

Where's the Water?

An educational game by Pebbles

XBCGD7311:
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Introduction

Disadvantaged communities in South Africa face many challenges in their daily lives. Access to clean drinking water is an existential need for human survival, yet many communities across South Africa have limited access to this human right. The goal of Where's the Water is to bring awareness to the issue, and educate players on how water is collected, treated and used. Additionally, the goal is to show the importance of water in society and nature, and encourage players to do their part in understanding, respecting, and conserving water.

Whereas the Water will not solve the issue, but educating people, particularly children and encouraging them to embrace water wise habits can make a difference in the years to come. Where's the Water aims to approach this important topic with empathy and understanding, backed by significant research.

Nevertheless, the team recognises the importance of entertaining gameplay, and aims to provide entertainment and education through the medium of gaming.

The document that follows, will explain the thought processes, target, and techniques that are employed in the creation of Where's the Water.

TASK 1: Proposal of two game ideas

We brainstormed and came up with two different social issues and games based around that idea. The first issue was the water crisis, and the game was a pipe game based on that. The second issue was the housing crisis and was a game where you built a house by collecting bricks and building supplies.

XBCGD Ideation 1: Water conservation

The Problem

Across the world there are an estimated 2.2 billion people that do not have access to clean drinking water (DBSA, no date). In the South African context, the situation is even more dire. According to ESI Africa “South Africa is approaching physical water scarcity in 2025 where they are expected to experience a water deficit of 17% by 2030, and climate change will worsen the situation.” (ESI Africa, 2020).

As discussed by the DBSA there are several contributing factors that compound the threat of water scarcity in South Africa, these include (but are not limited to); frequent droughts, global warming, poorly or untreated sewage, improper disposal of industrial and pharmaceutical wastewater, treatment plants in poor or critical condition, under-used groundwater and an uninformed/uneducated population in effective methods of water conservation (DBSA, no date).

The Goal

The goal of this project is to educate the youth of South Africa about the vital role water plays throughout our lives. From sustaining our bodies, to growing our food and even its role in the economy. We endeavour to take our players on a journey through the pipeline, from a water source, through treatment/filtration and thereafter down the many possible avenues that water travels to be used by South Africans.

Along the way we will challenge our players through more difficult gameplay loops and puzzles. Our target age group is children between the ages 9 – 14. We have selected this age group because we believe they are not only at an appropriate age to learn more complex details about the vital role that water plays in our world and be introduced to the topic of conservation but are developed enough to take on more challenging puzzles and are more likely to hold an intrinsic desire to best the challenges set for them.

The Game

Narrative

As stated above the overarching narrative will follow the journey of water being transported from its source to be treated at a treatment facility and then be distributed for various purposes (i.e., agriculture, drinking water etc...).

Mechanics

The game takes the form of a pipe connection puzzler. The player must connect variously shaped pipe objects to allow water to flow from a given source to a target. As levels become more complex the water may need to cross certain objects or be interacted with in different ways to meet the criteria to pass a given level.

For example, the first level where water must be transported from its natural source to a treatment facility need not be treated or filtered. However, to complete the second level at the treatment facility the water will need to go through a special filtering object. In a later level, the water may need to be filtered, chemically treated, and even heated and or cooled.

Levels will be set up with some pieces of the pipeline set in place as immovable stationary objects while other pieces of the pipe puzzle will be placed in error and must be manipulated or replaced entirely in order for the puzzle to be completed successfully and allow water to flow.

We also plan to introduce a hazard mechanic where several pipe elements can become rusted and must be interacted with in order to be repaired or the rust will cause the pipes to leak water (negatively impacting the player's score).

The score will be calculated based on the time taken, minigame score and amount of water conserved. We also plan to appeal to the Achiever and Collector archetypes (as described by Richard Bartle in his taxonomy of player types) (Schell, 2020). We plan to design for these archetypes through our gameplay and by rewarding the player with further information on

the role of water, its uses, how we prepare it, government/NGO conservation initiatives and personal practices regarding water conservation.

The player will collect this information in the form of in-game journal entries. The closer the player achieves to an “A” rank in a level the more information they unlock. This will incentivise players to replay levels to successfully “complete” the game and unlock all of the “prizes”.

Educating the player

At the beginning and end of each level, the player will be presented with information about water and the vital role it plays in our world. The information supplied at the beginning of the level will provide context for the level itself while the information presented at the end of a level will provide the player with context surrounding initiatives already being undertaken by the government and NGOs to address the problems South Africa is facing regarding its water supply. We also plan to point our players to several sources they can use to educate themselves further on water conservation.

XBCGD Ideation 2: Building a Future

The Problem

“The first step of the double diamond is discovery, learning about the problem and starting the initial research into the challenges and problems that need to be solved.” (Gearon, 2022). South Africa has a host of broad social issues and the game will serve to draw attention to a handful of them. Primarily, the housing crisis and the difficulties that children (especially those economically vulnerable) face while trying to get an education. Additionally the disconnect between those from wealthier backgrounds and those from poverty stricken backgrounds results in a lack of understanding that hinders attempts to improve the situation. That apathy towards fellow South Africans, and the idea that there is little point in trying to help reinforces the idea that there is little opportunity to improve. Understanding the problem is the first step towards making change.

The Goal

Provide a game targeted at children aged 10-13. This age group necessitates a simpler game, but is designed to show children with higher economic backgrounds the realities and difficulties that those on the lower end of the economic scale face. The goal is to foster understanding and empathy, as well as encourage the players to take more community minded decisions in the future. The final goal is to inspire hope for the future.

The Game

Mechanics

Layer 1

The mechanics of the game are simple. Good and bad objects will fall from the sky. The player will need to move left and right below the objects catching the good items while avoiding the bad items. The good items will provide score, while the bad items will stun the player making them unable to move temporarily. A combo metre will fill up rewarding consecutive catches while a timer ticks down. During the score screen, the player will be shown statistics and information about the problem.

Layer 2

At the start of a level, there will sometimes be an active effect that makes it more difficult. These could include heatwaves, rain, loadshedding or wind that will have an adverse effect on gameplay.

Layer 3

The game will consist of several short runs, in a roguelite format. In between runs, there will be a shop where the player can purchase modifiers to make following runs more efficient. These can range from increased movement, more time, more items falling, temporary shields to block stuns, etc. The objective of the player is to accomplish an overarching goal that will take several runs to complete.

Narrative

The narrative of the game can be varied according to level. To start with, the first level will follow a character attempting to gather materials to build a house. This journey will highlight the housing crisis faced by many South Africans. Over time the resources will stack up and the house will be built, the gameplay will highlight the time and difficulty the process will take.

The second level and issue will be that of education where a school child must gather books and school lunches while avoiding bad items representative of the issues faced such as violence and corruption.

Educating the player

The player will learn about the difficulties and struggles faced by many homeless and economically vulnerable South Africans. While the gameplay will be kept fun and simple, in between levels there will be narrative aspects as well as little facts, infographics, and statistics that show the realities that these people face on a daily basis.

Our Choice

As a group we have decided to go with the first game as our project for the XBCGD POE.

TASK 2: High Concept Document

The water crisis in South Africa

The ongoing and increasing water crisis in South Africa presents a daunting challenge that hangs over the heads of all South Africans. From severe droughts and climate change to poor water management systems, the crisis is becoming increasingly threatening to not only our prosperity as a nation but our ability to preserve our very lives. The annual precipitation in South Africa is only a mere 52% of the global average and yet most water management systems such as dams and yields are fully or over utilised (World Bank Group, 2022).

The water crisis is further exacerbating climate change impacts which is caused by the burning of fossil fuels for the production of electricity in South Africa (Igamba, 2022). Coal plants are massive consumers of water in South Africa and since there is no sign of South Africa moving to solar power or any other renewable energy source as its main source of energy any time soon, this will remain a substantial concern for the indefinite future. Coal plants require water at every stage of production. From the extraction and preparation of coal in coal mines to the incineration of coal at coal-fired stations. Even in the prevention of the dust and pollution produced by mines and PowerStation to the disposal of coal by products.

Eskom's new mega coal plants are bound to drastically worsen the water crisis in South Africa, especially for the poor. At the moment there are an estimated one million households in South Africa without access to water (GreenPeace, 2022). To put the negative impact Eskom has on South Africa's water crisis, Eskom's most water efficient coal plant, Kusile, situated in Delmas uses 2.9 million litres of water each hour of the day (GreenPeace, 2022). Eskom is estimated to use ten thousand litres of water a second which is equivalent to the amount the average person in South Africa uses in a year. Of the 22 active mines in South Africa back in 2010, only half were operating with a valid water licence. This lack of transparency and illegal activity is another threat to South Africa's water security. (GreenPeace, 2022).

Fast increasing population in conjunction with slow increasing water storage areas are also a major contributor to the severe water crisis in South Africa. For example, in Cape town the population saw a 67% increase from 1996 (2.4 million) to 4 million in 2017 while during that same time period, dam storage increased only by a measly 15%. (Calverley and Walther, 2022).

