

# Designing A Circular Economy Board Game to Engage the Banksia Community with Climate Resilience Efforts

AN INTERACTIVE QUALIFYING PROJECT REPORT  
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## **Abstract**

The goal of this project was to design an interactive game that highlights the principles of circular economies to assist Banksia Gardens Community Services (BGCS) in educating and engaging the community in Broadmeadows in climate resilience planning. To design our game, the team researched factors that make games educational and enjoyable by playing various genres of games, including serious games. Our game incorporates features and resources of the area surrounding BGCS, including the community garden, Heat Haven, Food Forest, and shipping containers. Several iterations of prototype testing were conducted to obtain our final product. The game board, its components, as well as the instruction booklet, were shared through a website and also presented to our sponsor, BGCS.

## Executive Summary

Serious games provide an opportunity to teach real world concepts by engaging players in interactive fun, using the game's design to teach complex, and potentially transformative, subjects related to climate change. Climate change is affecting billions of people worldwide through increases in extreme weather events and effects on agricultural production, which are estimated to cause over 150,000 deaths annually. In Australia, the average temperature rise has been greater than the world average at over 1.4°C (Museum, 2022). In 2019, Australia experienced both its driest year on record and its hottest year on record. Heatwaves in Australia are already so severe that roads can melt and turn vegetation black (Museum, 2022). Furthermore, impoverished people suffer the most at the hands of climate change, even though they produce the least amount of harmful emissions. One of the most disadvantaged areas in Australia is Broadmeadows, a suburb of about 12,000 people located in the northern region of Melbourne. There are many social issues prevalent in the area, including high rates of unemployment, of about 15.9% as of 2016, and high crime levels. Being a socio-economically disadvantaged community, residents of Broadmeadows have been some of the main victims of the increasing temperatures over the summer. It is common for temperatures inside homes to reach 104°F, and most residents live in public housing without air conditioning.

Banksia Gardens Community Services (BGCS) is a neighborhood house, registered charity, and community service organization in Broadmeadows. BGCS has been working with businesses, community groups, schools, and the local council to deliver programs that assist disadvantaged community members. BGCS believes there is a strong correlation between social and environmental justice and, in 2009, adopted environmental sustainability and climate resilience as one of their organizational principles. BGCS recently received a grant that includes two proposed climate relief community initiatives: a Heat Haven and a Food Forest. The Heat Haven will provide a community space where residents will get refuge from heat waves. The plans for the Heat Haven, shown below in Figure 1, include large deciduous trees with overlapping canopies to provide shaded areas for residents and staff to cool down, along with some umbrellas and a pergola for further shade. The Food Forest, also shown in Figure 1, is a long-term vision which will sustainably develop adjacent land, provide residents with a place to cool down, and support BGCS's food program through fruit trees, which provides food for the most vulnerable of the community.



Figure 1: BGCS's proposed Heat Haven (left) and Food Forest (right).

To help BGCS engage and educate the community in these climate resilience initiatives, and in circular economy thinking more broadly, our team designed a board game that highlights the principles of circular economies while highlighting the unique features of the BGCS grounds and community initiatives. The game teaches the principles of the circular economy, which include: recycling and reusing whenever possible to “close the loop” of the local economy, because resources are reused instead of passing straight through the economy; using resources in generative ways that amplify positive outcomes; and cooperating and collaborating, because achieving climate resilience requires an economy in which social and environmental goals are achieved for all.

### **The Game Design Process**

To start the game design process, the team looked at examples of other serious and entertainment games to understand how games are able to transform their subject matter into a work of entertainment and education successfully. Playing games, both among the team and with members of the community, allowed the team to identify lessons for our game design and, in particular, to identify what constraints were needed. While gaming, the team used a rubric for each game to note fun, mechanics, difficulty, artwork, cooperation, relevancy to BGCS, competition style, playing time, and age range. Through this, the team determined that the game should remain simple, engaging, educational, collaborative, fast-paced, and include the particular features of BGCS’s climate resilience plans.

When creating the board, the team wanted to highlight features of BGCS and the concept of a circular economy. To do this, the team took inspiration from the board game *Settlers of Catan* and utilized hexagonal Tiles in our prototype, as shown in Figure 2. The hexagons in our game represent BGCS locations and initiatives, allowing for players to build these features and expand the area as they play. The board was created in the formation of Rings to further the connection with a circular economy, with the idea that players had to start from the middle and expand sustainably across the board space.

The team designed the game to contain as many relevant BGCS features as possible for players to both relate to and learn about, enriching their playing experience. To determine these important features, the team spent time with community members and leaders. They participated in events such as a Community Planting Day, familiarizing them with the community garden, shipping containers that are used as innovation hubs and social spaces, and the social housing, all important BGCS features that represent the community. The team also discussed key circular economy goals at BGCS with Dr. Edgar Caballero Aspe, which helped them identify the relevant features, such as the composter, Food Forest, and Heat Haven. These features were chosen to highlight the sustainability programs at BGCS and to create interesting gameplay mechanics such as those relating to the reuse of resources and expansion.

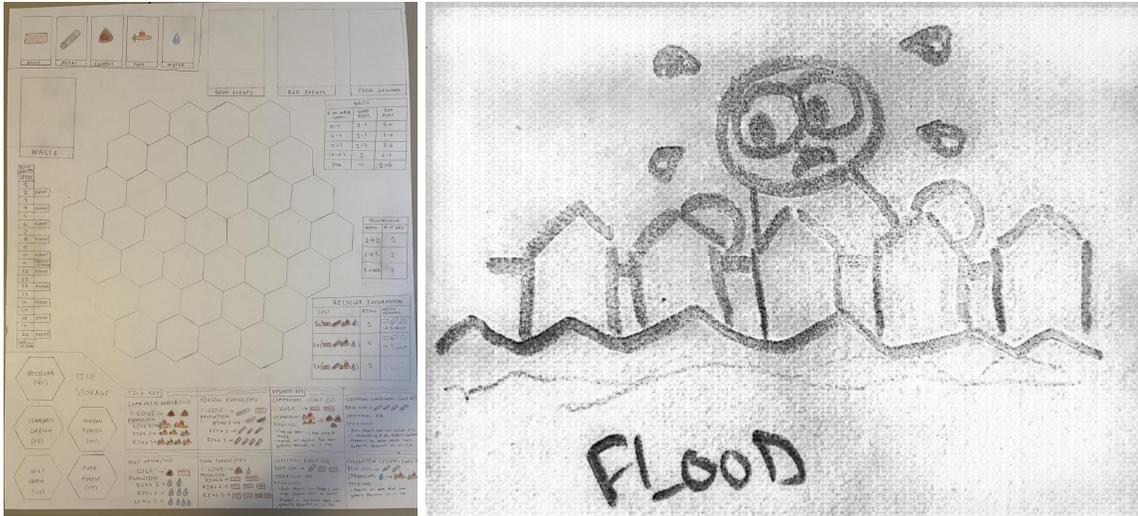


Figure 2: Picture of Prototype One (note hexagonal Tiles for the board).

### The Circular Economy Game

Players cooperate to sustainably develop all the Rings of hexagonal Tiles around the BGCS Tile in the center of the board by crafting Tiles and Tile Upgrades on the game board, shown in Figure 3 below. If players unsustainably develop the land, Waste builds up and extreme weather or other bad Events occur more often, leading to a likelihood that the players will exceed the waste limit or run out of game plays and will collectively lose the game. If they sustainably develop the land, then beneficial Events, such as social programs that BGCS runs, will occur more often, increasing the odds that players will complete the Rings by the end of the Round limit. Importantly, the game is a cooperative game, in which all players collectively win or lose. The cooperative nature of the game is emphasized by adding mechanics such as trading and Tile Upgrades affecting all players, not just those who built them.

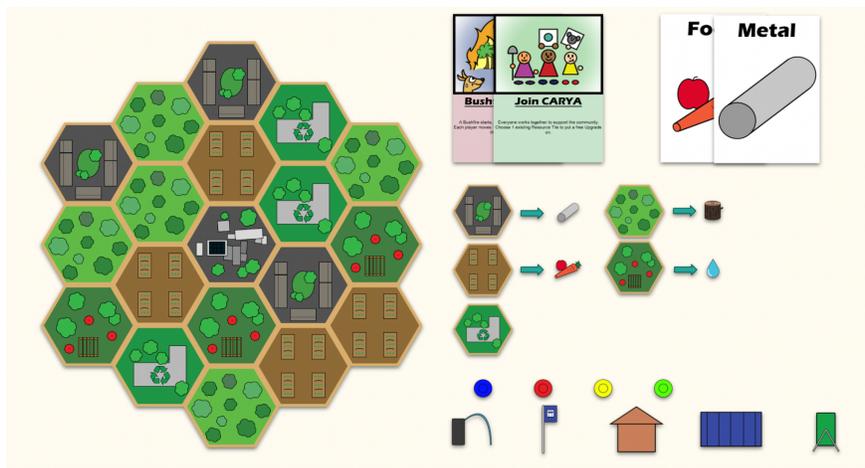
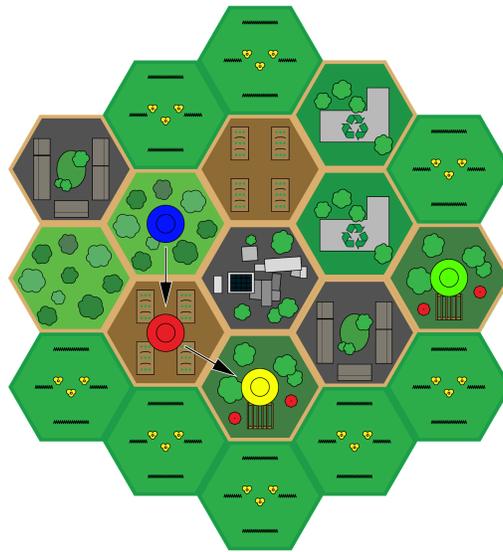


Figure 3: The final board game, along with its main components.

The game utilizes various Resources: Food, Water, Wood, Metal, and Compost. Resources play a critical role within the game, being utilized within player Actions such as Operating Upgrades, Crafting new Tiles, or trading between players. The use of Resources within the game also represents the circular

economy. Players must manage Waste generated by the Social Housing and Events or else Waste quickly accumulates, making the game more difficult and increasing the risk of losing. By recycling and careful, sustainable development of the area, players are able to manage how many of their Resources are Wasted. The focus on collaboration was maintained throughout the prototyping and testing process; for example, the mechanic of Chain Trading was introduced to allow players to cooperatively trade more often, an example of which is shown in Figure 4.



*Figure 4: Flow of a blue player Chain Trading to a yellow player.*

The Events mechanic globally affects all players, thereby giving them a common goal. Events occur every round and may be either good or bad, depending on the current level of communal Waste, some examples of which are shown in Figure 5. This solidifies the idea that climate change is a collective challenge and must be tackled through coordinated actions, because if Waste gets out of hand, players experience more bad Events. Events were created to give players a sense of both urgency and community, because they happen every round and require immediate player attention, and also take the collaborative effort of all players to quell. Good Events are often in the form of BGCS programs/initiatives or positive weather such as rain, while Bad Events are typically in the form of negative climate change impacts related to weather (droughts or heat waves) or bad behavior exhibited at BGCS, such as vandalism.

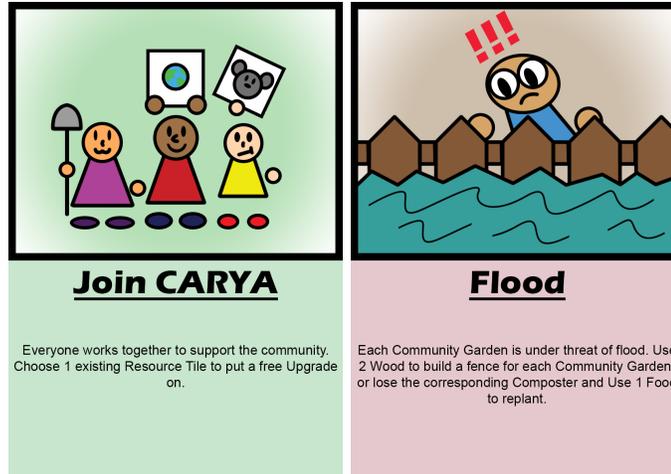


Figure 5: Two Event cards showing a good Event and a bad Event.

Playtesting was commenced to confirm not only the playability of the game at any given prototype stage, but to ensure the game did not violate any set design criteria. The first set of playtesting sessions was done within the team to test if the game fit the constraints set. The second set of playtesting sessions was done among the WPI IQP student cohort and the WPI advisors, testing intuitiveness and the winnability of the game. The final stage of testing was done to further test the intuitiveness and educational ability of the game, with individuals from the external groups Circular Economy Victoria, Hume City Council, and RMIT University, as shown in Figure 6.



Figure 6: The Final Testing of the Prototype with an external group.

## Conclusion and Next Steps

The game, by following the design constraints set and by teaching circular economy and climate change concepts, was positively received by the sponsors and community. Suggestions created by the community included utilizing the game as a team-building tool for sustainability oriented non-profit organizations, or promoting competition between groups by seeing who finishes the game the fastest. Through the interest and enthusiasm generated by BGCS partners, such as Circular Economy Victoria, there are new opportunities for WPI project teams or other partners that are interested in game design to

improve and produce the game. They could focus on further testing and refining of game mechanics or introducing new features.

A major potential expansion opportunity for the game would be to digitize it. The game dynamics could be easily replicated in an online game and, in fact, digitization could simplify many of the mechanics as presented to the player. For example, instead of counting the number of cards in the waste pile, rolling a die, and determining whether to draw a good event or bad event based on the amount of waste, the computer could automatically calculate which type of event to display immediately. Specific information could also be shown to the player when the player requires it, instead of overwhelmingly displaying a lot of information at all times — for example, it could only show crafting costs when players are attempting to craft. Digitization would increase the accessibility of the game, exposing more people to the principles of circular economies through fun gameplay. As Banksia Gardens Community Services continues to develop new community programs, these programs could be implemented in the board game. Additionally, the game could be adapted to represent other regions and ecosystems in Australia or globally, though we believe the current game design based on the Banksia Gardens community would have universal appeal and relevance.

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## **Authorship**

The main authors of this report are Jonathan Metcalf, Sean O'Connor, Elitumaini Swai and Evan Vadeboncoeur. The introduction, background, and methodology chapters were initially divided into multiple sections, and each team member contributed equally to the writing and completion of these chapters. The acknowledgements, authorship, abstract, executive summary, game objectives and specifications, prototyping and testing, final game design and recommendations, and the appendix sections were also written by each team member. After finishing individual sections, the entire team edited each section for grammar and to ensure all ideas and comments were addressed. Additionally, Professor McCauley and Professor Carrera contributed to the editing and revising of the report together with the ideas throughout the entire process.

