therapeutic or counselling contexts	☐	Putting on your own exhibition / public performance	☐	Observation of public performances, and/or public behaviour observation	☐	Photography	☐	Video	☐	Audio recording (e.g. of interviews)	☐	Use of data from social media	☐	Other research methods or techniques (you must explain in the box below)
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☐	Audio recording (e.g. of interviews)																														
☐	Use of data from social media																														
☐	Other research methods or techniques (you must explain in the box below)																														
10.4 Describe your previous experience or training in deploying the instruments or methods of research which you are applying here (refer to Section 5 and Section 10.3)	I have no prior experience in administering choice experiment surveys, but Thomas Lundhede, a researcher on the research team and an expert in choice experiments will train me to be able to do so. I did have a little bit of experience learning how to go about administering general surveys in a class during Honours last year.																														

*Ethics training is strongly recommended, especially for postgraduate students. Please consult the *Guidelines for Applicants* document for details of training options.

HREC (Non-Medical) Risk level categories definitions (November 2023)

This table identifies broad categories of risk. Schools/Departments can provide specific examples of these categories that are specific to that particular discipline, or the types of data collection methods or participant groups that are most common in that discipline. Please note that any study involving minors cannot be considered by Schools irrespective of the risk level.

Risk category	Definition	Examples	Notes
No risk	No contact with human participants	- Document analysis or literature review - Studies based on theoretical or secondary analysis alone - Use of non-human, quantitative datasets (e.g. economic data) - Use of previously-collected human datasets (where previous participants gave their consent for their data to be reused – please check this against the original consent forms; and where a permission letter from the P.I. of the previous study has been obtained) - Use of anonymized and aggregated human datasets (e.g. census data)	These studies <u>do not</u> require full ethics clearance but an ethics waiver form must be completed if required by a university, faculty or external body. These studies <u>may require</u> full ethics clearance, dependent on the type of study and faculty requirements. If full clearance is not needed, an ethics waiver form should be completed, if required by a university, faculty or external body. Applications deemed No Risk can be considered at School level.
Minimal risk	Where the likelihood and magnitude of possible harm are no greater than those imposed by daily life in a stable society, or routine educational or psychological tests	- Questions about people's everyday lives, activities and opinions rather than detailed biographical information - No sensitive questions or topics - Review of privileged information (e.g. documentation not publicly available) - Use of posts from social media	Applications deemed Minimal Risk can be considered at School level.
Low risk	Where the only foreseeable risks is that of discomfort, or where there may be some sensitivity involved in terms of the questions asked	- Questions about people's everyday lives, activities and opinions – may include biographical information and some potentially sensitive questions and/or topics - May include some vulnerable participants and / or contexts - Use of posts from social media	Applications deemed Low Risk can be considered at School level.

Medium risk	Where there is a likely risk of some harm for participants and/or the researcher, but where appropriate steps can be taken to mitigate or reduce risk	• Sensitive topics and/or questions that may have potential for trauma and emotional distress • May include vulnerable categories or marginalized groups, may include some types of low-level illegal activities, such as artisanal mining • Research locality itself may contain potential risks to the participants and/or researcher • There is a clear justification to undertake the research using this participant group and/or using the proposed instruments, despite the potential risks • Use of posts from social media	Applications deemed Medium Risk cannot be considered at School level and must be referred to the main committee. Support/counselling services must be provided for participants, if appropriate. A distress protocol should be given, if appropriate.
High risk	Where there is a real and foreseeable risk of harm which may lead to serious adverse consequences if not managed in a responsible manner	• Highly sensitive topics, e.g. experiences of violence, rape, illegal activities • Vulnerable or marginalized groups, or where multiple vulnerabilities exist • Research involving deception of the participants • Research involving serious illegal and criminalized activities, such as violence, fraud • Where the participants place themselves at risk of harm if they participate • Where the researcher may place themselves at risk of harm • Where the researcher may place themselves at risk of breaking the law • Where the research may reveal information that may place the participant or others at risk (e.g. victims of abuse, violence), requiring intervention from government, university or other institutions • There is a clear justification to undertake the research using this participant group and/or using the proposed instruments, despite the potential risks	Applications deemed High Risk cannot be considered at School level and must be referred to the main committee. Remedial interventions by external professionals can be taken should harm occur. Support/counselling services must be provided for participants and/or for the researcher. A distress protocol and debriefing strategy should be given, if appropriate

NOTES:

(1) Definitions of terms

Discomfort refers to a sensation of uneasiness, disturbance or mild pain.

Harm refers to damage incurred (which may include physical, psychological/emotional, social, economic or legal harm) as an outcome of an action, or through emotional distress.

Risk refers to (i) the likelihood of exposure to a particular negative consequence, and/or (ii) the magnitude of the possible consequences of exposure, and/or (iii) the possibility that research could result in harm.

(2) Discussion of risk

Individuals that may be at increased risk include:

- Those who are dependent/reliant on the institution/person who provides/mediates access to researchers;
- Those who are involved in illegal activities or who are criminalized by the state, e.g. drug dealers, sex workers, undocumented migrants.

NB: it is essential to consider the individual – not an aggregated group – when assessing risk.