Economic issues

South Africa's major cities are home to about 40% of the nation's population which produce 60% of South Africa's Gross Domestic Product (GDP) (World Bank Group, 2022). Narrowing it down and just focusing on just the City of Cape Town (CoCT) and its surrounding areas are responsible for 9% of the country's GDP and 70% of the province's GDP. On the other hand,

agriculture is responsible for 4% of the Western Cape's GDP and 8% of employment (World Bank Group, 2022).

Direct economic impact of the water crisis on the Western Cape was estimated to be R15 000 000 (3.4%, provincial GDP, and 0.3% of national GDP) in 2018 (World Bank Group, 2022). During the drought between 2016-2019, provincial exports fell 13-20% and the Western Cape accounts for 55 to 60% of the nation's agricultural exports (World Bank Group, 2022). The drought also had a major impact on subsistence farmers and domestic and international arrival resulting in an estimated 37000 lost job opportunities (World Bank Group, 2022).

FIGURE 2: Literature review-based summary of drought impact on sectors in the Western Cape



Source: Original to this publication.

Figure 1: World Bank Group. Literature review based summary of drought impact on sectors in the Western Cape. (World Bank Group, 2022)

Social issues

The current water crisis has resulted in lack of accessible and clean water to 19% of the rural population, 33% lack basic sanitation and more than 26% of schools and clinics in the country do not have access to water (Igamba, 2022). As per (Calverley and Walther, 2022), poor and marginalised groups in South Africa will experience the brunt of the water crisis and this is due to the deep-rooted history of inequity divided along racial and class lines in South Africa (Calverley and Walther, 2022).

The water shortage could result in a number of socio-political issues such as civil unrest, violent disputes between people which can lead to nationwide riots and protests and a more severe case would be the creation of a water black market which will allow vendors to sell contaminated water and control the cost of the water (Igamba, 2022). This seems

exaggerated but if the government continues to consistently fail to meet the demands of the population, these issues could become reality.

This problem is as pervasive and far reaching as could be. It has the potential to drastically affect the country's economy, cause civil unrest and even lead to disease, sickness, and death. The water crisis has the potential to affect all South Africans, we must take steps to protect and bolster our water supply. The best and farthest reaching approach we have to this, is to educate the current population (especially the youth of today) on the vital role that water plays in our world as well as how important it is for us to use water sustainably and give them the skills and techniques to do so in their own lives. This will empower them to educate their peers as well and is the first crucial step in addressing this important issue.

Target Demographic

We have elected to cater our game toward a target age group of 10 – 14.

When discussing the typical age demographics that a game designer usually considers Jesse Schell had this to say about our target age group the preteen or "tween": "Children of this age are going through a period of tremendous neurological growth and are suddenly able to think about things more deeply and with more nuance than they were a few years back. This age is sometimes called the "age of obsession," because children of this age start to get quite passionate about their interests. For boys especially, these interests are often games." (Schell, 2020: 125):

With the above information in mind, we believe that a target age group of 10-14 is perfect for our game because it allows us to make the puzzles more difficult and therefore more engaging for the player. We want them to struggle with the puzzles to gain the intrinsic reward of overcoming a challenge, to help us retain their interest and attention.

We believe that our topic (the water crisis facing South Africa) is relevant to our target population because the problem is so widespread and far reaching that it will inevitably affect them and their loved ones in their lifetime. They are also at an appropriate age to start learning about the various environmental and socio-economic issues faced by South Africans today.

It is important to start addressing these topics at their age because an informed generation can not only help to lessen the impact of these issues by using water more conservatively but as they grow and mature with the knowledge of these issues, they are able to innovate methods, products and techniques that can lead to a reduction in these issues or hopefully remedy them completely.

Player Type

According to Jesse Schell, Richard Bartle once proposed that there are four player types: Achievers, Explorers, Socialisers and Killers (Schell, 2020). Of these we have chosen "Achievers" as our target player type.

Schell describes the Achiever type as follows: "Achievers want to achieve the goals of the game. Their primary pleasure is challenge." (Schell, 2020: 135). From this we can design our game to reward players for completing/overcoming the challenges we set for them in the form of puzzles. We can also reward players with more prizes for completing the same puzzle more effectively or more efficiently. For example, a player will be rewarded with a single prize for completing a level with a "C" score but will be rewarded with 3 prizes for completing the level with a perfect "A" score.

This design is perfect for the achiever archetype as they are initially challenged with completing a level/puzzle and are appropriately rewarded for completing the puzzle. Thereafter should they have completed the level for the first time with a less than perfect score they are then challenged with the more difficult task of completing the level again with a perfect score (in other words they are challenged to do better than they did before). This design improves the replayability of each level, increases the lifetime of each player's experience of the game and entices the achiever archetype to keep playing with greater challenges.

By using this reward system as our vehicle for educating our players about the role of water in our world, existing conservatism efforts and how they use water more conservatively at home we hope to entice our players to not only challenge themselves to unlock all our rewards in-game but to go and conduct their own research and live more water conscious lives.

Broad Strategy of the Game

A broad strategy in game development refers to the overarching approach or framework that guides the development of the game's content, mechanics, and user experience. It encompasses the game's core objectives, the target audience's needs and preferences, the key messages, or lessons to be communicated, and the methods by which the game intends to engage, educate, and entertain its players. (Open AI, 2024).

Using the definition by OpenAI on what a broad strategy in terms of game development is, we will look over the Game Overview, Target Audience, Player Type Focus, Core Game Mechanics as well as the Engagement and Awareness Strategies.

Broad Strategy Document for "Where's the Water"

Game overview

The game is a serious game designed to raise awareness among preteens (ages 10-14) about the critical water supply, hygiene and conservation issues faced by South Africa. By combining engaging puzzles with real-world scenarios, the game aims to educate its target audience on the importance of water conservation, the impact of water mismanagement, and the role individuals can play in addressing this crisis.

Target Audience

As we discussed in the target demographic, we have chosen children aged 10-14, as we identified this age group is experiencing significant neurological growth, allowing for deeper thinking. (Schell, 2022). Our strategy leverages this development phase to induce a connection with water conservation topics through challenging and rewarding gameplay.

Player Types Focus

Aligning with Richard Bartle's player types, our game targets "Achievers". This aids our strategy as achievers are largely about points and status, these players have a desire to be able to show their friends how they are progressing. (Interaction Design Foundation, 2023). Therefore, positively aiding our strategy of creating awareness and educating the population.

Educational Content Integration

Each level will introduce players to facts about South Africa's water crisis, conservation techniques and the impact of water filtration systems. This information will be woven into the gameplay exposing the players to our strategy. More detailed information will also be earned by our players through the tiered reward system based on their effectiveness in each level.

This design choice not only promotes replayability but adds a level of intrinsic achievement to gaining the more difficult to receive information from higher level prizes. This intertwines the dopamine release earned intrinsically from beating a level or achieving a higher score with learning and the information received with their reward. This gamifies the learning process and adds a level of excitement and a desire to look over their hard-earned prize, causing them to review the information we are hoping to share with them of their own accord.

Engagement and Awareness Strategies

Players will be encouraged to use social media to share their high scores, which will aid in the awareness/popularity of the game and create free marketing for our game. This integration with social media will help us spread awareness of the water crisis faced by South Africa to an even broader audience (local and international friends, family, and followers of our players). This approach integrates well with our player type as Achievers enjoy sharing their success, prizes, and achievements.

In conclusion

The broad strategy of our game focuses on engaging the target audience through challenging gameplay, educating players about critical waters and inspiring real world conservation efforts through game experiences. By targeting achievers and integrating educational content seamlessly throughout the game experience. We aim to make a meaningful impact on players' perceptions, knowledge and behaviours regarding water conservation, sanitation, supply, and use.

Mood Board



Figure 2: O'Brien, C. 2024. Mood Board. Canva. Cape Town. Unpublished.
(<https://www.canva.com/>, 2024)

TASK 3: Core game elements:

Theme

Educational, stylized, conservation

Genre

Educational, puzzle-solving

Core Concept

The game revolves around solving 3D puzzles in which the player must connect a pipe system, maintain the various pipe elements and ensure that certain “special pipes” are connected when required (i.e a special piece could be a pipe used for filtration or to control the temperature of the water). These “special pipe elements” are each associated with a mini-game that must be completed. Each mini-game rewards the player with the ability to progress through the puzzle and awards a score based on how well the player did in the mini-game. This score is taken into consideration when awarding the player a score for the overarching level.

We also plan to educate our players on the vital role that water plays in our world, how we get it from its source, treat it and distribute for uses from agriculture to consumption and even entertainment. We want to tie the system of learning in with both our gameplay and reward system. To achieve this we want to introduce our players to important concepts that are appropriate for a given level and then reward them with further information upon completion of the level with more information being available for achieving higher scores.

We hope that by restricting some information behind high score requirements we will incentivise replayability of our levels and incentivise learning through the dopamine release of level completion and reward.