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We'd like to thank our advisors, Professor Stephen McCauley and Professor Fabio Carrera, for their combined feedback throughout the time spent working on this project.

We are grateful to the Banksia Gardens Community Gardens staff for making us feel right at home when we were working there.

We want to acknowledge the Wurundjeri Woi Wurrung people as the traditional owners of the land on which BGCS is located. We pay respects to their Elders past and present, and extend that respect to the First Nations and Elder members of our multicultural community.

Many thanks to the various playtesters for our game, including many other members of the WPI Australia D22 IQP cohort.

## 1.0 Introduction

The use of serious games provides an opportunity to teach real world concepts by employing the characteristics that make games fun. Serious games can utilize their game design to help simplify and effectively teach difficult contemporary subjects, such as climate change. Climate change has become an ever apparent issue affecting the entire world that is only getting worse. As humanity releases greenhouse gasses into the atmosphere, carbon dioxide has increased to over 400 ppm (Shu et al., 2018); this has caused many far-reaching effects, such as raising the average global temperature by 1.1°C since 1910, potentially raising the sea levels by 45 to 82 cm by 2090, and increasing the rate at which natural disasters occur such as hurricanes and droughts (Museum, 2022). This has affected billions of people worldwide, and the changes in more extreme weather events, patterns of disease, and effects on agricultural production are estimated to have caused over 150,000 deaths annually (*WHO | Climate Change*, 2022). One such place that has been greatly affected by climate change is Australia; the average temperature rise has been greater than the world average, being over 1.4°C. In 2019, Australia experienced both its driest year on record and its hottest year on record. Based on medical records for the 19 weeks of bushfires during 2019 to 2020 fires, it is estimated that bushfire smoke directly caused 417 deaths and 1,124 hospital visits for cardiovascular, respiratory and related health conditions (*Hume Regional Climate Change Adaptation Strategy*, 2021). These fires are becoming increasingly severe and much more common, especially 2019 and onward (Abram et al., 2021). Overall, 354 Australians have died as a result of a heatwave between 2001 and 2018; one primary contributing factor was socio-economic disadvantage (Coates et al., 2022).

Social-economically disadvantaged communities are mostly the main victims of the climate change effects. One of the most disadvantaged areas in Australia is Broadmeadows; Broadmeadows is a suburb of about 12,000 people located in the city of Hume to the north of Melbourne in the state of Victoria. There are many issues prevalent in the area, including high rates of unemployment of about 15.9% as of 2016, and high crime levels, leading it to be rated as one of the top ten riskiest places to live near Melbourne (*Employment Status | Hume City | Community Profile*, 2022). Residents in Broadmeadows and the areas near it are especially affected by climate change, especially in the summers; it is common for temperatures inside homes to reach 40°C, which is 104°F. As more disadvantaged residents tend to live in public housing towers, air conditioning is a luxury that most do not have access to. Especially during the COVID-19 pandemic, common rooms in these towers that are usually air conditioned have been closed, leaving some residents to even be taken out in ambulances (Silva, 2022). Even if residents have access to air conditioning, the problem is not entirely solved, as electricity bills increase more than most residents can afford to pay.

Banksia Gardens Community Services (BGCS) is a neighborhood house, registered charity, and community service organization that was established in the Broadmeadows area, in the Hume municipality. BGCS has been working with different businesses, community groups, schools, philanthropy, and the local council to deliver programs that assist disadvantaged community members. Considering the climate crisis, BGCS believes there is a strong correlation between social and environmental justice. In recognizing this, BGCS has adopted environmental sustainability as one of their organizational principles from 2009 (*About Us - Banksia Gardens Community Services*, 2022). So far, BGCS has worked on several projects aimed at alleviating climate change. They have created a program called Climate Adaptation Requires Youth Action (C.A.R.Y.A). Participants learn about climate change and adaptation practices, and then help their community adapt to climate change. Banksia Gardens

Community Services recently received a grant to transform the area around it into a space that engages the community and helps combat the impacts of climate change through several concepts involving circular economies. These concepts include three main initiatives: a Heat Haven, an expansion to their current community garden, and a Food Forest. The Heat Haven will be a place with vegetation and umbrellas that provides a space for refuge from heat waves, which are ever more present as climate change worsens. The community garden is a garden space that produces food for relief programs for the most vulnerable, and also has extra plots of land for people to grow their own crops. The community garden also includes a plant propagation system, which is a system to enable growing new plants from a variety of sources, including seeds or cuttings from other plants, which can build resilience in the face of the changing climate. Finally, the Food Forest is a long term vision for BGCS's project that reduces heat, increases biodiversity in the area, and creates a natural space for healthy human interaction, as well as providing more sources of food for their food relief program.

BGCS would like to engage and educate the community with the idea of a circular economy through an interactive game. Since Australia and the area around BGCS are so prone to droughts and heat waves, making sure the community remains informed about food security and how to stay safe in heat waves is critical, as well as conserving water whenever possible. This project provided a way to fill this gap by assisting BGCS to educate and engage the community in Broadmeadows in climate resilience planning through an interactive game that highlights the principles of circular economies. The team aimed to engage the community with the idea of the Heat Haven, community garden, and Food Forest by including all of these ideas within the board game. The game will focus on engaging the community with the idea of the circular economy as it relates to BGCS's climate relief effort.

## 2.0 Background & Literature Review

The foundation of this project is built upon the need for decisive action to aid climate relief efforts as clearly shown by the impacts of climate change, especially in Australia. Under this background section the following will be discussed in series: Impacts of climate change in Australia, living in Broadmeadows, and impacts of climate change in Broadmeadows. Following that will be the Banksia Gardens Community Services efforts towards combating climate change as well as their efforts in engaging the local community with the climate change resilience initiatives. After that, the climate resilience efforts relating to the concept of circular economy will be discussed. Lastly will be the overview on community engagement through gaming — specifically games for sustainability.

### 2.1 Impacts of Climate Change in Australia

Australia has been subject to climate change in the last century. The country is experiencing excess droughts, scorching temperatures, forest fires and floods; the heatwaves in Australia are already so severe that roads can melt and turn vegetation black (Museum, 2022). The locations of heat waves are shown below in Figure 7. In general, weather conditions are becoming more severe all across the continent. From 1910 to 2004, the mean annual maximum and minimum temperatures in Australia have increased. The average maximum temperature each decade has increased by  $0.06^{\circ}\text{C}$  ( $0.108^{\circ}\text{F}$ ). Similarly, the annual rainfall total across all of Australia has increased since the year 1900, but this has not happened evenly throughout the country. Rainfall in the tropical areas of Australia has increased, while rainfall in southwestern Australia has decreased. As temperatures rise, governments seek to provide plans to combat climate change and construct places of refuge for those affected.

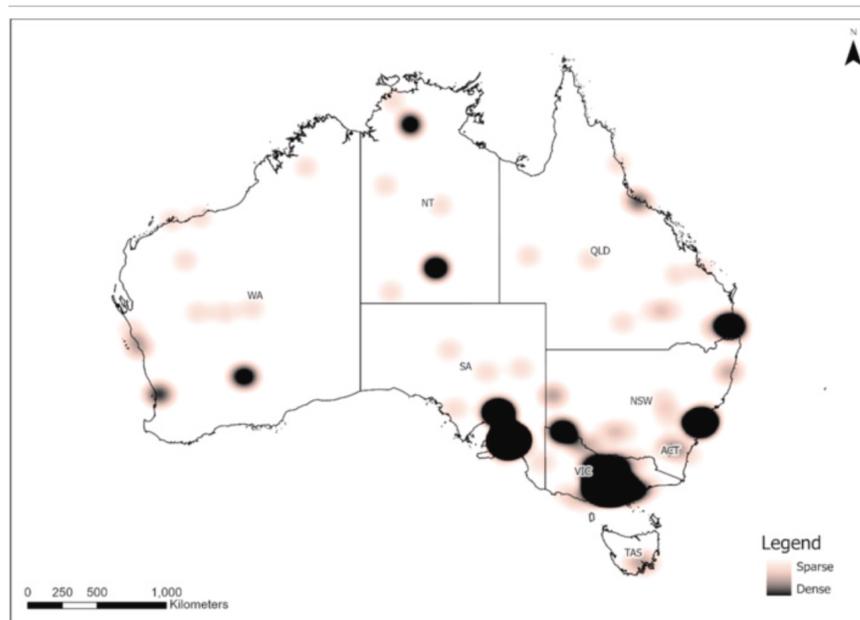


Figure 7: Heatwave incident locations in Australia, 2001-2018. (Source: (Coates et al., 2022))

Figure 8 below shows the effects of climate change on bushfires in Australia. In the subfigure

labeled A, the widespread red areas are areas that were burnt between September 2019 and February 2020, which is spring and summer in Australia. In the subfigure labeled B, the different colors represent the monthly total Fire Radiative Power (FRP), which measures radiant energy released per time unit by burning vegetation. As is clearly apparent, the mean FRP from 2003-2019 was much lower than the summer of 2019/2020's FRP; even the maximums for each month through almost 20 years of data is much less than half of the most recent summer's FRP. From these statistics, it's clear that major forest fires are becoming more and more common in Australia, most likely due to climate change. (Abram *et al.*, 2021)).

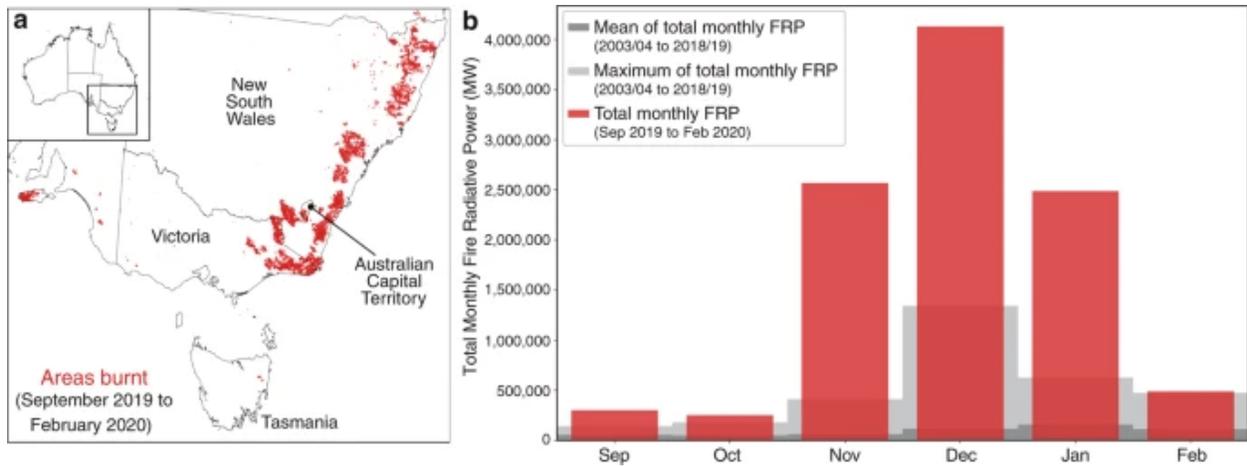


Figure 8: Area and intensity of the Black Summer fires in southeast Australia. (Source: (Abram *et al.*, 2021))

## 2.2 Living in Broadmeadows

Broadmeadows is a historically underprivileged neighborhood of Melbourne. It has a low education rate, with only 17.7% of residents completing 12th grade of primary school, as well as a high unemployment rate of 15.7%. Figure 9 shows some statistics about unemployment in Australia, and more specifically in Broadmeadows. Important to note is Hume and Broadmeadows is overall more unemployed than the rest of Australia.

Broadmeadows is very diverse, being home to a host of different races, ethnicities, and religions. Residents trace their heritage to Iraq, Lebanon, Pakistan, and India. There are also a variety of religions among the population. People practice Islam, Catholicism, among other religions (2016 Census QuickStats, 2016).

Broadmeadows - Persons (Usual residence)	2016		
	Number	%	Greater Melbourne %
Unemployed (Unemployment rate)	620	15.9	6.8
Looking for part-time work	264	6.8	3.3
Looking for full-time work	356	9.1	3.5
Hours worked not stated	144	3.7	1.8
Employed part-time	1,362	34.9	33.5
Employed full-time	1,774	45.5	58.0
Employed	3,280	84.1	93.2
Total labour force	3,900	100.0	100.0

Figure 9: Unemployment across Australia reported in 2016. (Source: (Employment Status | Hume City | Community Profile, 2022))

The majority of Broadmeadows' social housing was built between 1950 and 1969, but they fall short of the liveability residents need (Haweil, 2021). The need for social housing has increased with the increase in applications, and while the government has begun its Big Housing Build of \$5.3 billion to fund new housing, the funding is short of the target amount needed. Broadmeadows is home to Banksia Gardens Community Services, the largest social housing site in the suburbs.

2.2.1 Impacts of Climate Change in Broadmeadows

The International Institute of Environment and Development reported that impoverished people suffer the most at the hands of climate change, even though they produce the least amount of harmful emissions; Broadmeadows is no exception to this. Poor people also have the least amount of options available to them when it comes to climate change related events because of lack of resources and mobility. Broadmeadows' residents are subjected to this unfortunate problem.

The Hume region has and will continue to be significantly impacted by the rise of climate change. The poor housing leaves residents to combat the extreme weather. Many apartments, such as tower housing, do not have air conditioning or ceiling fans, leaving residents to seek out the cooled common rooms of their buildings. However, despite density limits being eased in Victoria, these types of rooms have been locked during the pandemic (Silva, 2022). Instead, residents find solace in public shopping areas to escape the heat. The exposure to extreme temperatures causes financial issues for those unable to afford the high energy bills, and the increased risk of cardiovascular and respiratory illnesses and other conditions (Daly et al., 2021).

### ***2.3 Banksia Gardens Community Services' Efforts Towards Combating Climate Change***

Banksia Gardens Community Services is a neighborhood house not-for-profit organization located within Broadmeadows whose mission is to transform lives, strengthen communities, and reduce disadvantage (*About Us - Banksia Gardens Community Services, 2022*). A picture of the house is shown below in Figure 10. The organization originated in the early 1970s due to the demand for housing in Broadmeadows, but in 1981, the Center was used to encourage participation for tenants and local residents. The estate's issues of vandalism, violence, and drugs led to the area becoming known as the "Bronx", and the need to evolve with the changing times was growing. In 1993, a multipurpose facility was created by the Office of Housing to provide programs for the local community. BGCS has collaborated on projects with Massachusetts-based university Worcester Polytechnic Institute (WPI) since 2010 ("WPI in Melbourne," 2022). Figure 11 below shows a brief history of BGCS from when it was first founded to present day.