(3) Discussion of vulnerability

Vulnerability can stem from: a lack of capacity or impaired ability to provide voluntary informed consent; health status; social pressures that may impact on the ability to make a free and informed decision; an inability to protect one's interests in research. Vulnerability may be considered as dynamic and specific to a particular context, and may arise as a result of power asymmetries between participants and researchers/institutions. There may be layers of vulnerability that function and interact within a participant's circumstances. Being vulnerable does not necessarily imply that harm or exploitation will occur, but it does increase the risk of harm or exploitation through research.

In addition to those in vulnerable categories, vulnerability may also include individuals whose ability to provide informed consent may be reduced where:

- Their decision-making capacity is limited due to individual mental health status;
- Their decision-making capacity is limited due to the environment in which they live/work, e.g. prisoners/detainees, residents of drug rehabilitation centres;
- They are under 18 years of age;
- They are dependent on the state to maintain a legal status, e.g. documented asylum seekers, documented refugees.

NB: it is essential to consider the individual – not an aggregated group – when assessing vulnerability.

The researcher needs to minimise the risk of harm, ensure that the consent process supports a truly informed decision, and put in place additional measures to ensure ethical involvement of vulnerable groups. Where necessary, include details of steps to be taken to facilitate data collection across language barriers (e.g. interpretation or translation) and/or in cases of illiteracy.

Useful references:

Bracken-Roche, D., Bell, E., Macdonald, M.E. and Racine, E. (2017). The concept of 'vulnerability' in research ethics: an in-depth analysis of policies and guidelines. *Health Research Policy and Systems*, 15 (1), 8, doi:10.1186/s12961-016-0164-6.

Horn, L., Sleem, H. and Ndebele, P. (2014). Research vulnerability. In: M. Kruger, P. Ndebele and L. Horn (Eds.), *Research ethics in Africa: A resource for research ethics committees*. Stellenbosch: SUN Press, pp. 81-90.

(4) Distress protocol

A 'distress protocol' is a procedure to follow in emergency situations where, for example, a participant becomes clearly distressed during an interview. Under such situations, the interview is terminated and the distress protocol is enacted. Researchers may need to consider:

1. The possible distress experienced by the participant: e.g. questions that address issues of abuse, abandonment, previous negative sexual experiences, or traumatic memories that may induce distress. A distress protocol must include the name and contact details of an appropriate provider who can provide support, at no cost to the participant. This may include counselling services or access to NGOs/law clinics;
2. The possible distress experienced by the researcher: this may include provisions for how the safety of the researcher will be supported, and should be discussed with supervisor and the name and contact details for counselling services provided if needed.
3. Guidelines on how to draw up a distress protocol are given on the ethics website.

Appendix E



University of the Witwatersrand,
School of Human and Community Development

Fatima Vally
Mining Affected Communities In Action
62 Juta Street
Braamfontein
Johannesburg, 2000
+27(0) 67 720 1594
fatima.vally@macua.org.za

14/06/2024

Dear Madam,

Re: Permission to conduct research through MACUA

My name is Chiedza Siobhan Chimuka

I am a Masters student in organisational psychology at the University of the Witwatersrand, Johannesburg. My supervisor is Prof Andrew Thatcher. I am conducting a research study about the individual preferences for access to clean water of people in mining affected communities. The study title is “Clean Water for All, But at What Cost?” A Choice Experiment Analysis in Mining Affected Communities.

I request permission to get access to community members through your organisation’s expertise.

I will invite individuals from your organisation to participate in this study. If they agree, they will be trained to understand the survey first.

They will then be asked to distribute the survey to members of these communities explicitly communicating issues of consent before collecting the data. Their participation will be treated confidentially, and identities will not be revealed in the research.

Volunteers should know that taking part in the research study will not cost them anything. MACUA enumerators will be fairly remunerated for the data collection.

The risks for this research study are no more than what happens in everyday life.

This research study will be written up as a research report. The report will be available on the university library website. If you would like to receive a summary of this report, I will be happy to send it.

If you have any questions during or afterward about this research study, feel free to contact me or my supervisor on the details listed below. If you have any concerns or complaints about the ethical procedures of this research study, you are welcome to contact the University Human Research Ethics Committee (Non-Medical), telephone +27(0) 11 717 1408, email hrecnon-medical@wits.ac.za.

Yours sincerely,

Chiedza Siobhan Chimuka

2380829@students.wits.ac.za

Supervisor: Andrew Thatcher

Andrew.Thatcher@wits.ac.za

Appendix F



Consent Form

“Clean Water for All, But at What Cost?” A Choice Experiment Analysis in Mining Affected Communities

Chiedza Siobhan Chimuka

I,, agree to participate in this research project.

I agree to the following:

(Please circle the relevant options below)

The research study was explained to me. I understand what this study is about.	YES	NO
--	-----	----

I understand that I can volunteer to take part in the study	YES	NO
---	-----	----

I agree that my participation will remain anonymous (my name will not be used by the researcher in their research report)	YES	NO
---	-----	----

I agree that other researchers may use the information I provide in my survey (depending on their own ethics clearance being obtained) but my name and any personal information will not be used or passed on	YES	NO
---	-----	----

..... (signature)

..... (date)

..... (signature)

..... (name of researcher/emmunerator)

..... (dat