We have several additional systems and hazards for our players to overcome that we would like to implement (such as progressively degenerating pipe elements that must be repaired in order to prevent leaking and losing water). However, the above are the minimum gameplay elements we believe we will need to implement for an enjoyable and viable product.

Game World

The game is set in a stylized version of modern day South Africa. While this is a serious edu-game we would like to maintain a more light-hearted environment. However, we do want to immerse our players in the game and their tasks. To achieve both of these conflicting environments we plan to use more ambient sounds in the over-world and transition to a more upbeat and colourful environment while playing the mini-games (this

will be further enhanced through the implementation of upbeat background music suitable for the mini-game).

Main Characters

The game will feature two main characters. Wrenchy, an anthropomorphic pipe wrench and the player character. Wrenchy will function as a narrator character that will present the player with their in-game instructions along with any narrative information we want made available for a level/level completion and will consistently comment on their gameplay. In terms of personality, Wrenchy is a hardworking and cheerful character that encourages the player to succeed. In terms of appearance, Wrenchy is a red adjustable pipe wrench with large eyes and expressive eyebrows.

The player character will be a faceless everyman character that the player can insert themselves into. Since the game utilises a first person perspective, there is no visual representation of what the player character looks like. This allows the player to assimilate with their character and project their own skills and learning journey into the game.

Story

The story of the game is more of an evolving linear narrative that educates the player about the role of water across the various industrial and commercial sectors of modern day South Africa. Taking the player along the same journey that water undertakes from its source, to the various treatment facilities and systems/procedures that it goes through along its way to be used in various fields (agriculture, municipal, entertainment) and even consumed by humans. Wrenchie will take on the role of the player's handy sidekick and multi-purpose tool. He will guide the player throughout their various tasks, hinting at possible puzzle solutions, explaining mini-games, commenting on their gameplay and providing some comic relief.

Level Design

Level and puzzle design will get progressively larger and more difficult as the game progresses. We will increase the complexity of the game by introducing new mechanics as obstacles that must be overcome for a puzzle to be solved successfully. For example, in the first level, the water must pass through a filtration system (the player must first solve enough of the puzzle to get the water to the filtration system and then play the mini-game associated with the operation of the filtration system before they can progress the puzzle further).

In the second level the water may need to be filtered AND chemically treated to ensure that it is safe for use or consumption. While in the 3rd level the water may or may not need to be filtered and or treated again before it is split and diverted across multiple pipes as it is diverted across a farm's sprinkler system. Finally in the 4th level the player may be required to complete any or all of the previous processes before passing it through a temperature

control piece to ensure that its temperature remains above or below a certain threshold in order to successfully complete the level.

As stated above we do have several additional mechanics and hazards that we plan to implement to provide the player with more depth to the puzzle solving and a sense of urgency. Some of these mechanics include:

Light platforming to gain elevation and provide our players with access to interactable puzzle pieces as well as a better perspective to solve the puzzle. This adds verticality to the game and allows first time players to see more of the puzzle and strategise a way forward.

A rust mechanic that causes affected pipes to degenerate and can lead to water loss which will impact the players score and may even prohibit them from passing the level. We do this to add a small sense of urgency to the player, an apparent threat to their reward at the end of the level if they aren't careful.

Puzzle components

Across the various levels of the game puzzles will need to increase in difficulty, complexity, and scope. To help us achieve this we will introduce special puzzle pieces that achieve specific tasks/puzzle requirements. These special puzzle pieces include: filtration pieces, temperature control and split pipes. Some of these puzzle components require the player to complete a mini-game in order to progress the overarching puzzle. These mini-games are scored independently to the overarching level, however, the results players receive for the completion of these mini-games do affect their score for the overarching level.

Filtration pieces: Used to filter water in early levels. The filtration mini-game sees the player taking control of a stationary turret that must aim and shoot at falling debris that is currently flowing through the water. The player score is determined by how many pieces of debris make it past the player.

Temperature control: heat or chill water. The temperature control mini-game is a simple timing minigame where the player must click a button with the right timing to control the temperature of the water.

Chemical treatment pieces: Used to remove microscopic hazards from the water in early and later levels.

Split pipes: Divert water along multiple paths (agriculture level).

Coding Systems

Player

The player will use several scripts to handle movement, interactions, and mini-games. For movement, the player will use the new input system for all actions, with input actions being events that the movement script subscribes to, such as Move, Jump, and Fire. The interaction script will allow the player to pause, interact with different pipes, and display the manual.

Score keeping

The score will be calculated based on a few factors that can be tracked through sentinel values and co-routines. These factors include: time taken, moves made, water wasted.

The time taken can be calculated through a coroutine that increments the sentinel value “time taken” by 1 every second.

“Moves made” can be incremented by 1 every time the player places a pipe (not moving or rotating a piece, just placing it).

Water wasted is more interesting. We will track this as a value out of 100. When the player opens the pipe block to allow the water to flow and complete the puzzle, if the puzzle is not correct, water will leak and be lost from the system. The player can close the pipe and try to correct the pipe positions to complete the puzzle. The amount of water wasted will be subtracted from the player's score at the end of the level.

Unlocking rewards

Rewards are given out in the form of journal entries that highlight information about the water issue that a given level focuses on (i.e. the level created for agriculture will reward the player with more information regarding the role of water in agriculture, the current challenges faced by farmers as well as information regarding any current initiatives conducted by the SA government or 3rd parties to help mitigate or solve these issues).

Rewards will be given out in tiers (i.e. a perfect score “A” unlocks all 3 rewards associated with a given level while a moderate score “B” unlocks the first 2 rewards, and a “C” will result in the player only unlocking the initial reward).

Puzzle Implementation

The puzzle system will be implemented using a pipe system where the player can interact with different pipe sections to move them into place. A script will be developed to handle the rotation of the pipes at specific sections, allowing designers to rotate the pipe sections on the x, y, or z plane. To detect if the connection is successful, two strategies can be adopted: one where the pipes are either connected or disconnected, and another using a raycast at opposite ends of the pipes to check if both rays hit a pipe.

Game Management

Game management is a crucial coding structure. We have decided to implement a game management system that varies based on the level design, making a modular system key to ensuring the game manager class is reusable across scenes. We will create a pipe management system that tracks if pipes are connected, leaking, or rusting, allowing us to create varied levels with different numbers of pipes and unique puzzles for each level. The pipe system manager will also track if the mini-game is completed. Once the mini-game and all pipes are connected, the pipe system manager will allow the score system to calculate the final game score.

Modular Object Scripts

Creating unique and different levels requires scripts that allow programmers and developers to reuse and manipulate their functionality through the editor. Each pipe will contain a pipe connection script that manages connections between pipes and allows manipulation of various components such as colour and connection state. An interaction script will handle player interactions with specific pipes, such as opening and closing valves or initiating a mini-game. A script to handle rotating objects to fit into the pipe system will enable designers to change the rotation and specify the plane (x, y, z) for pipe connections.

User Interface

The user interface scripts should be lightweight and modular. The Unity event system will be used for activating and deactivating UI elements. A script will be developed to handle pausing and unpausing the game, displaying a pause menu or a manual menu. These menus will use the Unity event system for closing.

Modular Level Design

As we have discussed the gameplay will largely involve puzzle solving mechanics, therefore it is crucial for the developers to focus on making these mechanics as simple as possible. This will help the level designers flourish and make it easy for them to design complex levels. To do this we need a modular system, here is how we hope to accomplish this:

- A prefab parent of which all pipes will be made a variant of, therefore if we need to change a number of pipe prefabs it can be done by changing the parent.
- A focus on decoupling code, this can be achieved by using various design patterns like the mediator pattern and the observer pattern.
- An event system that will speak to the game manager and other scripts to handle level completion and other level states. This will make the level structure modular for similar levels where a quota will have to be met, then the game manager can handle all the states. For instance, we have a pipe system, once a pipe system connects, it tells the event system, the event system tells the game manager and the UI handler pops up showing the level is complete and this can be repeated over and over.

Making it extremely useful and allows the designers freedom to create elaborate puzzles.