*Figure 10: The Banksia Gardens Community Services building.*

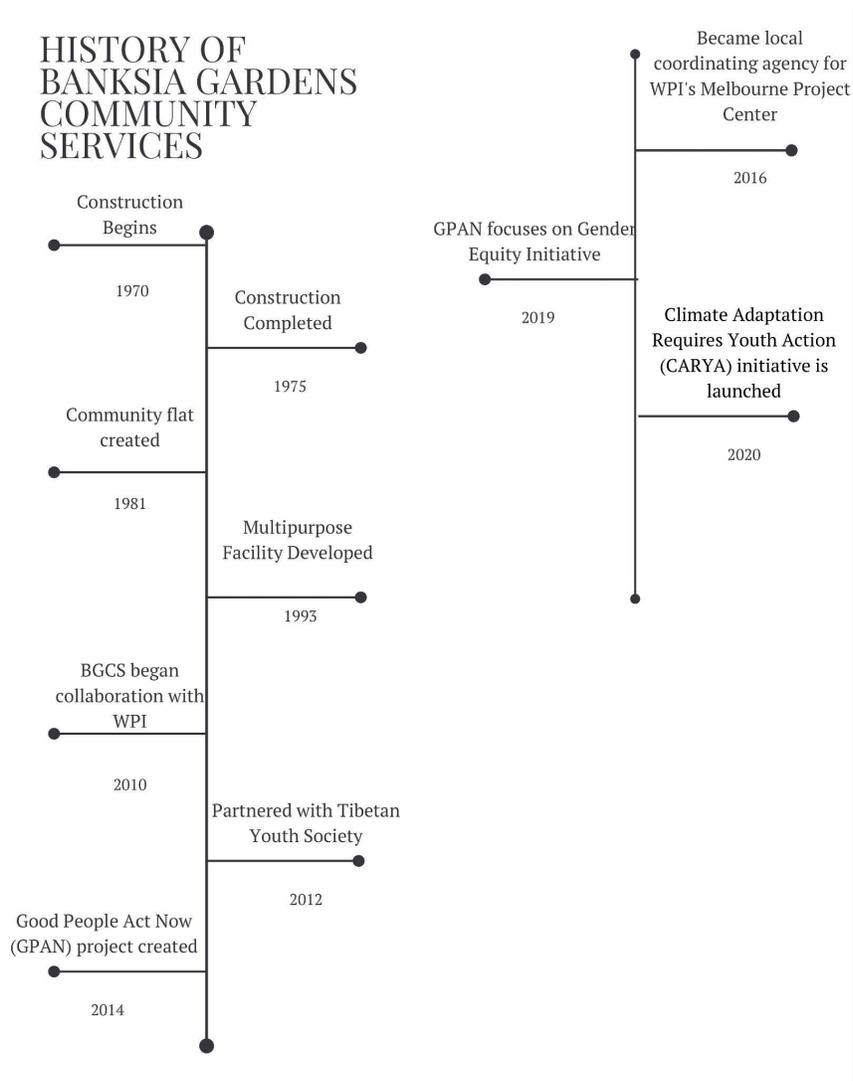


Figure 11: A timeline of Banksia Gardens Community Services. (Source of Information: (About Us - Banksia Gardens Community Services, 2022))

### 2.3.1 BGCS Climate Initiatives and Engaging with the Local Community

Banksia Gardens Community Services is focused on providing relief programs for the local community that provide educational and employment opportunities to enhance their well being, and on raising awareness with the community’s relationship with environmental stability and acting responsibly to minimize its environmental impact (“Environment”, 2021). One program that BGCS is running is the community garden, an example of BGCS’s commitment to environmental stability while providing new opportunities for its residents, as the garden is volunteer-run. Residents can grow plants, learn and improve their gardening skills, and meet other members of the community (*About Us - Banksia Gardens Community Services*, 2022). The ability for residents to grow their own plants gives a sense of ownership over the garden despite it being created by BGCS. Another program is C.A.R.Y.A, an initiative designed to give young members of the community a space to connect and discuss the issues of climate change and to facilitate ways to meaningfully take action, shown in Figure 12 (“Climate Adaptation Requires Youth Action – CARYA,” 2022). The program included a ten week training program consisting of weekly online

workshops to discuss these topics. The program acts to create awareness for the issue of climate change while engaging the local community with said issue. It was initiated by one of the Worcester Polytechnic Institute student Interactive Qualifying Projects (IQP) teams in 2020. They worked on creating a framework that gave BGCS a strong program foundation in empowering youths of ages 18 to 29. They prepared an instructor manual that set up the details of the program and established a network of organizations to support C.A.R.Y.A as well as its participants (Mohapatra et al., 2020).



Figure 12: CARYA program taking action on environmental issues. (Source: (Mohapatra et al., 2020))

## 2.4 Climate Resilience Efforts & Circular Economy

A circular economy is one that promotes recyclability and reusability. If a good is at the end of its usefulness, there is a purpose for it elsewhere. The notion of a circular economy stems from “closing the loop” of an industrial ecosystem, much like a terrarium, in which everything is conserved. Circular economies seek to “[replace] production with sufficiency: reuse what you can, recycle what cannot be reused, repair what is broken, remanufacture what cannot be repaired” (Stahel, 2016). Figure 13 depicts the difference between a linear economy, in which the resources are used and then disposed of immediately, and a circular economy, in which the loop is closed as much as possible to reuse resources.

Australia has increased its circular economy efforts in recent years. In doing so it has “developed eco-industrial parks in metallurgy/metal industries, eco-cities and small-scale waste-to-wealth creation strategies” (Halog et al., 2021). Due to its prevalence in manufacturing, Australia has focused on furthering recycling methods for metals, which contributes greatly to its circular economy. These projects are sustainable, yet also produce wealth for the economy. Klynveld Peat Marwick Goerdeler, a multinational professional services network, estimated the contribution of Australia’s circular economy to its GDP to reach up to \$210 billion (Halog et al., 2021).

Banksia Gardens Community Services strives to engage and teach its community about the circular economy as it relates to its climate initiatives. These initiatives are the community garden, Heat

Haven, and Food Forest. This IQP seeks to illustrate a circular economy in an interactive game that is approved by the community.

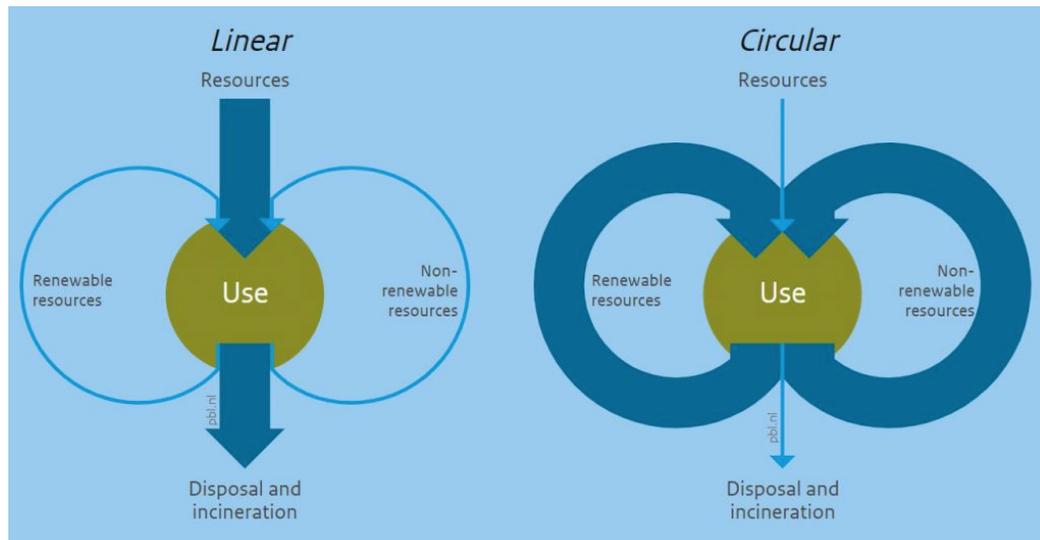


Figure 13: Depiction of linear vs. circular economies. (Source: (Circular-economy-related opportunities, 2022))

#### 2.4.1 Community Garden, Heat Haven, Food Forest Initiatives

Some of the current climate change resilience initiatives that are being worked on by BGCS include a community garden, a Heat Haven, and a Food Forest. BGCS's community garden program is volunteer-run and seeks to educate members in gardening and life skills. It produces food for the most vulnerable of the community members. The proposed expansion to the community garden is shown below in Figure 14. It includes a small workshop, open gathering spaces, a storage shed, and a small trail among the gardens. The goal of this place is to “provide a beautiful place for local residents to gather, relax, work [and] learn together” (Caballero, 2022).

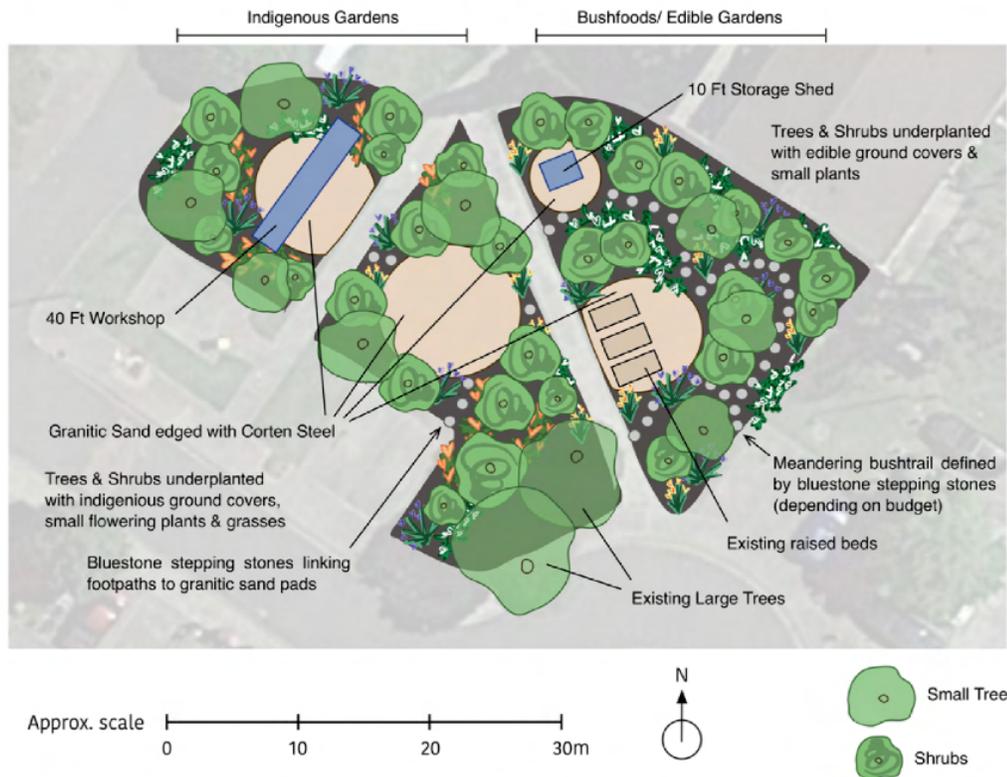


Figure 14: BGCS's proposed community garden expansion. (Source: (Caballero, 2022))

The Heat Haven seeks to provide a community space where residents will get refuge from heat waves. The proposed site for the Heat Haven is shown below in Figure 15. It is planned to have large deciduous trees with overlapping canopies to provide shaded areas for residents and staff to cool down. It also further has a pergola and some umbrellas for further shade. Plants native to Banksia Gardens will be planted throughout to improve the aesthetics of the area.

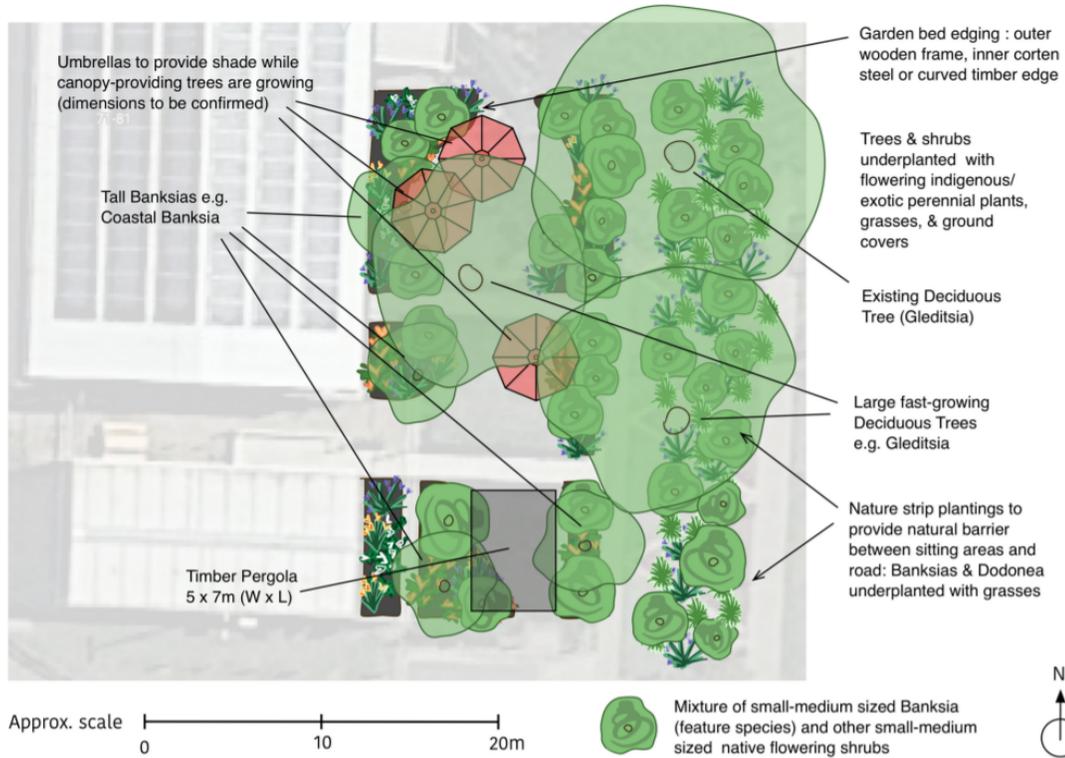


Figure 15: BGCS's proposed Heat Haven. (Source: (Caballero, 2022))

The Food Forest is a long-term vision which will provide residents with a place to cool down, develop adjacent land, and support their food program. The proposed design for the initial stage of the Food Forest is shown in Figure 16. The primary goal of this initial stage will be to “provide structure and shade for additional planting in the future” (Caballero, 2022). It contains many types of trees: apple, plum, almonds, olive, and loquat. Further expansions to the Food Forest are desired, but have not been planned fully at this moment.