UI Mockups and Style guide:

Splash Screen

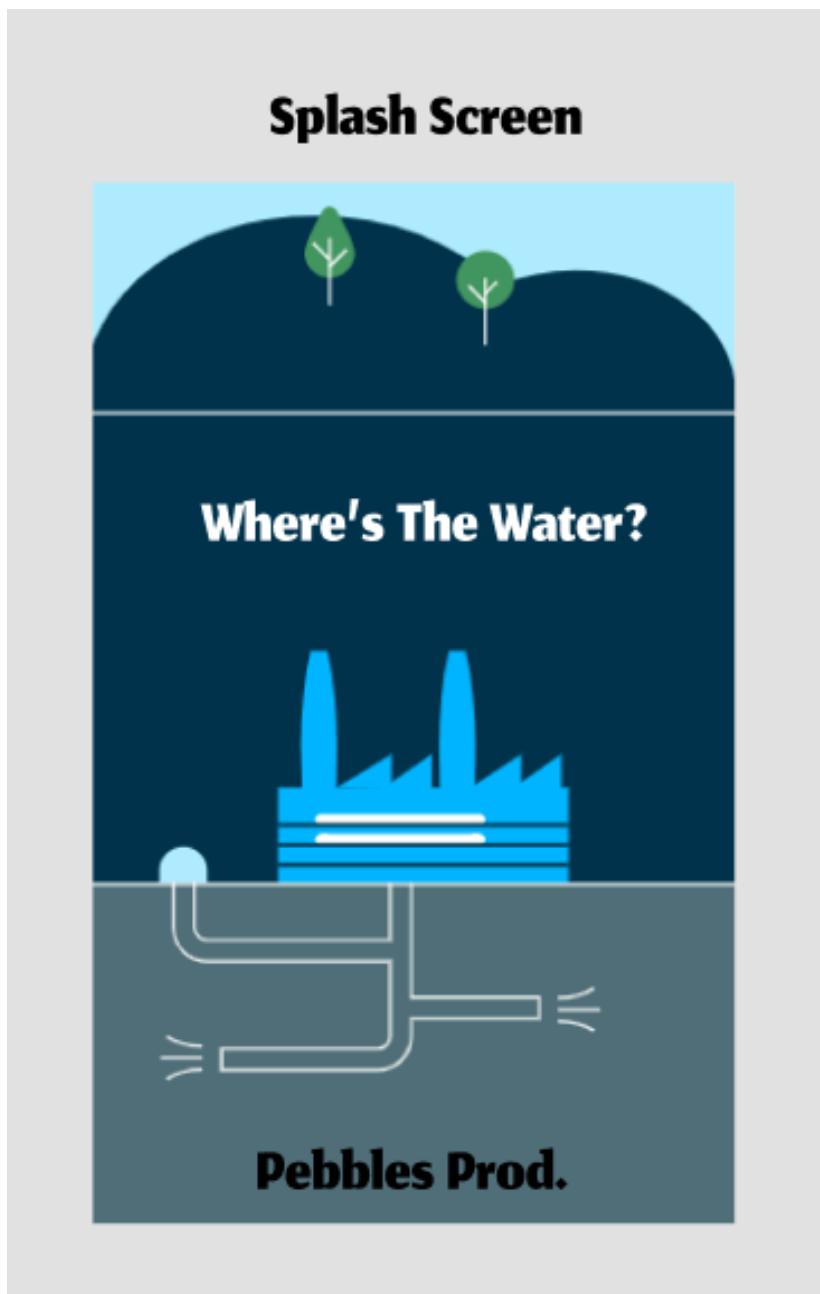


Figure 3: Henry, M. 2024. UI Splash Screen. Figma. Cape Town. Unpublished. (Figma, 2024)

Style:

Splash Screen

- Background: The splash screen should feature a clean, simple background with subtle animations to catch the player's attention without overwhelming them.
- Logo: Centred on the screen, the game logo should be prominent and clearly visible, using the primary colour palette of the game.
- Loading Indicator: A simple, circular loading indicator below the logo to inform players that the game is loading. This indicator should use secondary colours to differentiate it from the main elements.

Main Menu

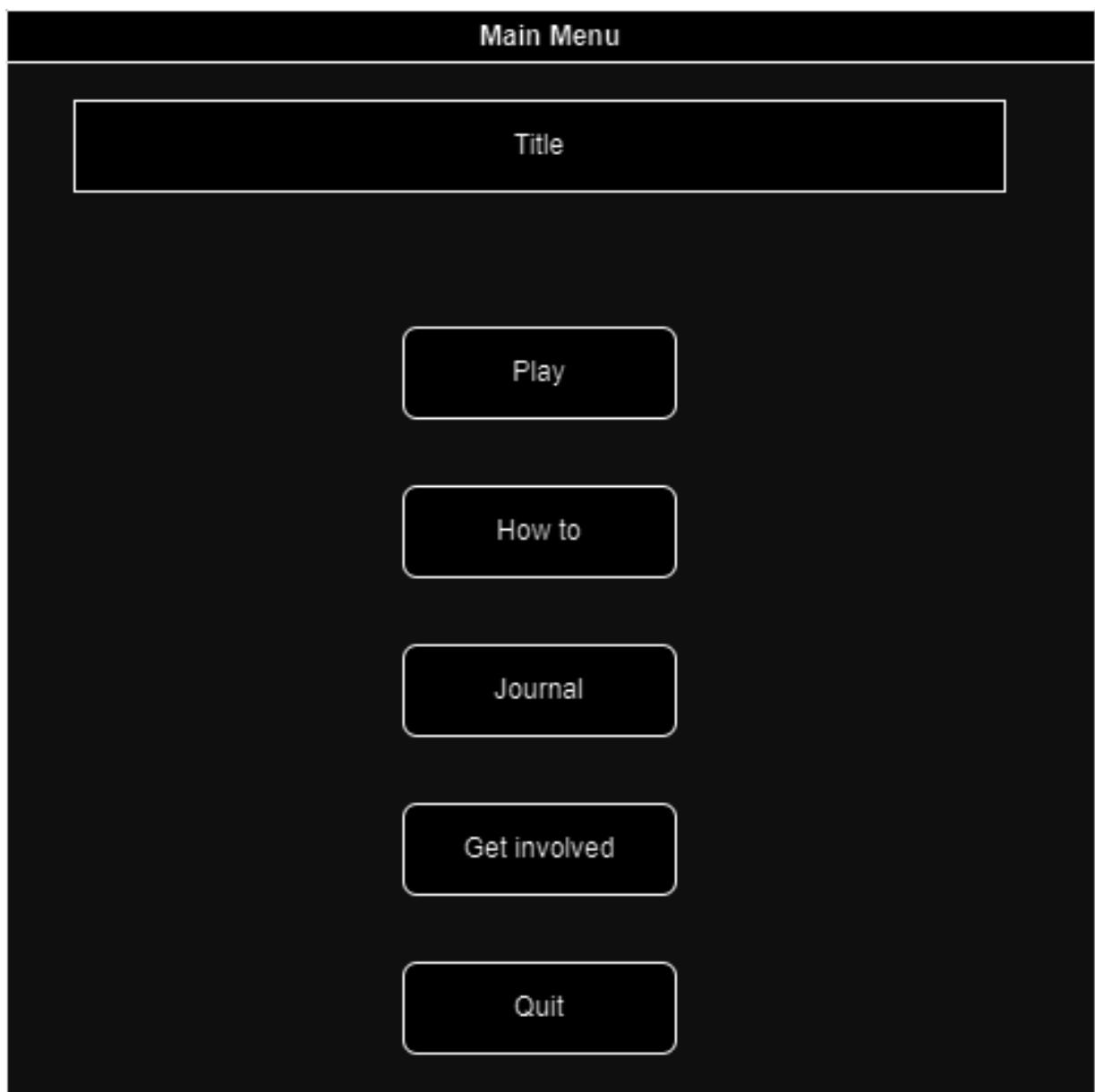


Figure 4: Zunde, J. 2024. UI Main Menu. Draw.io. Cape Town. Unpublished. (Draw.io, 2024)



Figure 5: Henry, M. 2024. UI Main Menu. [Screenshot]. Unity. Cape Town. Unpublished.

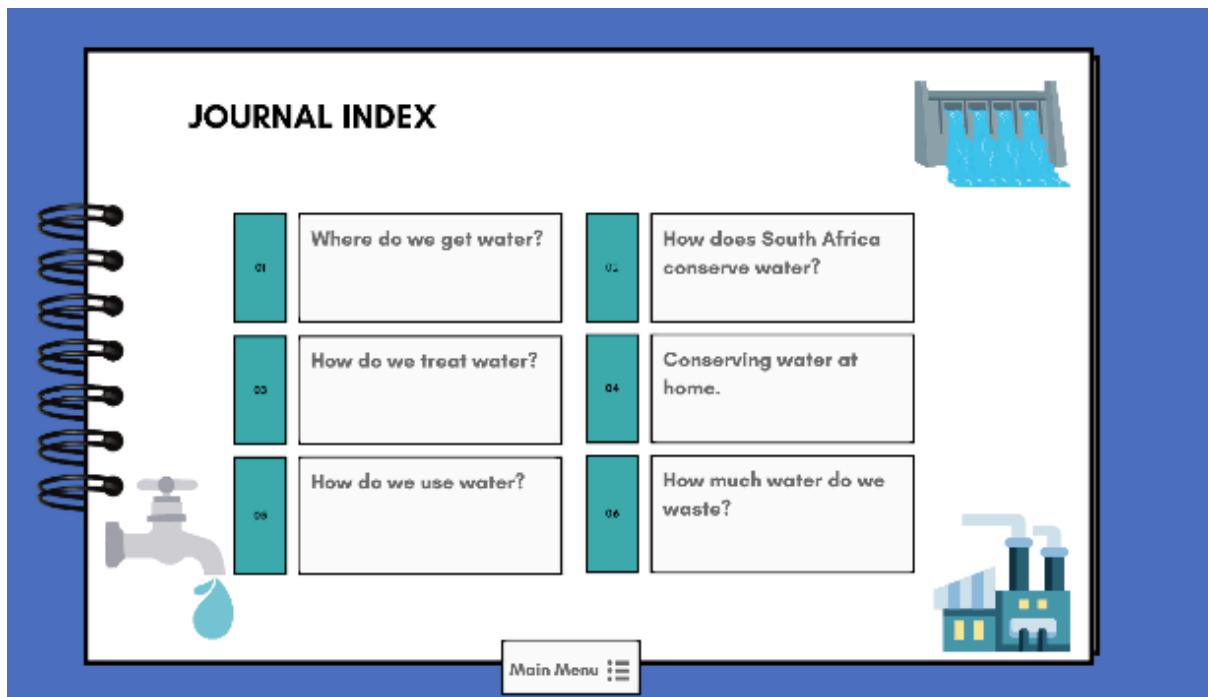


Figure 6: O'Brien, C. 2024. UI Journal. Canva. Cape Town. Unpublished.
(<https://www.canva.com/>, 2024)