### Stage 1 Planting: Canopy Layer (Large Fruit & Nut Trees)

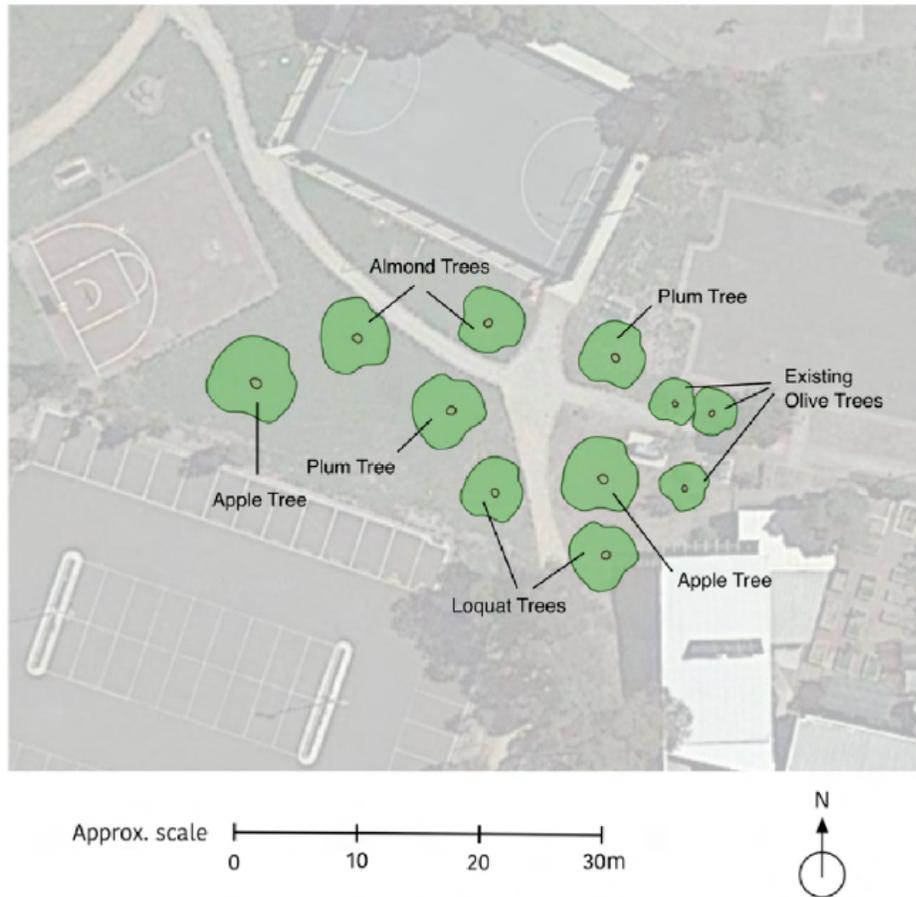


Figure 16: BGCS's proposed Food Forest. (Source: (Caballero, 2022))

## 2.5 Community Engagement Through Gaming

A large part of what makes Banksia Gardens Community Services different from other similar community service organizations is its engagement with the community. For example, one recent expansion it is doing to its grounds is adding some shipping containers to provide new spaces to conduct activities. It strives to ensure interactions are between community members, not simply a helper providing a service to a disadvantaged person (*About Us - Banksia Gardens Community Services*, 2022). This IQP seeks to ensure at all steps that it is approved by the community to uphold Banksia Gardens Community Services's beliefs.

### 2.5.1 Games for Sustainability

Serious games are designed with gameplay characteristics from common entertainment games while focusing on learning, training, and concepts of applying theoretical instructions in real life environments (Stanitsas et al., 2019). Serious games provide users with an increased interest in training, project understanding, and evaluation. However, they can be complex and expensive to develop.

An example of a serious game is *The Fish Game*, where players must choose the number of fish

they want to take from the lake while other fishermen try to catch as many fish as possible. An example of playing *The Fish Game* is shown below in Figure 17. The lake can only contain a specific number of fish at a time, and reproduction occurs at a rate of 25%. The game targets environmental sustainability and the effects of taking too much, as “aim of the game is to show how individuals’ decisions affect resources and may cause its depletion” (“The Fish Game,” 2022).

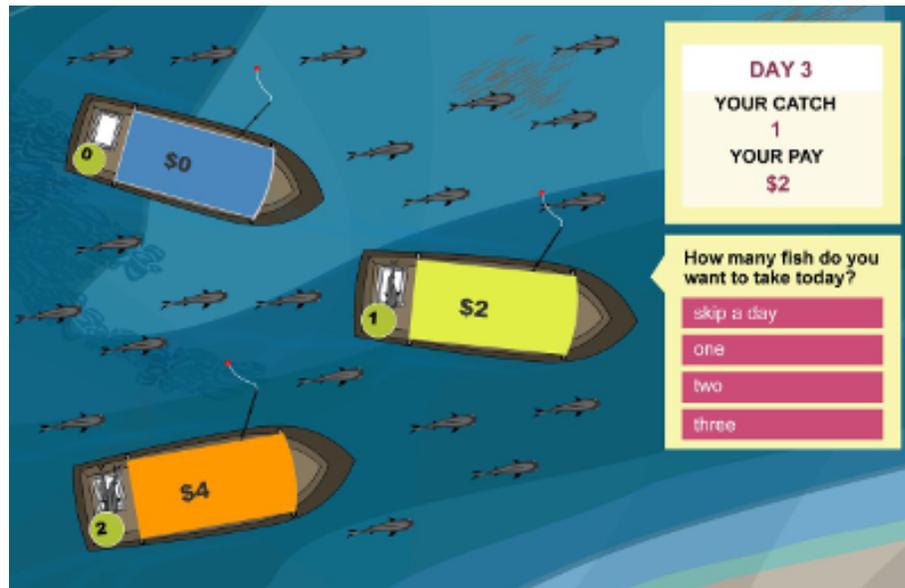


Figure 17: *The Fish Game*, an example of a serious game. (Source: (“The Fish Game”, 2022))

### 3.0 Methodology

The goal of our project was to design a board game that highlights the principles of circular economies to assist Banksia Gardens Community Services (BGCS) with engaging the community in Broadmeadows in climate resilience planning. This interactive game is intended to engage members of the community by creating a sense of ownership and connection with BGCS and the environment around them. Considering the recent climate crisis problems that have been facing the world, BGCS believes there is a strong correlation between social and environmental justice and has adopted environmental sustainability as one of their organizational principles. BGCS is intending to create a Heat Haven, Food Forest, and community garden expansion for use relating to the climate crisis such as heat waves and food insecurities, but want to make sure the community remains informed about food security and how to stay safe in heat waves.

#### *Objectives:*

1. To identify the factors that make games educational and enjoyable by playing various genres of games, including serious games, among the project group as well as with Banksia Gardens community members.
2. To create a game board based on features and resources of the surrounding area of Banksia Gardens Community Center including the community garden, Heat Haven, and Food Forest.
3. To prototype a game that is engaging and informative about climate resilience efforts.
4. To gather feedback of the prototype from gamers in the community to implement in the prototype.

The project focused on the area around BGCS as shown in Figure 18 below. The area contains various buildings and land dedicated to BGCS' community initiatives. This project took place in the autumn season in the southern hemisphere. As it focuses on climate change relief, it is important to realize that different times throughout the year will have different weather, and as such, the effects on the residents of the area will change throughout the year. The team created an interactive board game for the purpose of engaging and educating the community about climate relief efforts such as the community garden, Heat Haven, and Food Forest.

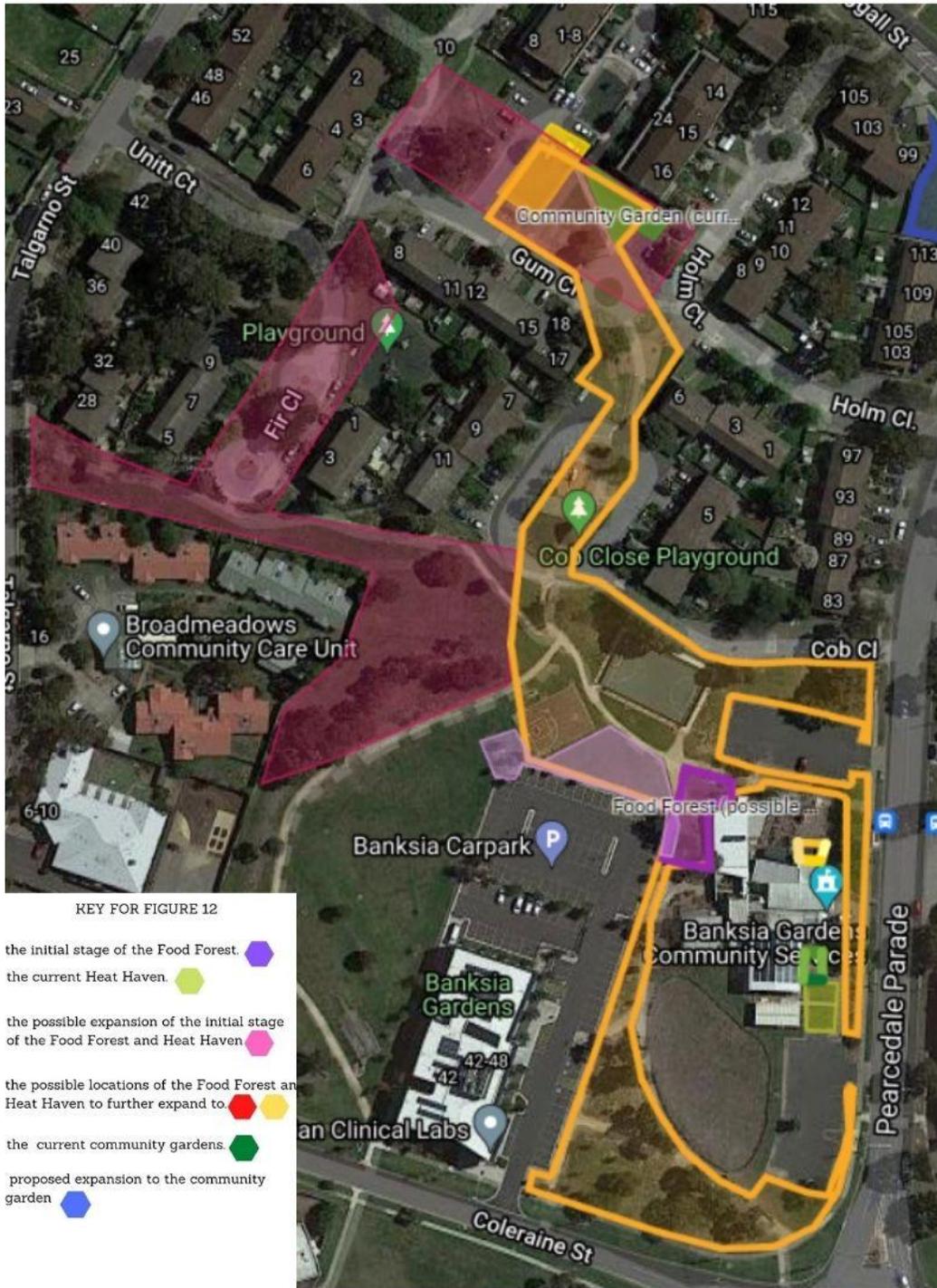


Figure 18: A map of Banksia Gardens Community Services. Depicted are proposed areas and expansions for community initiatives including the community garden, the Food Forest, and the Heat Haven. (Source: (Sharing Map Activation Hub, Food Forest & Heat Haven, 2022))

## **4.0 Game Objectives and Specifications**

To prepare for the creation of an interactive game, the team began research on the educational and entertainment value derived from games. This research consisted of playing a set of games showcasing a variety of genres, topics, and player counts both as a team and in groups representative of the final game's demographic, then filling out rubrics for each game about certain characteristics such as aesthetics and cooperativity that the team wanted to analyze. These play groups consisted of younger members of the Banksia Gardens community. This information gathered through playing the games, both in the design of the games themselves and the responses from the play groups, was then compiled and organized to assist in the process of creating the interactive game.

### ***4.1 Playing Games***

To gain a proper understanding of how to create an interactive game of educational and entertainment value, the team needed to experience these games first hand. Much of the time spent leading up to the trip itself was used for playing games/serious games among the group at Worcester Polytechnic Institute. The selection of games was determined by a variety of factors, including relevance to the project topics, the number of players, and medium. Serious games that dealt with topics of climate change or sustainability were preferred, games that could be played in groups rather than individually were considered, and board games were a focus over digital games. However, to better understand serious games, choices that fell out of these preferences were also considered to give a stronger picture of how they were designed in a broad sense. Genre was also a factor in the types of games chosen for play, and it was noted when games of the same genre had design similarities.

Serious games are not exclusive to a specific medium, and as such the team explored games that were both physical board games and digital games. By exploring digital games, the team would better understand how the games are able to deliver their themes and topics through the game design. Similar design principles could potentially be explored in physical counterparts. The team also explored other board games outside the realm of serious games. This was done to recognize design aspects of standard board games and to gain a better picture for how to create engaging, entertaining games for a wide group of players.

When playing through the games, noting commonalities and similarities between games was a core part of understanding serious games and how to structure them. By knowing how the games were able to transform their subject matter into a work of entertainment and educational content successfully, the team would be better equipped to create their own interactive game. The information taken in by the team while playing the game is laid out in Appendix A. Among the group, the team played Settlers of Catan, Agricola, The Fish Game, Windfall, and In The Loop, completing the rubric for each of them.

### ***4.2 Developing Game Constraints***

After playing the curated collection of games as a base, the team moved to analyze the data collected over the play sessions. The data was organized into data specific to the games and understanding their similarities and differences. These findings were compiled in a spreadsheet linked in Appendix A to

help determine ideas and options for the interactive game. Different characteristics were noted in the rubric to align with different constraints the team wanted to set for our game. Each game the team played gave a different, useful perspective on each of these categories.