Journal/Reward Screen

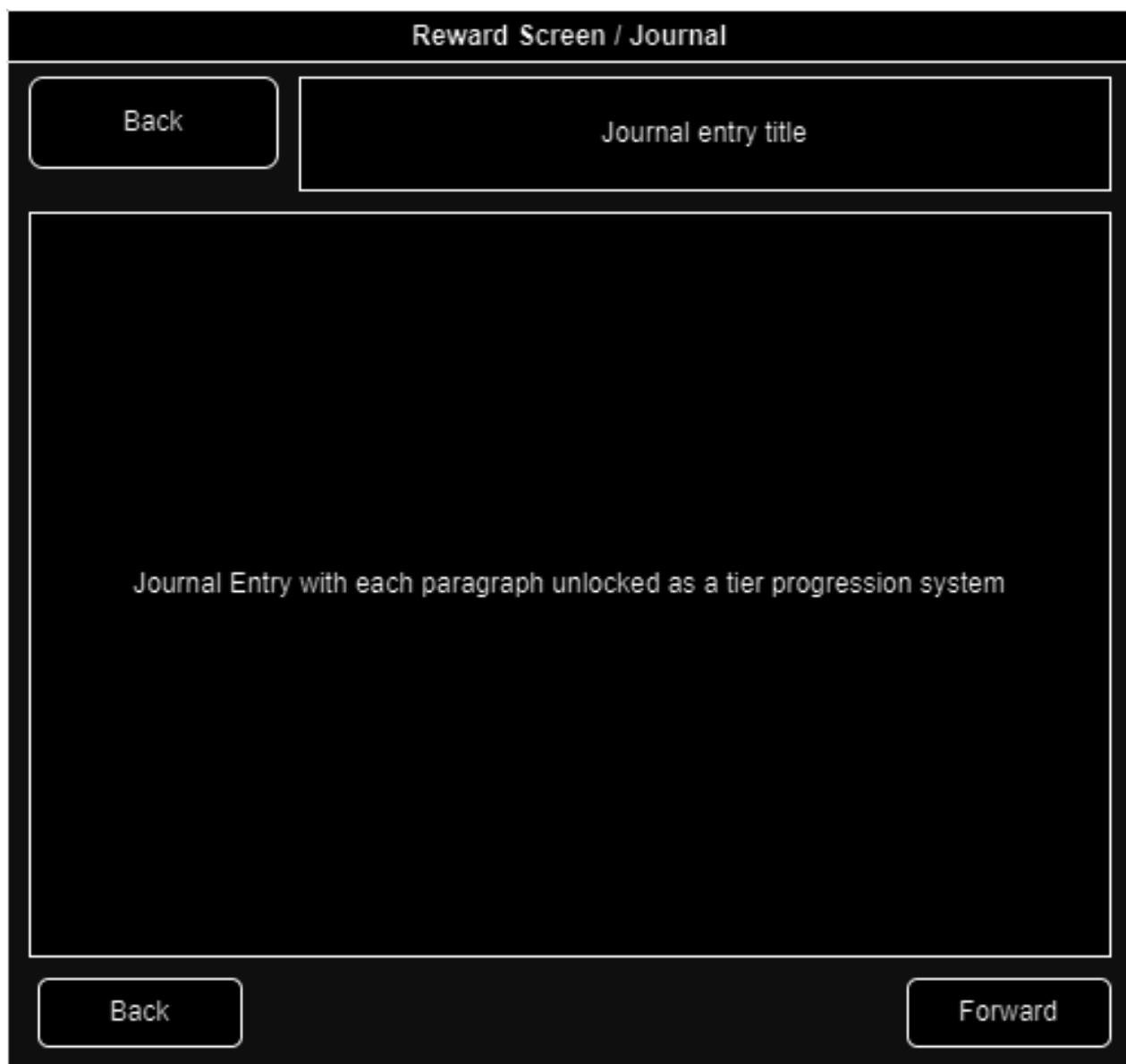


Figure 7: Zunde, J. 2024. UI Journal/Reward Screen. Draw.io. Cape Town. Unpublished. (Draw.io, 2024)

Style:

Layout: The main menu should be easy to navigate with large, clearly labelled buttons for primary actions such as "Play," "Journal," "Controls," and "Quit."

Design Style: Incorporate 3D game elements into the UI design. Buttons and other interactive elements should appear as 3D models, providing a tactile feel.

Colour Scheme: Use the primary colour palette of the game to maintain consistency. Secondary colours can be used for hover and active states.

Font: Use a blocky, easy-to-read font that fits with the game's stylized art style. Ensure text is large enough to be read easily on various screen sizes.

In-Game UI

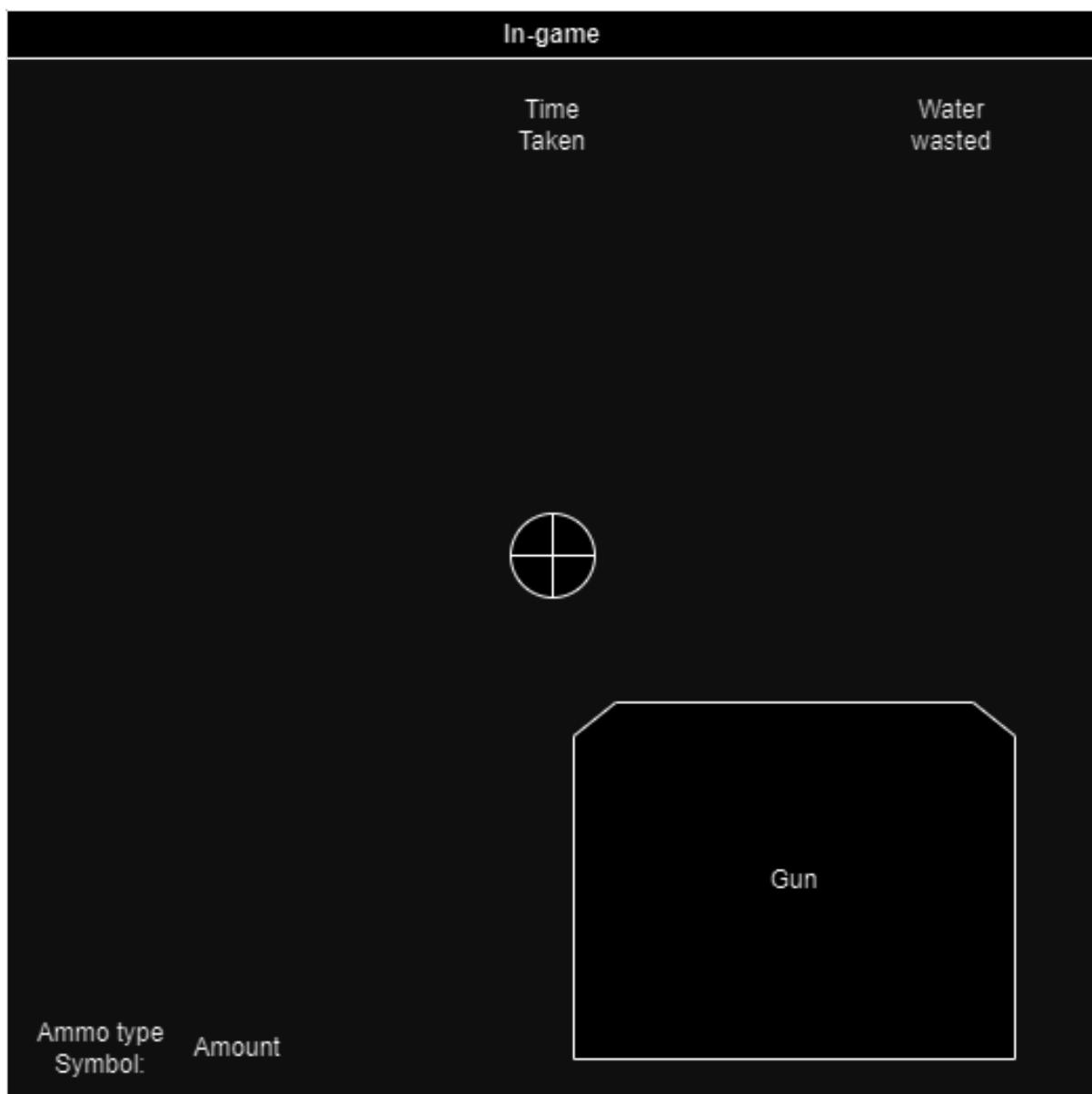


Figure 8: Zunde, J. 2024. UI In-Game. Draw.io. Cape Town. Unpublished. (Draw.io, 2024)