The most important design constraints the team determined for the game were for it to be simple, engaging, educational, collaborative, fast-paced, and to contain features of Banksia Gardens Community Services. The games played helped reinforce the constraints to stress in the game and also those to avoid. For example, the group played *Settlers of Catan*, which is a fast-paced, competitive game that allows players to build outward from their settlements. It allows for collaboration via trading, and is engaging as players always have something to do even on others' turns. It is relatively simple for newcomers, and a lot of fun to play. The team aspired to make a collaborative-first game as competitive and fast-paced as *Catan*, though competitive against the environment rather than other players.

*In The Loop* was the quintessential example of what the team should avoid. It was a thinly-veiled re-hash of *Go Fish*, all the while pretending to be a circular economy game. *In The Loop* had to tell players it represented a circular economy, rather than expressing it through game mechanics. The team very quickly learned that they wanted the educational value of the game to be implicit in its mechanics and objectives, which in a way, made playing *In The Loop* valuable. The team determined that it is better for the players — especially ones unfamiliar with the concepts — to learn on their own by experiencing the game, rather than being instructed on it in the manual.

The team also played *Jenga*, *Headbanz*, and *Cluedo* with some younger members of the Banksia Gardens community, ranging from ages 5–10. The team found that *Jenga* was the only game out of the three that they could easily engage with, understand, and focus on (albeit turns were often taken out of order), leading them to conclude that their game ideas were most likely too complex for that age range.

## 5.0 Prototyping and Testing

After determining game objectives and specifications, the team set out to create the game itself. The team first had to consider the overall design of the game board and how relevant features would manifest in the game. The team then worked on prototyping and later testing the game in an interactive process. Prototypes and mechanics were tested in an iterative loop, where testers from different backgrounds participated to help the development process. A final concept was created at the end of the process.

### 5.1 *Creating the Game Board of Banksia Gardens*

The creation of the interactive game as a whole required the creation of a game board of BGCS. After the team had a better understanding of how board games are designed to be entertaining and remain educational, the team determined what features would be relevant to include on the game board. To create the game board of Banksia Gardens Community Services, the group first had to determine how to present Banksia Gardens — both physical features and its spirit — within a board game. The team accessed pre-existing online mapping resources to gather a baseline of information; most notably, the team used the map of Banksia Gardens provided by the sponsor that indicated climate initiatives (see Figure 18). The team then confirmed these locations with the sponsor via a meeting. The original map provided was created through Google Maps.

#### 5.1.1 *Determining Important Features*

The team had to determine what important features of Banksia were incorporated in the game board. The group classified “features” of Banksia as its programs, initiatives, and physical locations. To get a feel for the most important features of Banksia, the team spent time at BGCS, participated in events, took photos, spoke to staff, and went on miniature tours.

The team was first given a tour of the property by Dr. Edgar Caballero Aspe. He showed the team the tentative locations for Banksia’s upcoming climate initiatives, the Food Forest and Heat Haven. He explained the circular economy relationship between the Food Forest, Heat Haven, the various food programs, and their composting efforts, which led the team to understand that the Food Forest, Heat Haven, and composters would be relevant features to portray on the game board.

The team also partook in a Community Planting Day, an organized event in which all members of the Banksia Gardens Community — staff, social housing members, volunteers — may help clean up and plant new crops in the community garden. The event was run near a refurbished shipping container that acted as a community hub for shade and storage of goods. The shipping container sported an awning, multiple windows, and sliding doors. Seeing the residents come from their social housing to help plant the community garden, and use the shipping container for the event helped the team determine that these features would be necessary to represent on the board. All of these items and programs represented community and sustainability, which were the essence of the game being created.

The team further familiarized itself with the various programs that BGCS runs, because they wanted the game to contain many relevant concepts that prospective players could either learn about or relate to. These programs included CARYA, the Computer Access Program, Study Group, Bee Hotels, and multiple others. Since the board was already filling up in terms of both space and complexity, the

team decided to incorporate these programs as Event Cards (as opposed to things that physically manifest on the board), which are a mechanic that globally affect all players.

Elements outside Banksia Gardens Community Services that residents are familiar with were then considered. Dr. Caballero Aspe proposed the team include the nearby shopping center, since it is an integral part of the lives of the social housing residents. The team agreed with him, and put this idea on the backburner since the overall structure of the game had yet to be determined. The group did, however, have a general idea that the shopping center would be a late-game mechanic.

Lastly, the group added features of BGCS that don't yet exist, but seek to capture the essence of the initiatives and provide players with more comprehensive gameplay. For instance, the team determined a shelter would be a nice addition to the Heat Haven, since its goal is to provide BGCS community members with shade and shelter from climatic weather. The Food Forest could potentially need an automatic irrigation system in the future, so the team determined an irrigation system could be an upgrade to this area.

### *5.1.2 Translating Features into a Game Board*

First, the team considered the requirements of the board. The team needed to know the board's size and what scale to use with the mapping data, the materials used to create it (cardboard, wood, plastic, etc.), and the cost of the project, specifically the cost to prototype and the overall budget the team had to create a game. Additionally, the team considered what art styles would suit the intended feel of the game the best; the team eventually settled on a cartoonesque depiction of the area, which would simplify the design while not removing necessary details.

Next, the team looked at creating the board itself, and considered what methods would be best to design it and create it. The team used a mix of freehand drawing and drawing software tools to design the game, because they gave enough flexibility to efficiently create multiple iterations. The team went through several iterations of the development cycle, and within each cycle, the team gauged approval from the community and sponsor as the game board was modified. Initially, the board was a poster board that was drawn and written on with pencils and colored pencils. This allowed for changes to be quickly implemented on the board and additional information to be written on the board, even while playing the game. Concurrently, the team created artwork for the finalized version of the board using Adobe Photoshop. This art reflected the cartoonesque depiction that was desired. Due to time constraints of the project, the team was unable to print the finalized art onto a proper board or laminate the final game cards, but left plans to do so with succeeding IQP groups.

With a better understanding of serious games and the knowledge of what features to put on the board, the team was able to tackle the creation of prototypes to showcase how the game would be designed and do testing on. These prototypes would be tested for feedback, allowing for changes and new prototypes to be made as a result.

## *5.2 Prototyping*

With the relevant features of the board and the general design constraints out of the way, the team then set out to prototype the game in an iterative process. Before prototyping, general game mechanics were determined. Three prototypes were then created that each progressed the game in different ways. The first prototype was very basic and helped the team visualize the overall game. The second was a complete board game that helped refine the game. The third was a final concept that incorporated all

feedback and balances along with new artwork. Game mechanics, intuitiveness of the game, and general player responses were tested within the separate prototypes.

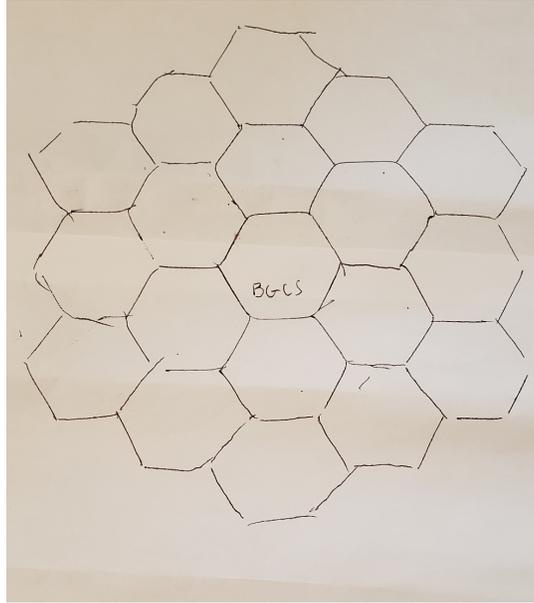
### *5.2.1 Determining Game Mechanics*

The team brainstormed a list of ideas for the interactive game, ranging from small notes to larger overarching ideas, with the goal of effectively teaching the target concepts. They focused on combining and adapting the ideas brainstormed into a working game. The ideas had to balance the tasks of conveying the concepts of climate resilience and circular economy effectively while remaining engaging as a game. As such, it was important to consider how the game was to be designed and structured to accomplish this balance. Examples of previous serious games were crucial in understanding this balance, and by looking at how to adapt the basic ideas that shape these concepts into game systems, it was possible to achieve this balance.

The game also had to provide a rewarding experience, which can be derived from the gameplay and the end result. The concepts of climate change and circular economy are collaborative by nature, due to their effects on everyone rather than specific individuals, and as such it was determined that the game should reward collaboration. To further reinforce collaboration, Events were created for players to work together to overcome, including heat waves, drought, and vandalism — though there are good Events to reward all players as well, which were often BGCS programs. The design choice to make bad Events more common as players produce excess Waste, as well as forcing players to discard cards if they go above their hand size helps highlight the importance of keeping Waste under control. Design decisions like these were determined with the goal of teaching these lessons through the constraints of the game.

### *5.2.2 Creating Prototypes*

Once the group determined the basis for the interactive game, they began work on prototypes. The team made several prototypes, which were named Prototype Zero, Prototype One, and Final Concept. Prototype Zero, shown in Figure 19, was very simple — it was crudely pencil-traced hexagons on thin taped-together pieces of printer paper. This prototype was no more than the layout of the game board, which was largely inspired by *Settlers of Catan*. It also provided a guideline for the game mechanics and gave an idea of the movement system. This prototype was never used for actual play, though it still played an important role in the development process.



*Figure 19: Prototype Zero.*

Prototype One, seen in Figure 20, was made after the mechanics of the game were sorted out, which were discussed with the team's sponsor. It was done on a posterboard in colored pencil. Tiles were cut out from envelope paper and had abbreviations written in colored pencil. Resource cards were cut from poster board and colored with colored pencils. Each Resource type had 16 cards, for a total of 80 Resource cards. Event cards were cut from poster board as well, but were filled in with graphite pencil descriptions. General game information was stored in tables scattered around the board, such as Crafting costs, Waste/Event information, a Round counter, and Recycler costs. The board also hosted locations for Resource cards, Event cards, a Waste pile, and Tile storage. This prototype was used everytime the team playtested it with the cohort, advisors, sponsor, and others.

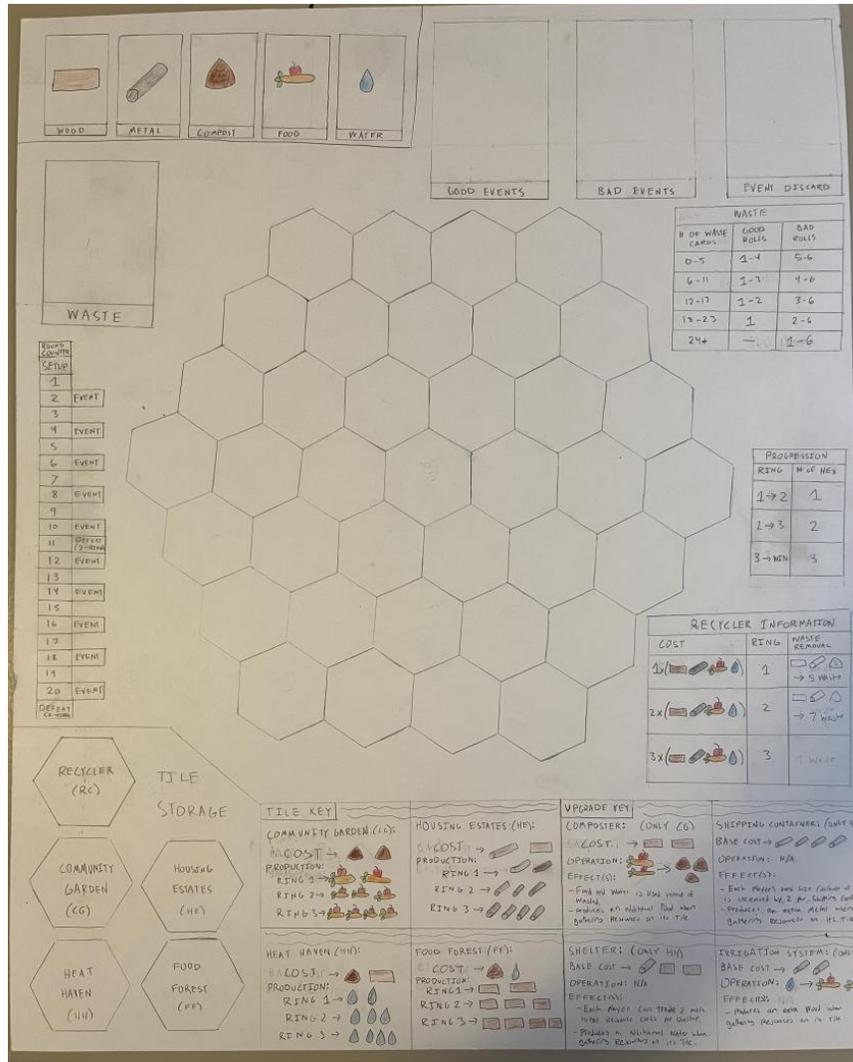


Figure 20: Prototype One.

The Final Concept prototype was drafted after the mechanics of the game had been playtested. Adobe Photoshop was used to design all cards, Tiles and Upgrades. The team created an Information Sheet for players to reference while playing the game (see Appendix D) instead of convoluting the board with tables and charts. This version of the game was never playtested with since it was not printed in time for the end of the IQP.

### 5.3 Testing

Various playtesters were used to test the prototypes in order to determine design flaws within the game. After playing the game, feedback on potential changes and their experiences with the prototype was noted, including the enjoyment of playing the game and the clarity of concepts such as a circular economy. The feedback from the playtesting sessions was then compiled to indicate where the game stood with regards to achieving its goals and used to then modify existing prototypes or create new ones, which would then be tested. The process of creating prototypes and then testing them was a cycle to better

improve the game's functionality, enjoyability, and conveyance of the targeted themes. Through the course of testing, more changes occurred to the game than what was mentioned here; the less important changes were omitted from this report for the sake of brevity.

### 5.3.1 Testing Among the Team

The team began the initial stage of testing the prototype they created solely among the team. The goal of this initial testing was to confirm the game was actually playable, winnable, and fit the design criteria the team laid out, such as being enjoyable and educational. The game was very much still in its conceptual phase and the mechanics were not fully fleshed out. Actually being able to play the game would corroborate — or not — the team's estimate of how the game would play out. The testing was conducted by playing the board game on Prototype One with Jonathan and Evan both playing as two separate players to bring the total count to four players as seen in Figure 21. The game was playtested several times this way, each time improving the game's balance of the various mechanics.