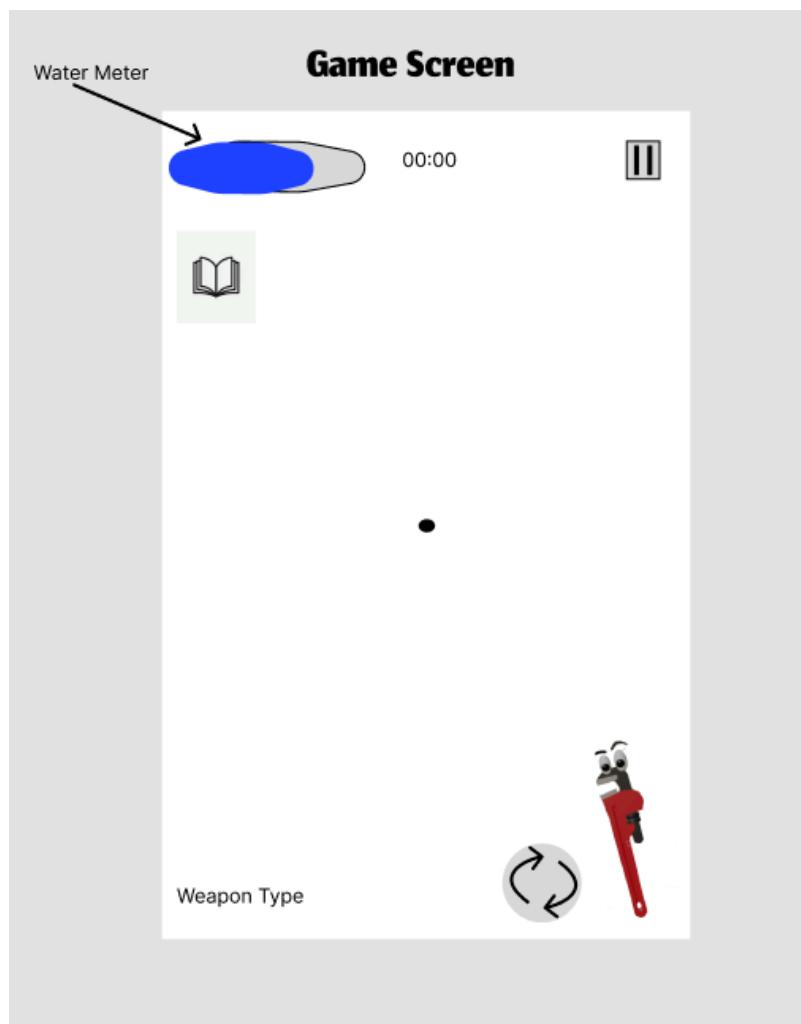


Figure 9: Henry, M. 2024. UI Game Screen. Figma. Cape Town. Unpublished. (Figma, 2024)



Figure 10: Henry, M. 2024. UI Game Information. [Screenshot]. Unity. Cape Town. Unpublished

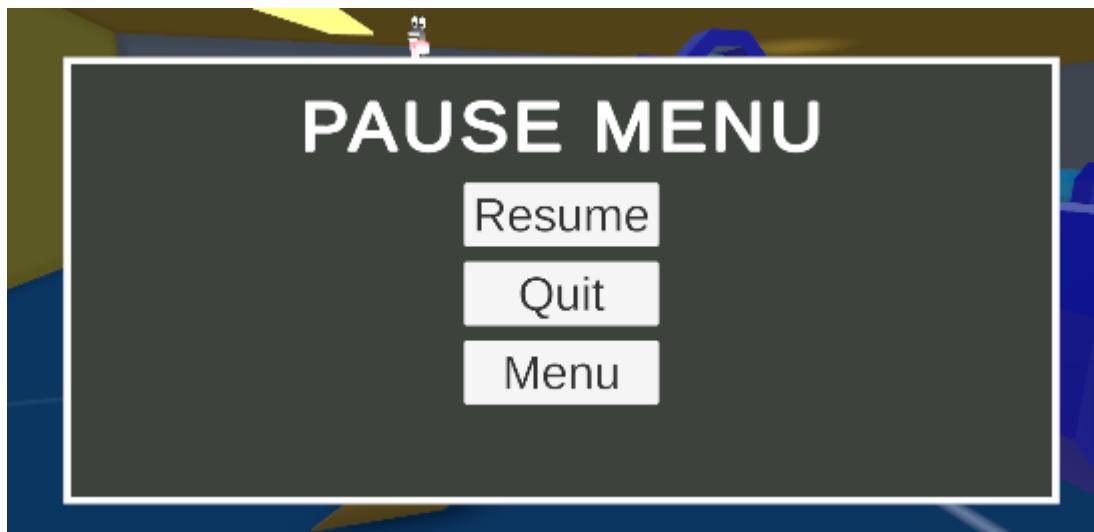


Figure 11: Henry, M. 2024. UI Pause Menu. [Screenshot]. Unity. Cape Town. Unpublished.

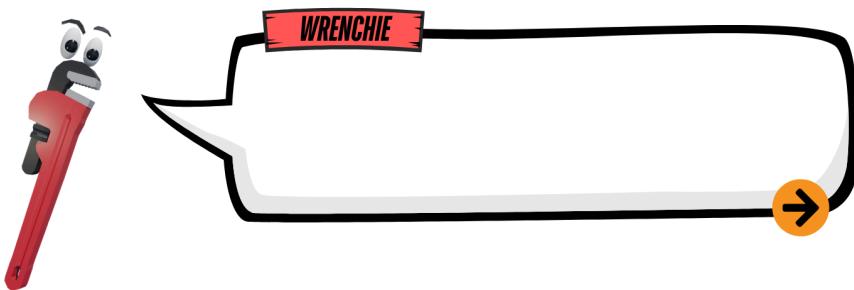


Figure 12: O'Brien, C. 2024. UI Wrenchie Dialogue. Canva. Cape Town. Unpublished. (Canva, 2024)

Style

In-Game UI

- **Consistency:** Use the same font and colour scheme from the main menu to maintain visual consistency throughout the game.
- **HUD Elements:**
 - **Water Meter:** Displayed in the top left corner, the water meter should use a blue fill to indicate the water level. Ensure it is easily readable at a glance.
 - **Hint Button:** A button to access the game manual or hints should be placed below the water meter. This button should be easily accessible but not obstruct the gameplay.
 - **Time:** Displayed in the top right corner, the time will increase throughout the game.
- **Pause Menu:** The pause menu should appear as an overlay with options to resume, restart, and exit. Use the Unity event system for activation and deactivation of the UI.
- **Dialogue Boxes:** For character dialogues, such as Wrenchie's, use a clear and readable font with a consistent style. Dialogue boxes should not obstruct important game elements and should provide clear, concise information.

- **Journal/Manual:** For educational content, use clear and readable fonts. Make sure the key aspects are highlighted for the player.

Wrenchie Dialogues

- **Design:** Wrenchie's dialogue box should have a playful yet clear design, with a white background and black outline. The text should be in the same blocky font used throughout the game.
- **Placement:** Position Wrenchie's dialogue box in a non-intrusive part of the screen, ensuring it does not cover critical gameplay elements.
- **Hint Icon:** Incorporate a hint icon on Wrenchie's dialogue box for players to access additional tips or information.

3D Style Guide

For the 3D models, we'll be primarily using a low poly style of model. This will be beneficial for both performance and to give it somewhat of a retro feel. It is also very time efficient allowing for more art assets to be created in a short time frame. We are experimenting with using pixelated textures for the models, however this may dramatically increase the time taken, and that effort might be better spent elsewhere.

Description of the core game mechanics

To give a good representation of the core game mechanics for our game, we first need to know what are the core mechanics of a game. To understand the core mechanics one has to know what game mechanics are. According to Schell (2020: 166), 'Game mechanics are the core of what a game truly is.' He further argues that they are the foundations of a game when the visual, technology and narrative are taken away. Schell states that these mechanics fall into seven main categories: Space, Time, Objects, Actions, Rules, Skill and Chance.

From Schell's template we can formulate our game mechanics.

Space

Description: Every game exists within a type of space, which is the "magic circle" of gameplay, defining the places within a game and their relationships to one another. Game spaces can be discrete or continuous, have dimensions, and contain bounded areas that may or may not be connected (Schell, 2020:166-167).

Our game will take place in a nested space, the game will function in a discrete but continuous space meaning the player will have linear gameplay, a level start and a level finish but the player will be free to explore the level as he or she sees fit. To be more specific on the mechanics of space, the player will be in an underground facility or fenced off facility

where there is free reign to look and move around the level. The player will also be transferred to a discrete space, when entering the mini-games. The section on actions will inform the reader on what actions the player can take within the space.

Time

Description: Time in games can be discrete or continuous. Discrete time is represented by turns, where each turn is a distinct unit of time and the time between turns is irrelevant. Continuous time flows uninterrupted, and many games use a mix of both. Time can be manipulated in games, offering control not available in real life (Schell, 2020:172 - 174).

The mechanic of time within the game will be continuous. Our game will make use of a timer to add pressure and intensity to the gameplay however it will not affect the gameplay but will affect the scoring of the player. This time-mechanic can be controlled by pausing the game.

Objects

Description: Objects in games include any items that can be seen or manipulated, acting as the "nouns" of game mechanics. These objects usually have attributes, some of which are dynamic, affecting gameplay by their states and changes (Schell, 2020: 174 - 176).

The dynamic objects within the game are: the playable character, the turn-wheels with different pipes attached to them. The multi-purpose tool used for fixing pipes or moving said turn-wheel. The turret used to destroy waste obstacles. Waste obstacles that appear in one of the mini-games. Pipes that rust over time. The objects will have different states attached to them. For instance the player object will have 4 primary states: Idle, Jumping, Interaction. The static objects will not affect the game mechanics, used to enhance the aesthetic of the game and guide the player on what to do. The journal entry will be an important mechanic within the game as it will provide players with necessary information about different game features and hopefully educate players.

Actions

Description: Actions are the "verbs" of game mechanics, representing what players can do in the game. Actions are categorised into basic actions, which are the simple operations a player can perform, and strategic actions, which are more complex and relate to achieving goals within the game's context (Schell, 2020:179).

For the mechanic of action we will focusing on the basic actions within the game, which are

- Moving omnidirectionally - restricted to the x, y, z plain
- Jumping
- Using multipurpose tool

- Interacting with various items in the game
- Controlling turret
- Shooting turret

Strategic Actions

- Reading level brief before completing puzzle
- Changing pipe topology for water flow using tool
- Solving puzzles before releasing water
- Analysing different pipes and what they do
- Shooting waste in mini-game
- Maintaining pipe decay

Rules

Description: Rules define the core structure of the game, outlining the space, time, objects, actions, and their consequences. They form the foundation that enables all other mechanics and introduce the goals that transform activities into games(Schell, 2020: 184).

To define the rules of our game we will be looking at the operational rules and foundational rules. The operational rules meaning how to play the game, this includes:

- Players will use their multipurpose tool to interact or trigger the position pipes in the correct order.
- Players will look at the manual to gain insight on the specific level.
- Players will have to complete a level by connecting all the correct pipes and by completing the minigames, finishing the puzzle.
- Players will be scored on time and the amount of water wasted.
- Players will be tasked at maintaining the pipes during gameplay.

Foundational rules , the formal or foundational structure of the game

- The multipurpose tool can be used to interact with pipes and other interactable items.
- The manual can be used to complete levels faster and aid in game.
- All Pipes must be connected in order to complete the level.
- Rust may form around a pipe where the player has to hurry to clear it.
- A filter system can be used to clean dirty water.
- The turret can be used to clear waste.

- A red pipe can be used to heat up water.
- A lever or trigger may be rotated to connect pipes.

Skill

Skills required by a game can vary widely and typically include a mix of physical, mental, and social skills. These are the real abilities players must use to play and succeed in the game, distinct from virtual skills that represent the abilities of in-game characters(Schell, 2020: 190 - 192).

Players will have to make use of mental and physical skills within the game this being

- Coordination, from hand to mouse to firing at lever, trigger and aiding movement.
- Critical thinking, choosing the correct pipe to complete the pipe system.
- Comprehension, understanding the manual to complete the system.
- Puzzle-solving skills.

Chance

Description: Chance introduces uncertainty into games, interacting with other mechanics to create surprises and maintain player interest. Mastering the use of chance is crucial for game designers to craft experiences full of challenging decisions and unexpected outcomes (Schell, 2020:193 - 194).

The game will involve an element of chance or randomness with the rust mechanic, rust may form around a piece of pipe during gameplay and the player will have to quickly stop it. The pipe will be chosen randomly and at a random time interval, based on the difficulty of the level.

Sound design

Sound design is often considered one of the more underrated aspects of games. When playing a game or watching a film, your ears pick up sounds before your mind even registers where it came from or what you are looking at. It engages the player. While it is a bit of a cliché, we want the player to feel as if they are walking around the world and solving the game in person.

We want to immerse them in this world and the best way we can achieve this level of immersion is by having appropriate sound effects, from wind blowing, leaves rustling, birds chirping to footsteps and the sound of the pipes moving. However, we cannot just have one sound for an action. For example, if you were to walk with your eyes closed and transition from tar to gravel, you will know that you have changed terrains primarily due to sound. That is why we will have various sounds for certain actions such as footsteps on concrete, grass or gravel. These small details create a connection between the player and their

in-game avatar on a subconscious level and it will influence their overall gameplay experience.

For our game we decided to create a calm atmosphere due to the premise of the game having the player solve puzzles. We believe having a chaotic atmosphere would just create too many distractions for the player and would shift the focus from learning and understanding the context of the puzzle to just frantically trying to solve the puzzle.

Some examples of this would be our decision to choose the sound of gentle running water of a stream or creek instead of the sound of turbulent running water in a river, as our in-game audio representation of water moving through the pipes. Another example of this would be to have a background sound of a gentle breeze and birds chirping instead of hurricane type winds or thunder for when the player is solving a puzzle outdoors.

Additionally, during time sensitive objectives, having a ramping intensity soundtrack heightens the sense of urgency. We could make use of this type of design when our player has a leak in their pipeline and is losing water. The increased urgency in the background sound, coupled with a special effect sound of water leaking would indicate to the player that something is wrong and they need to act quickly.

Running water sound effect

Pixabay. 2024. *Running Water Gentle Sound*. [Sound recording]. Available at: <https://pixabay.com/sound-effects/running-water-gentle-sound-185148/> (Accessed 16 March 2024).

A gentle water running sound effect that will be used for the water running through the pipes in game. This specific sound was chosen to create a calming atmosphere to allow players to solve the puzzles without any distractions.

Metal pipe sound effect

Pixabay. 2021. Squeak_01. [Sound recording]. Available at: <https://pixabay.com/sound-effects/squeak-01-6193/>

A metal squeaking sound effect for when the player turns the pipe to create the effect that the pipes are rusty due to the water.

Pixabay. 2022. Metal Slam 5. [Sound recording]. Available at <https://pixabay.com/sound-effects/metal-slam-5-189786/> (Accessed 16 March 2024).

A metal clanking sound effect to indicate that the two pipes have connected.

Walking

Pixabay. 2021. Concrete Footsteps. [Sound recording] <https://pixabay.com/sound-effects/concrete-footsteps-6752/> (Accessed 16 March 2024).

In-door walking on concrete sound for when the player is walking around in the game just to add to add the sense of the indoor environment

Background ambience

Pixabay. 2022. Low Hum. [Sound recording].

<https://pixabay.com/sound-effects/low-hum-14645/> (Accessed 16 March 2024).

Subtle background industrial humming sound that fits well with the in-door water filtration environment and to further immerse the player in the game world.

Pixabay. 2022. Dripping water in cave. [Sound recording]. Available at:

<https://pixabay.com/sound-effects/dripping-water-in-cave-114694/>

Water dripping indoors to create a gentle background ambience and environment.

Pixabay. 2022. generator large 01. [Sound recording]. Available

<https://pixabay.com/sound-effects/generator-large-01-31429/> (Accessed 16 March 2024).

Generator buzzing sound effect for the generator asset to add to the industrial aesthetic of the game.

Menu interaction sound effects

Floraphonic. 2024. Punchy Taps UI 4. [Sound recording]

<https://pixabay.com/sound-effects/punchy-taps-ui-4-183899/> (Accessed 16 March 2024).

Floraphonic. 2024. Punchy Taps UI 9. [Sound recording]

<https://pixabay.com/sound-effects/punchy-taps-ui-9-183908/> (Accessed 16 March 2024).

UNIVERSEFIELD. 2022. Interface. [Sound recording]

<https://pixabay.com/sound-effects/interface-124464/> (Accessed 16 March 2024).

Archaic menu navigation sound effect to fit with the puzzle and mini game premise of the game.

Menu music

XtremeFreddy. 2023. Game Music Loop 7. [Sound recording]

<https://pixabay.com/sound-effects/game-music-loop-7-145285/> (Accessed 16 March 2024).

Fun catching and hip menu music to fit the archaic style of the minigames but also mellow to fit the puzzle solving aspect of the game.

Level completed

UNIVERSEFIELD. 2023. Game Level Complete. [Sound recording]

<https://pixabay.com/sound-effects/game-level-complete-143022/> (Accessed 16 March 2024).

Fun archaic sound to indicate the successful completion of a level.