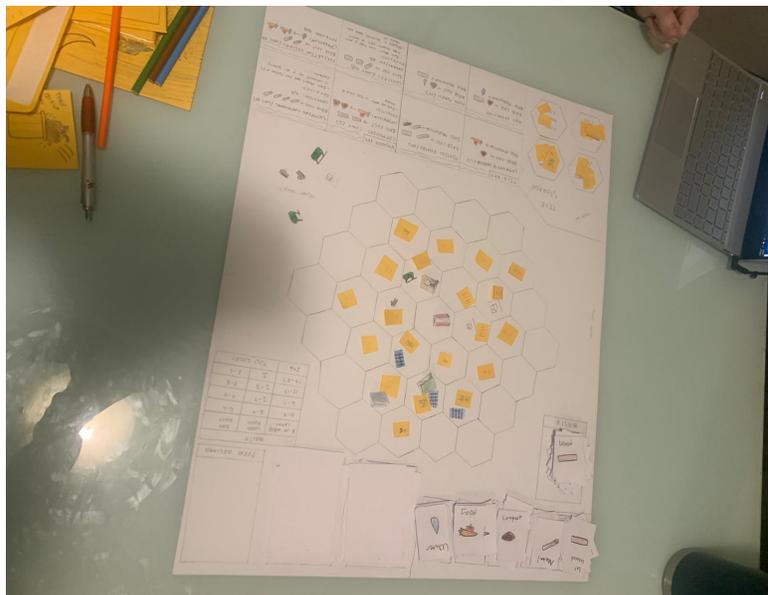
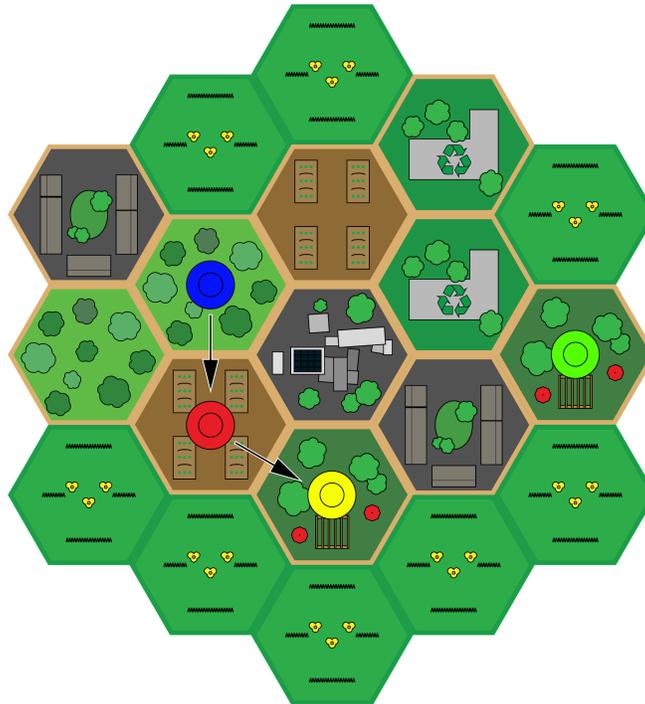


Figure 21: Testing among the group.

The first playtest found that the game violated the design criteria of being enjoyable and fast-paced. The team playtesting was unable to complete the game in time, only making it to Round 11 out of 20, as large parts of their turns were devoted to recycling waste that built up too rapidly, leading them to be unable to make advancements elsewhere to sustainably develop the board. They had barely begun developing the second Ring by that time. Additionally, each turn felt too restrictive and slow paced, so several changes were required. The major overhauls were aimed at the structure of turns and trading. Originally, turns consisted of moving, Gathering Resources, taking an Action, then trading. This felt awkward and punishing to players, with many instances of frustration that players had to move before trading and other steps of the turn. To fix this, turns were restructured into an *Action* → *Movement* → *Action* structure, in which Gathering Resources became an Action; furthermore, trading was allowed at any point during a turn, though still with the same restriction that players could only trade with one other player up to the trade limit. To go alongside this change to trading, Chain Trading was added, which permitted players to trade with other players as long as there was an uninterrupted chain of players

between them. An example of this is shown in Figure 22, in which the blue player is able to trade with the yellow player on their turn, as the red player creates a chain between them. Overall, the effects of these changes were that turns became much more flexible and less frustrating, as new strategies such as remaining on a Tile to Gather Resources twice or even Gathering Resources then moving to a different Tile could now be done, combined with trading with players potentially further away than before.



*Figure 22: An example of Chain Trading.*

The next playtesting session found that the game was much more enjoyable, but still not quite winnable — the team made it to Round 16 out of 20 while fully developing the second Ring and starting the third Ring. However, once the third Ring began being developed, the new amount of Waste being created was far too much to continue developing, requiring all effort to go towards removing Waste. Furthermore, the game began to get slow-paced again as Tiles were farther apart, requiring some sort of buff to movement later in the game. At the same time, it felt as though the Tile Upgrades were necessary in the start of the game, but then quickly became irrelevant. To fix this, Waste and Tile Upgrades were overhauled. Recyclers were changed to recycle more Waste the further out they were; additionally, the Waste produced by Social Housing Tiles was scaled down. To fix the pacing as the game scaled up, and to make Upgrades more relevant, the Bus Stop Upgrade was added, which gave all players 1 extra Tile to move. Furthermore, every Upgrade now made the Tile that the Upgrade was on to produce one more Resource that it could produce. These changes were successful, allowing the game to be won during the next playtesting session on Round 16, taking about 60 minutes.

### 5.3.2 Testing With the Cohort and Advisors

After the game was in a balanced enough state after the initial testing that it was winnable and enjoyable, the next stage of testing was entered, which was to test among the other members of the WPI Melbourne D22 IQP and the advisors of the IQP as shown in Figure 23. The goal of this stage of testing was twofold: first, to make sure that the game was intuitive for new players, and second, to make sure the game was still winnable even if the game was not played perfectly.

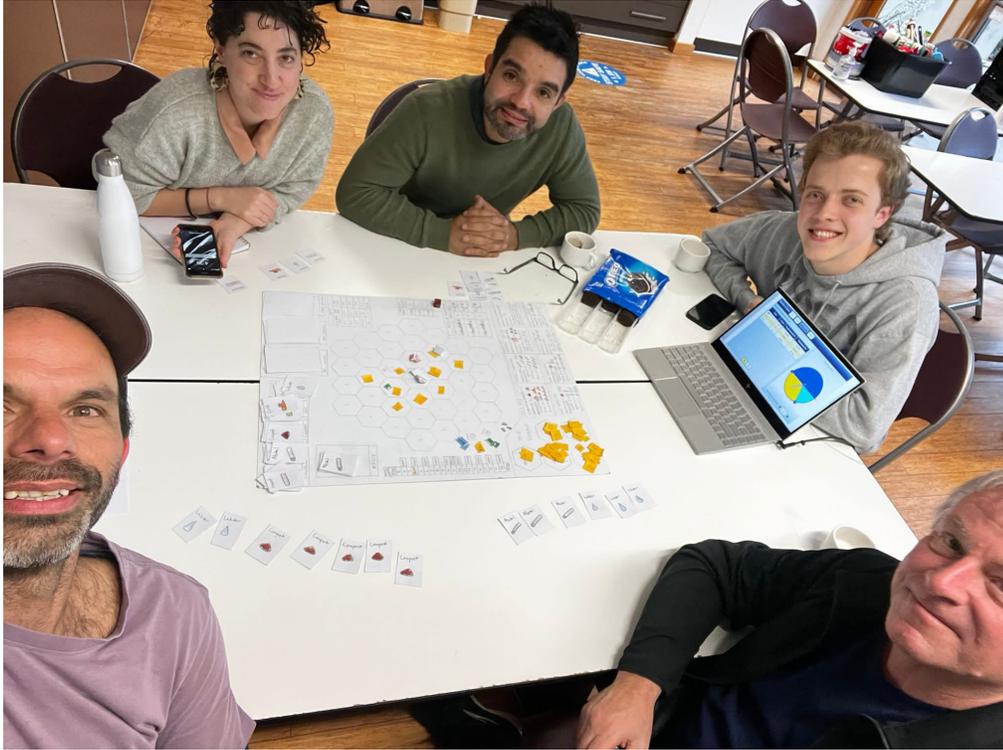


Figure 23: Testing with the advisors (left) and the cohort (right).

The team found that the game was simple enough that the last half of the game was generally played close to perfectly if the players made it that far. However, the main takeaway from this testing was that the instruction rulebook needed to be restructured to better fit what a new player would expect to see. Topics that new players would encounter first such as setting up the board and Round and turn structure were moved to the beginning, while more complex or later game topics such as Upgrades were moved to the end. Additionally, a Game Overview section was added to summarize the important information that players needed to know throughout the game. The goal of this section was to act as the foundation of knowledge that players would have. Finally, some information was changed on the board to be more clear to players. For example, “Cost” was renamed to “Crafting Cost” and the Rings and BGCS were labeled as BGCS, 1, 2, and 3 to be more clear.

### 5.3.3 Testing With External Groups

For the final stage of testing, the team tested with individuals from external groups as shown in Figure 24: Circular Economy Victoria, which is a non-profit organization focused on implementing circular economies in Victoria; Hume City Council, which is the local government; and RMIT University, a local university. The goal of this stage of testing was to continue testing the intuitiveness, but more so to confirm the educational ability of the game, since the team was playing with experts on the topics.



*Figure 24: Testing with external groups.*

The group found that with the updated instruction rulebook, the players were better able to understand the game. However, it was still not perfect, and more clarifying information was added to the rulebook to help new players pick up the game easier. It was found that the pace was slow at the beginning due to this, but then sped up after the players understood the game better. Feedback given for the game in regards to the educational ability was positive; players felt that the cooperative nature was well highlighted with trading and other mechanics to correspond with the cooperative nature of the global fight against climate change. It was said that the idea of a circular economy was laid out well, along with required preparation before bringing in new people by building a new Social Housing Tile.

## 6.0 Final Game Design and Recommendations

Through thorough prototyping and testing, the team finalized the game design of the project. The team took the recommendations given to further refine the game with small modifications to the mechanics, structure, and artwork. To further refine and improve the game for future groups, the team created a set of recommendations to improve the experience and quality of the game.

### 6.1 Final Game Design

The objective of the game is for players to collaborate in expanding Banksia Gardens sustainably by Gathering Resources, trading, Crafting, and lowering Waste. Players win as a collective group by building out all of Banksia Gardens and eliminating all the Waste. However, if the maximum amount of Waste is reached by the end of a round, or players are unable to complete the win conditions in the given number of Rounds, everyone loses. To succeed at the game, collaboration and careful utilization of resources is important for players, as Waste will accumulate quickly otherwise.

#### 6.1.1 Gameplay Overview

The game takes place on a board consisting of two Rings of Tiles, hexagon pieces that represent locations of Banksia Gardens and are required for expanding the map. For the default difficulty, the map consists of a BGCS Tile in the center, followed by 6 empty free spaces around the BGCS tile for the first ring, and twelve free spaces around the first Ring for the second Ring; the final artwork is shown below in Figure 25. Placeable Tiles replace the free spaces, which includes the Food Forest, Social Housing, Heat Haven, Community Garden, and Recycler. Players have the option of expanding to the third Ring which consists of 18 hexagonal Tiles if they would like to play for longer.

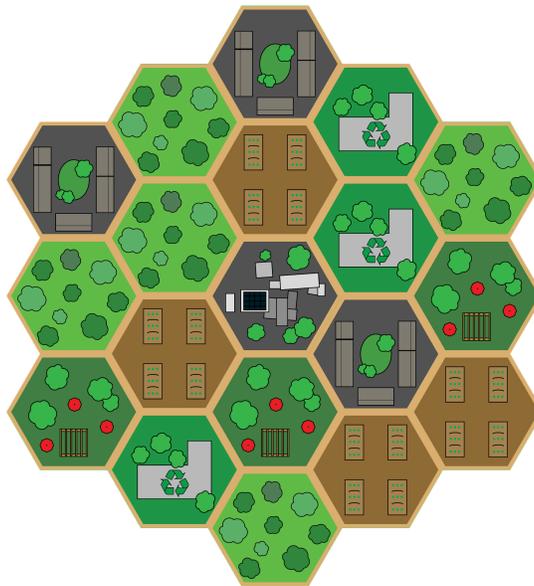


Figure 25: Final concept prototype game board done in Photoshop.

There are 20 Rounds in the game; each Round consists of some upkeep, an Event, and each player taking a turn. Players each take turns in clockwise order, with each turn consisting of an *Action, movement, Action* sequence. Players collect Resources at Tiles, including Wood, Metal, Water, Food, and Compost, with the first four Resources produced by the Food Forest, Social Housing, Heat Haven, and Community Garden Tiles respectively, and Compost produced by the Composter Tile Upgrade. Resources allow for players to create new Tiles, Upgrades, and feed the residents of the Social Housing. Upgrades provide Tiles with the ability to produce one more Resource of the type it produces, as well as a specific Effect depending on the Upgrade. Examples of these cards are shown below in Figure 26.

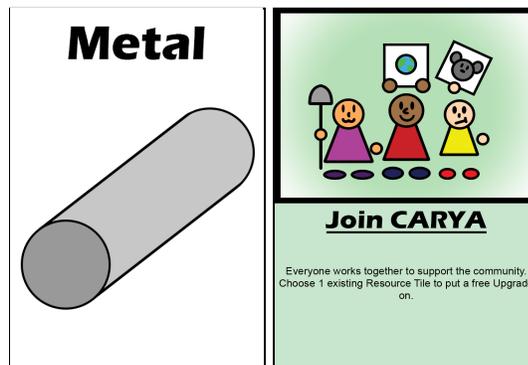


Figure 26: Example artwork of a Resource card and an Event card done in Photoshop.

During a turn, an Action consists of Gathering, Crafting, or Operating, while movement is dictated by a spinner. Players can also trade at any point during the turn with other players, encouraging the trading mechanic to reinforce the notion of collaboration. Players often find themselves in situations when they cannot do further actions with their own Resources, but other players can in their following turns, leading the player to trade their potentially wasteful Resources to those that need it more. Trading plays directly into the mechanics of Gathering, Crafting, and Operating. Players Gather specific Resources from the Tiles they begin and end on. Crafting allows the players to expand the circular economy around BGCS, letting them use Resources to place Tiles and Upgrades on the board. Crafting serves as a way for players to track their progress visually as they sustainably expand. Players can operate specific Upgrades with certain Resources, gaining new Resource cards in exchange for others.

At the beginning of each Round, players will encounter Events and Social Housing Upkeep. For Events, players must roll a die for an Event card, represented by good or bad Events. Event cards will either force players to cooperate to help negate negative Events or will benefit all players. As seen in the Social Housing Upkeep, Wasting and Recycling are key mechanics of the game that teach players directly about circular economies. Each round Social Housing Tiles produce Waste — the discarding of Resource cards into the Waste Pile — as houses in communities do in the real world. As the Waste Pile reaches its maximum, not only do bad Events occur more frequently, mirroring the reality of climate change, but players risk losing the game. However, players have the option to return these wasted resources back to the economy by operating the recycler. The further away from BGCS a recycler is, the more Resources it costs to build, and the more Waste it may return from the Waste Pile. The more you invest in a recycling system, the more you get back, showcasing the importance of the recycling infrastructure. The amount of Waste increases as players build more Social Housing Tiles, which is required to establish the full circular

economy, incentivizing players to be mindful of how they use their turns. By Wasting without thinking, games can be lost quickly.

The rules are contained within the Instruction Rulebook (see Appendix C), covering the mechanics of the game and providing helpful hints. Players are also able to utilize an Information Sheet with figures showcasing the Resource production and cost requirements (see Appendix D). The visual layout of the example final game board along with some of its main components is shown below in Figure 27.

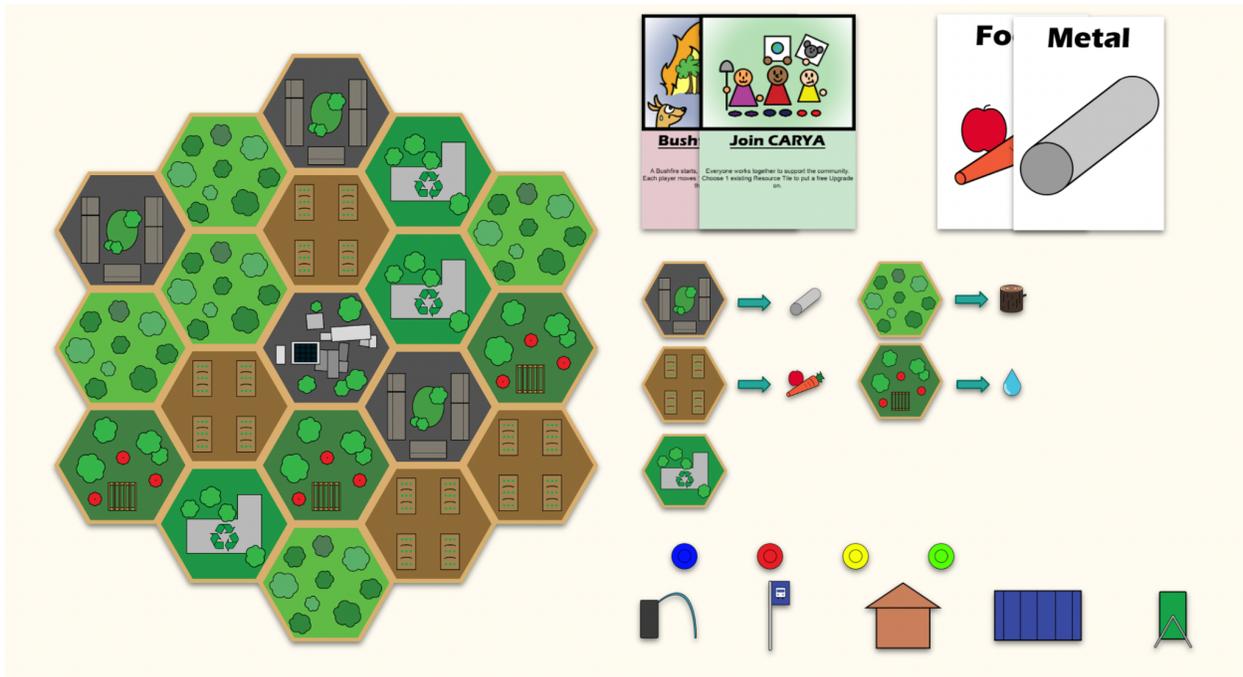


Figure 27: Picture of the final board game created along with its main components.

### 6.1.2 Connection to the Circular Economy

The circular economy concepts the game seeks to teach to unfamiliar players are closing a waste loop by recycling and being mindful of consumption in the community. Refer to Figure 28 for the following simplified explanation of the circular economy in the game. The Tile at the top of the loop represents Social Housing. Each Social Housing requires a Food and a Water to sustain at the beginning of each round, to simulate maintaining members in one's community. If Food or Water is used to maintain a Social Housing *before* a Composter is built (the green apparatus depicted in the middle of the diagram), then it is not used sustainably, since leftover organic matter is not composted, and the Food and Water are Wasted, as indicated by the rightmost section of the diagram, where the Food and Water are “X’d” out. If players have crafted a Composter, upon using the Food and Water to sustain the Social Housing, the Resources are composted, and are recycled back into the overall resource bank of the circular economy.

Additionally, Social Housings produce two Waste per Round, as indicated by the “X’d” out Wood and Metal in the rightmost portion of the diagram. This Waste represents the cost of maintaining a community – people produce waste and must learn it is important to recycle to protect the environment and their fellow community members. Moving clockwise from the waste portion of the diagram, the recycler can be seen. Waste can be returned from the Waste Pile at the cost of Crafting and Operating a

recycler. The recycler uses Resources sustainably when run, meaning they are returned to the Resource Bank), and the loop then repeats itself.

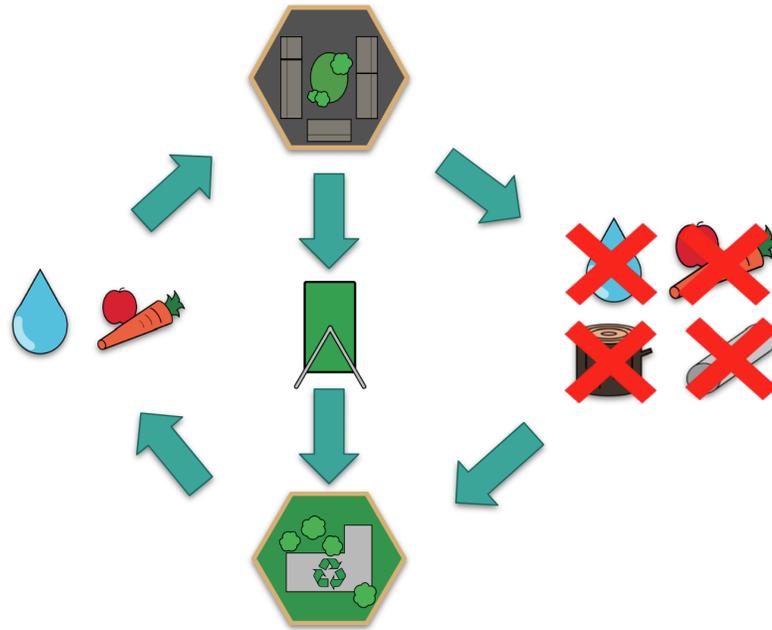


Figure 28: Diagram representing the flow of the circular economy in the game.

## 6.2 Recommendations

Determined by the work completed, the game can be further refined and expanded upon. Future teams from WPI or other institutions could continue the work left by the team, such as future IQP or MQP groups specializing in Computer Science or Interactive Media and Game Development majors. These teams can further refine the game and find new opportunities to expand the reach of the game through conventions and presentations focused on games. Recommendations created by the team included the creation of a physical board for the final game, further testing, stronger accessibility features, and digitization of the board game.

### 6.2.1 Printing Finalized Artwork and Pieces

The final physical components of the game were those created for Prototype One, allowing the team to test and refine the game. However, the artwork for the final game including its board tiles, Upgrade pieces, Event Cards, and Resource Cards were created and were ready for printing. The game greatly benefits through the addition of the new artwork, increasing the enjoyability and understandability of the game, making it a priority for future iterations. It was decided on to print the final art onto quality material, such as chipboard or cardboard, creating a durable and professional looking product. In addition, the creation of game pieces such as player tokens and the spinner through 3D-printing were considered during development, but could not be fully realized due to limitations on time and access to such technology. These pieces would need to be designed and printed, but would help keep all pieces created for the game original and professional.

### *6.2.2 Continued Testing and Accessibility*

Further testing and refinement is crucial for improving the mechanics and player experience. An increase in testing provides the team an opportunity to understand how specific groups and people react to the various components of the game and the improvements needed. The difficulties associated with the instruction rulebook players encountered could be further understood through these tests. Testing could also allow for teams to look at how players respond to new ideas and features, such as an emphasis on finishing the game as quickly as possible or new programs as they are developed by Banksia Gardens Community Services. This also provides opportunities in understanding issues of accessibility players may encounter within the game. An example comes from color choices causing issues for those with colorblindness, making a difficult experience for specific players. With this understanding, game art and features could be modified for an open and accessible experience. If the game continued to be refined and made professionally, future groups could attend events such as board game conventions or go to local game stores.

### *6.2.3 Digitization of the Board Game*

Digitization of the game was heavily considered, as it significantly increases the accessibility and learnability of the game. Through digitization of the board game, players can easily access the game through a computer and internet connection. A digital version would also simplify much of the mechanics present within the game that players have to handle themselves. Actions such as rolling the dice, spinning the spinner, and managing the Event, Resource, and Waste card piles, can all be calculated by the computer running the game rather than forcing players to do so. This helps lower the number of mechanics and factors players must keep track of, making for a faster and simpler experience.

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## Appendix A: Gaming Research Rubric

Game Name	Team Member	
Category	Rating (1-5)	Description
Fun		
Mechanics		
Difficulty		
Artwork/Aesthetics		
Cooperation		
Relevancy to BGCS		
Competition Style		
Playing Time		
Age Range		

Link to Rubric Results:

[M22-Game: Game Rubric](#)

## **Appendix B: Questions for Gaming-Related Interviews**

1. In your own words, could you describe the prototype you tested?
2. How did you approach the prototype? What did you want to first try?
3. How would you describe your feelings while testing the prototype?
4. What were the most frustrating aspects of the prototype's design?
5. What were the most enjoyable aspects of the prototype's design?
6. Did your decisions feel meaningful?
7. On a scale of 1-10, with 1 being the least and 10 being the most, how would you rate the understandability of the prototype? Were the objectives and mechanics easy or difficult to understand?
8. Could you describe any strategies you may have used?
9. Did you notice any potential dominant strategies?
10. What do you believe was the main topic or theme focused on in the prototype?
11. Were the topics of climate change and circular economy clear?
12. Did the mechanics of the prototype make sense in the context of these topics?
13. Do you feel you have a better understanding of those topics after playing the prototype?
14. What were elements of the prototype you would want to add, change, or remove?
15. Did you encounter any issues with accessibility?

## **Appendix C: ResourCED Instruction Rulebook**

Link to Rulebook:

[ResourCED Instruction Rulebook](#)

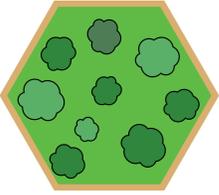
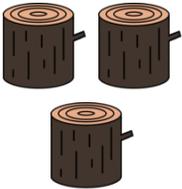
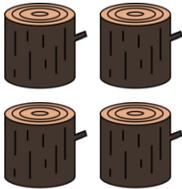
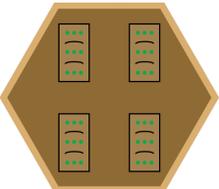
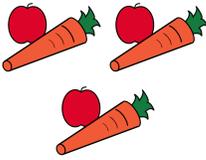
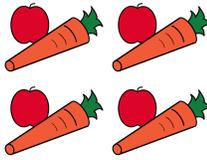
## Appendix D: Circular Economy Game Information Sheet

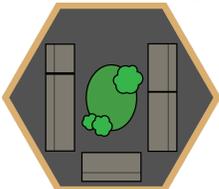
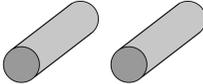
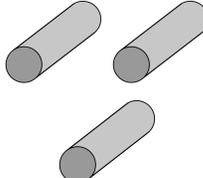
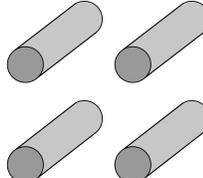
### Turn

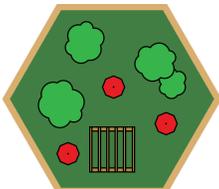
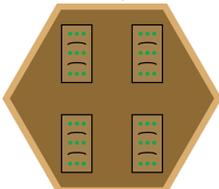
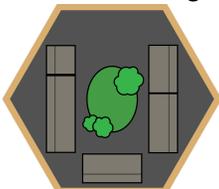
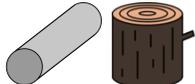
- You may Trade at any time during your turn with one other player according to the current Trade Limit.
- Your turn follows an *Action* → *Movement* → *Action* structure.
- Spin before taking Actions or Moving to plan out your turn.
  - You may move Tiles up to the number you spin, including 0.
- Actions include Gathering, Crafting, and Operating (see Instruction Rulebook for more information).

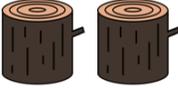
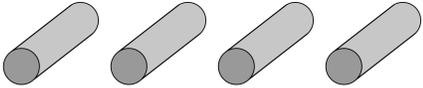
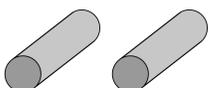
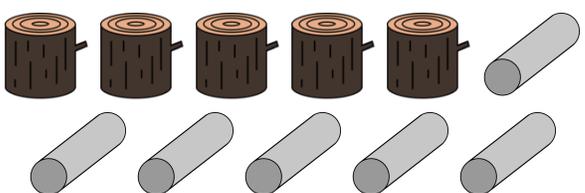
### Resource Production

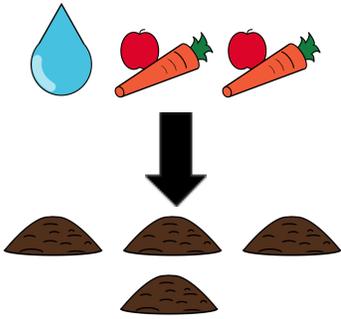
- Each tile produces a different type of Resource.
- The number of Resources produced from any Tile is increased by one if the Tile has an Upgrade on it.
- Note that Compost is not produced from a Resource Tile.