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2. Draw.io. 2024. Security-first diagramming for teams. Version 24.1.0 [App]. Available at: <https://www.drawio.com/> (Accessed 23 March 2024).
3. Figma. 2024. Figma: The collaborative Interface Design Tool. [App]. Available at: <https://www.figma.com/> (Accessed 23 March 2024).
4. Microsoft Clipchamp. 2024. Microsoft Clipchamp for Windows. [App] Available at: <https://clipchamp.com/en/windows-video-editor/> (Accessed 17 June 2024).
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2. Greenpeace, 2022. [Online] Available at: <https://www.greenpeace.org/africa/en/blogs/1405/eskom-set-to-accelerate-water-crisis/> [Accessed 14 March 2024].
3. Igamba, J. 2022. Greenpeace. [Online] Available at: <https://www.greenpeace.org/africa/en/blogs/51757/water-crisis-in-south-africa/> [Accessed 6 March 2024].
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5. OpenAI. (2024). ChatGPT (GPT-4) [Large language model]. <https://chat.openai.com/c/e5ac6add%202aa4-451a-87d5-617242a1e577>
6. Schell, J. 2020. The Art of Game Design: A Book of Lenses. 3rd ed. Boca Raton: CRC Press.
7. World Bank Group, 2022. The Economic Implications of Water Resources Management in the Western Cape Water Supply. [Online]. Available at: https://documents1.worldbank.org/curated/en/099100002272330999/pdf/P171483_06acd480fc0bfb504b0df294bfe8.pdf [Accessed 6 March 2024].

Video footage:

1. DW News. 2023. What's at the root of South Africa's water crisis? | DW News. Available at: https://www.youtube.com/watch?v=_jVZhMQkTtU&t=113s&ab_channel=DWNews [Accessed 17 March 2024].

2. O'Brien, C. 2024. Water Sad. [Personal Video Edit]. Microsoft ClipChamp. Cape Town. Unpublished.
3. SABC News. 2024. South African municipalities grapple with water supply crisis. Available at: https://www.youtube.com/watch?v=4pc_Sz0KrSM&ab_channel=SABCNews [Accessed 17 March 2024].

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2. Henry, M. 2024. UI Splash Screen. [Personal Digital Drawing]. Cape Town: Unpublished.
3. Henry, M. 2024. UI Game Information. [Screenshot]. Unity. Cape Town. Unpublished.
4. Henry, M. 2024. UI Main Menu. [Screenshot]. Unity. Cape Town. Unpublished.
5. Henry, M. 2024. UI Pause Menu. [Screenshot]. Unity. Cape Town. Unpublished.
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Calm running water:

1. Pixabay. 2022. Creek sounds in Georgia. [Sound recording]. Available at: <https://pixabay.com/sound-effects/creek-sounds-in-georgia-25053/> (Accessed 16 March 2024).
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3. Pixabay. 2022. Relaxing, Mountains, Rivers, Streams, Running Water. [Sound recording]. Available at: <https://pixabay.com/sound-effects/relaxing-mountains-rivers-streams-running-water-18178/> (Accessed 16 March 2024).

Outdoor sound (Breeze, birds chirping, leaves rustling):

1. Pixabay. 2022. The Sound Of Nature. [Sound recording]. Available at: <https://pixabay.com/sound-effects/the-sound-of-nature-123109/> (Accessed 16 March 2024).

Projectile hitting target to turn pipe sound:

1. Pixabay. 2022. Hammering on Anvil. [Sound recording]. Available at: <https://pixabay.com/sound-effects/hammering-on-anvil-71902/> (Accessed 16 March 2024).

Gun firing and hit sound:

1. Pixabay. 2022. Laser Gun. [Sound recording]. Available at: <https://pixabay.com/sound-effects/laser-gun-81720/> (Accessed 16 March 2024).
2. Pixabay. 2021. Gun shot. [Sound Clip]. Available at: <https://pixabay.com/sound-effects/gun-shot-6178/> (Accessed 20 November 2024).
3. Pixabay. 2022. Bullet Hit. [Sound Clip]. Available at: <https://pixabay.com/sound-effects/080998-bullet-hit-39870/> (Accessed 20 November 2024).

Metal clanging for when pipes connect:

1. Pixabay. 2022. Metal Slam 5. [Sound recording]. Available at <https://pixabay.com/sound-effects/metal-slam-5-189786/> (Accessed 16 March 2024).

Ticking for timer to finish puzzle (optional):

1. Pixabay. 2022. Clock Ticking (60 second countdown). [Sound recording]. Available at <https://pixabay.com/sound-effects/clock-ticking-60-second-countdown-118231/> (Accessed 16 March 2024).

Wind sound created by pipes turning:

1. Pixabay. 2021. Light woosh. [Sound recording]. Available at <https://pixabay.com/sound-effects/light-woosh-7119/> (Accessed 16 March 2024).

Background sound of water filtration plant (Possible overlay some of these sounds):

1. Pixabay. 2022. generator large 01. [Sound recording]. Available at <https://pixabay.com/sound-effects/generator-large-01-31429/> (Accessed 16 March 2024).
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3. Pixabay. 2022. Low Hum. [Sound recording]. Available at: <https://pixabay.com/sound-effects/low-hum-14645/> (Accessed 16 March 2024).
4. Pixabay. 2021. Running Gear. [Sound recording]. Available at: <https://pixabay.com/sound-effects/running-gear-6403/> (Accessed 16 March 2024).

Menu scroll sound:

1. Floraphonic. 2024. Punchy Taps UI 4. [Sound recording]. Available at: <https://pixabay.com/sound-effects/punchy-taps-ui-4-183899/> (Accessed 16 March 2024).

Menu/Pause Menu selection:

1. Floraphonic. 2024. Punchy Taps UI 9. [Sound recording]. Available at: <https://pixabay.com/sound-effects/punchy-taps-ui-9-183908/> (Accessed 16 March 2024).
2. UNIVERSEFIELD. 2022. Interface. [Sound recording]. Available at: <https://pixabay.com/sound-effects/interface-124464/> (Accessed 16 March 2024).

Player Movement Sounds:

1. Pixabay. 2021. Concrete Footsteps. [Sound recording]. Available at: <https://pixabay.com/sound-effects/concrete-footsteps-6752/> (Accessed 16 March 2024).
2. Pixabay. 2021. Cartoon Jump. [Sound recording]. Available at: <https://pixabay.com/sound-effects/cartoon-jump-6462/> (Accessed 18 November 2024).

Steps on grass and gravel:

1. Pixabay. 2021. Going on a forest road gravel and grass. [Sound recording]. Available at: <https://pixabay.com/sound-effects/going-on-a-forest-road-gravel-and-grass-6404/> (Accessed 16 March 2024).

Relaxed Menu Music:

1. AlexGrohl. 2024. Sad Soul (Chasing a Feeling). [Sound recording]. Available at: <https://pixabay.com/music/beats-sad-soul-chasing-a-feeling-185750/> (Accessed 19 November 2024).
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3. Pixabay. 2022. LOOP MENU PREVIEW. [Sound recording]. Available at: <https://pixabay.com/sound-effects/loop-menu-preview-109594/> (Accessed 16 March 2024).

Energetic menu music:

1. Pixabay. 2022. menu. [Sound recording]. Available at:
<https://pixabay.com/sound-effects/menu-53679/> (Accessed 16 March 2024).

Alternative Menu Music:

1. Pixabay. 2022. COTTAGECORE. [Sound recording]. Available at:
<https://pixabay.com/sound-effects/cottagecore-17463/> (Accessed 16 March 2024).

Sad Intro Video Music:

1. SoulProdMusic. 2023. Breath / Emotional Sad Piano Melody. Available at:
<https://pixabay.com/music/modern-classical-breath-emotional-sad-piano-melody-171358/> (Accessed 17 March 2024).

Background Music:

1. folk_acoustic. 2022. Morning Garden - Acoustic Chill. [Sound recording]. Available at:
<https://pixabay.com/music/acoustic-group-morning-garden-acoustic-chill-15013/> (Accessed 19 November 2024).

In game pause sound:

1. Floraphonic. 2024. Punchy Taps UI 8. [Sound recording]. Available at:
<https://pixabay.com/sound-effects/punchy-taps-ui-8-183904/> (Accessed 16 March 2024).
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<https://pixabay.com/sound-effects/pause-89443/> (Accessed 16 March 2024).

Level completion sound:

1. Pixabay. 2021. Level win. [Sound recording]. Available at:
<https://pixabay.com/sound-effects/level-win-6416/> (Accessed 16 March 2024).
2. Pixabay. 2022. Level Completed. [Sound recording]. Available at:
<https://pixabay.com/sound-effects/level-completed-90734/> (Accessed 19 November 2024).
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<https://pixabay.com/sound-effects/game-level-complete-143022/> (Accessed 16 March 2024).

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1. Pixabay. 2022. Button. [Sound Clip]. Available at:
<https://pixabay.com/sound-effects/button-124476/> (Accessed 19 November 2024).

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