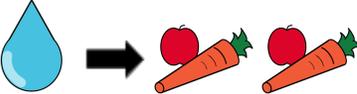
Tile	Resources Produced		
	Ring 1	Ring 2	Ring 3
Food Forest 			
Heat Haven 			
Community Garden 			

<p>Social Housing</p> 			
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Tile Crafting Costs	
Notes:	<i>Crafting can only be done on BGCS and requires you to Use Resources.</i>
Tile Name	Resources Required
<p>Food Forest</p> 	
<p>Heat Haven</p> 	
<p>Community Garden</p> 	
<p>Social Housing</p> 	

Upgrade Crafting Costs		
<b>Notes:</b>	<u>Upgrades can only be built on their corresponding Tile.</u>	
Name	Tile	Crafting Cost
Composter	Community Garden	
Shipping Container	Social Housing	
Shelter	Heat Haven	
Irrigation System	Food Forest	
Bus Stop	BGCS	

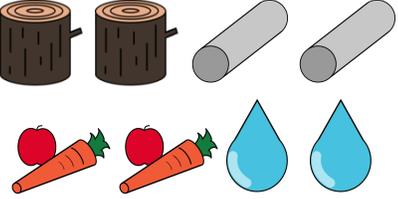
Upgrade Operations and Effects		
<b>Notes:</b>	<i>Upgrades can be Operated (requires players to Use Resources), and can also give latent Effects to all players.</i>	
Name	Operation	Effect(s)
Composter		Food or Water is Used instead of Wasted. Produces an additional Food when landed on.
Shipping Container	N/A	Each player's hand size (default: 7) is increased by 2 per shipping container

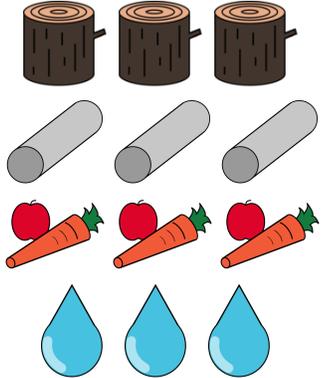
		(can be stacked). Produces an additional Metal when landed on.
Shelter	N/A	Each player can trade 2 more total Resource Cards per Shelter (can be stacked). Produces an additional Water when landed on.
Irrigation System		Produces an additional Wood when landed on.
Bus Stop	Travel to the Shopping Center. Get any amount of Resource Cards of any type from the Resource Bank, then Waste that many Resource Cards from the Resource Bank.	Movement of all players is increased by +1 on any spin. Produces an additional Resource of any type when landed on.

### The Recycler



- The Recycler is a special Tile that can be Operated similar to an Upgrade.
  - The bottom 5, 7, or 9 Waste Cards are returned to the Resource Bank when it is run.
- Its Crafting Cost is dependent on the Ring, but the Operation Cost is always the same.

Ring Location	Crafting Cost	Operating Cost	Waste Removal
1	N/A		5 Waste Cards
2			7 Waste Cards

3			9 Waste Cards
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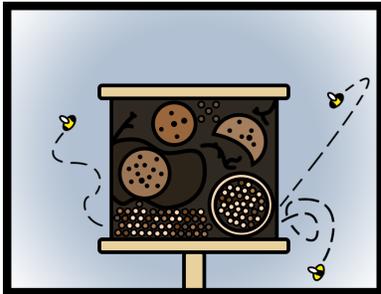
**Progression**

- Players need a certain Total Number of Social Housings before moving to the next Ring. Players also must decrease the Waste Pile to 0 after Crafting the required amount of Social Housings.

Ring Progression	Total Number of <b>Social Housings</b>	Waste Pile
2 → 3	3	N/A
3 → Win	6	0

# Appendix E: Final Artwork

## Events



### **Bee Hotels**

Banksia Gardens Community Services builds a new Bee Hotel to house more bees. Each player draws a card from the Food pile.



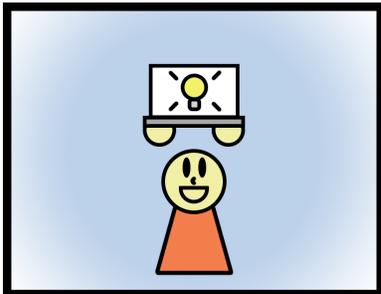
### **Join CARYA**

Everyone works together to support the community. Choose 1 existing Resource Tile to put a free Upgrade on.



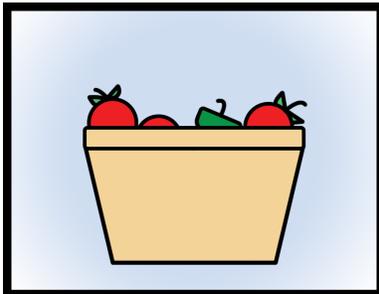
### **Community Planting Day**

Banksia Gardens Community Services plants new trees. Each player draws a card from the Compost pile.



### **Computer Access Program**

Everyone gets access to a new computer. Each player draws a card from the Metal pile.



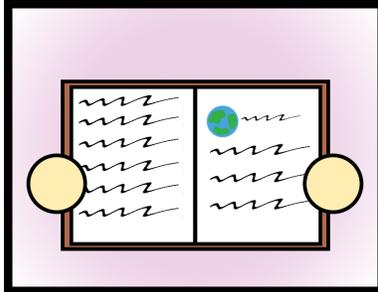
### **Harvest**

The community garden is harvested. Each player draws a card from the Food pile.



### **Rain**

Rain nourishes the land. Each player draws a card from the Water pile.



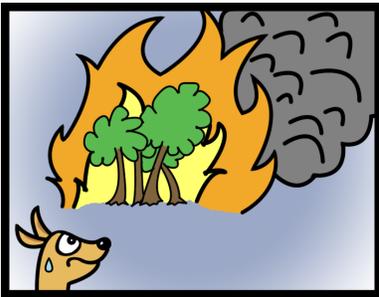
### **Study Group**

The study group brainstorms new climate relief initiatives. Each player randomly draws a card in turn order from the Waste pile hands down and adds it to their hand.



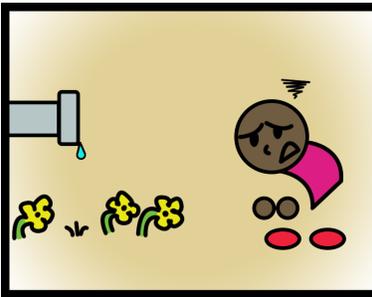
### **Trash Pickup Day**

Everyone picks up as much trash as they can find. Roll a die and Recycle that many cards.



### **Bushfire Smoke**

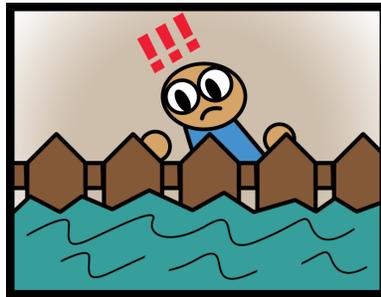
A Bushfire starts, spreading smoke across BGCS. Each player moves 1 step less on their next turn unless they are in BGCS.



### **Drought**

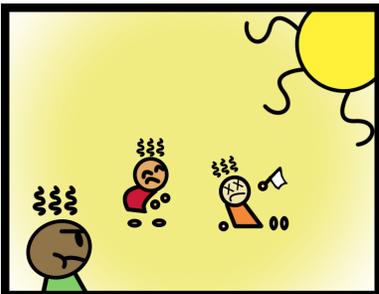
All Irrigation Systems on the board dry up, each costing 1 Water to fix. If an Irrigation System is not fixed, it is removed from the board. If there are no Irrigation Systems, nothing happens.

If a player is not on a Food Forest or BGCS, they Use 1 Water, skipping their turn if they cannot.



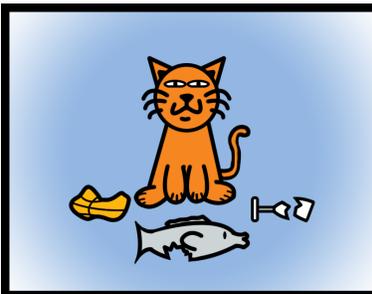
### **Flood**

Each Community Garden is under threat of flood. Use 2 Wood to build a fence for each Community Garden, or lose the corresponding Composter and Use 1 Food to replant.



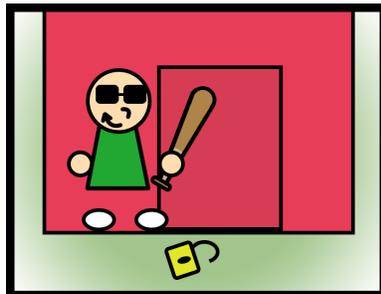
### **Heat Wave**

A heat wave hits. If a player is on a Heat Haven or at BGCS, they Use no Resources; if not, they Use one Food or one Water, skipping their turn if they cannot.



### **Property Damage**

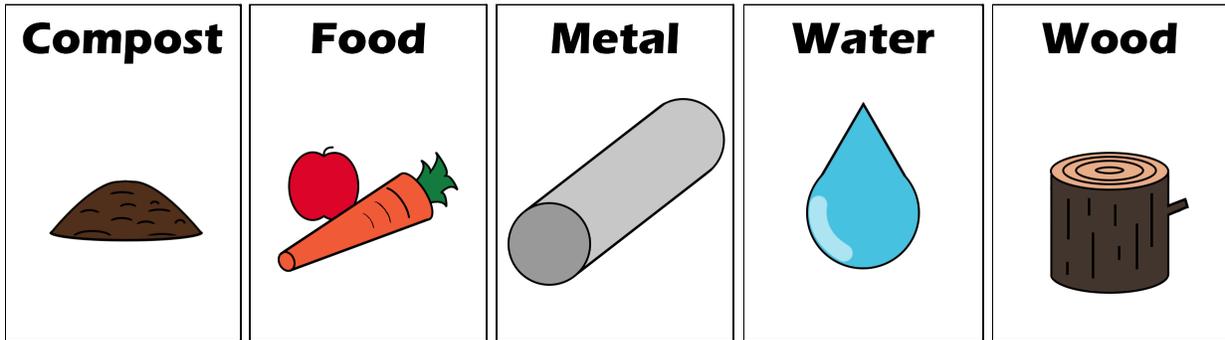
A neighborhood cat strolled into your house and caused havoc. Choose a player to Waste a card of their choice.



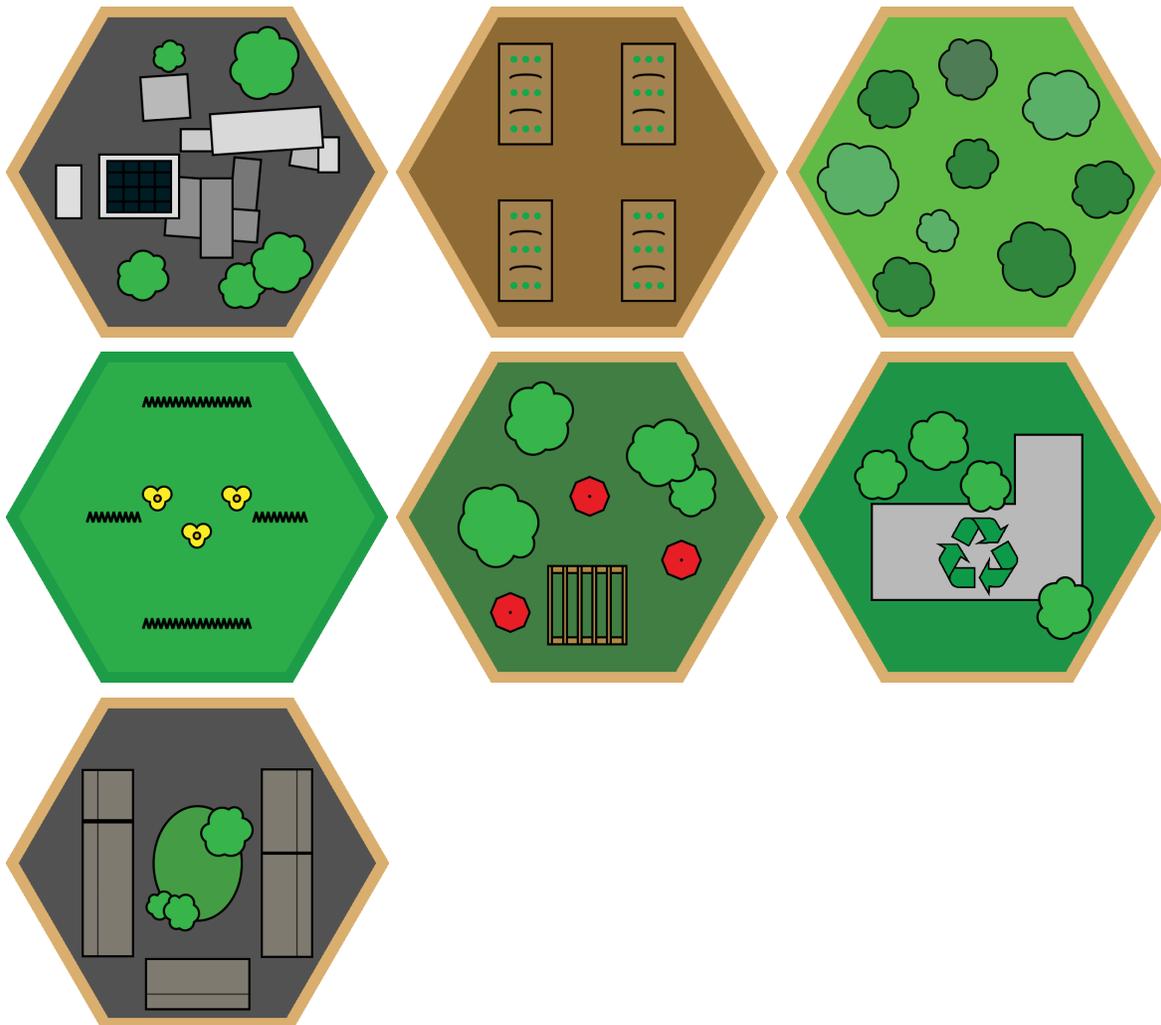
### **Vandalism**

Vandals break one Shipping Container on the board, costing 3 Metal to fix. If not fixed, choose a Shipping Container to remove from the board. If there is no Shipping Container on the board, nothing happens.

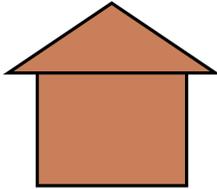
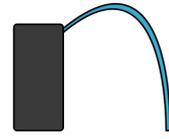
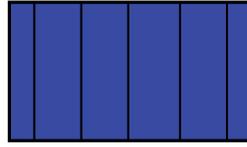
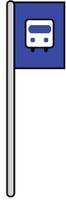
*Resources*



*Tiles*



*Upgrades*



*Boards*

