Reclaimed Memory

A PC Game

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Project Overview

Reclaimed memory is a game for PC developed in Unreal Engine 5 for a general audience that illustrates a plausible future where the effects of climate change have triggered the upheaval of society as we know it. In addition to cautioning the player about the consequences of inaction, it explores the practical realities of adapting to survive in changing climates.

The idea behind designing in a 3D interactive medium was to go beyond 'painting' a picture of post-apocalypse to thrust the audience within a plausible reality and the consequences it may entail. Rather than simply stoking fear of negative outcomes, the goal was to **(1)** educate the player about feasible outcomes of climate change, **(2)** spur them to seriously consider climate change as a credible threat to humanity, and thus **(3)** encourage solution-driven thinking and action.

In pursuit of these goals, the game's setting and narrative were informed by a rigorous review of current scientific literature concerning our understanding of climate change and how it could feasibly impact us. This research was compiled into a centuries-long historical timeline and textual descriptions of potential game locations. These artifacts were then translated, through environment sketching and storyboarding, into potential environments and interaction sequences that could compose the final product. With this baseline in place, the bulk of the semester was spent blocking, developing, evaluating, and revising the level layout, interaction mechanics, environments, and objects inside Unreal Engine to proactively design the final user experience to align with the project goals and adapt to feedback and new insights.

The result is a brief hunt for 'artifacts' of modern human civilization that tell the story of what happened both in the immediate environment and the world. Spanning both outdoor and indoor areas, the player's journey takes place in a real geographical area whose identity is revealed over the course of gameplay.

While sources like blogs generally utilize simple language accessible to readers of various education levels, peer-reviewed and government publications often contain lengthy discussions with plenty of technical vocabulary. Readers with experience studying science and reading at a college level will best be able to understand and benefit from these discussions.

Concept Development

In first developing ideas for this project, the general topic of climate change quickly emerged as a compelling problem space to explore. First and foremost, each of us is an inevitable stakeholder in the immediate future of our natural environment. Not only is a desirable climatic future (however we choose to define it) in every person's best interest, but it may be influenced by human action both on an individual and societal scale. Furthermore, the wealth of science and wide variety of conflicting sentiments surrounding the subject makes climate-related media an interesting educational and rhetorical opportunity. By disseminating our best understandings of climate science and compellingly arguing for certain courses of action—in a way, designing future human action—I believe that scientists, artists, designers, and audiences can all play a role in solving for an optimal future.

From this conceptual starting point, I considered what I wanted to say about climate change, who my audience would be, and how I wanted my work to impact them. When I imagine post-apocalyptic media in general, I imagine riveting adventures through troubling dystopian worlds that evoke a solemn appreciation for the world as we know it. However, in discussing my early ideas with Professor Collins, I quickly realized that a grim portrayal of the future alone would not inherently constitute a nuanced solution to my intended problem space.

To help illustrate this point, Professor Collins directed me to the work of Dr. Michael Mann, a scientist and professor who has played a key role in the development of our current understanding of climate science throughout the early 21st century. Dr. Mann was the lead author of the 1999 paper in Geophysical Research Letters that introduced the "Hockey Stick" graph of CO_2 concentrations and sparked societal conversations of climate change as a genuine threat to humanity (Mann et al.). In addition to educating the public about the gravity of climate change, however, Mann warns against engaging in 'climate doom,' or extreme pessimism regarding the trajectory of the global climate and the efforts that have been and can be done to correct it. Speaking with California Magazine in 2020 in relation to what he refers to as the “narrative of doom,” Mann says: “Not enough has been done to combat climate change for sure. But to say that nothing has been done is simply false.” (Schatz) For Mann, the projected outcomes of climate change are incredibly real and dire, but also important is acknowledging that efforts have been made and focusing on the belief that a favorable outcome is still possible with further action.

Returning to Reclaimed Memory, the point here is that my design objective is not to maximize fear of a future after climate change, but rather to motivate action to improve that future based on the best available understandings of climate scientists. According to the perspective of Dr. Mann, this must involve both acknowledging the severity of climate change as a threat to humanity and maintaining a focus on positive steps that humans have taken and can continue to take in the face of this adversity. This is how I arrived at my three-pronged goal of:

(1) educating the audience of real potential outcomes,

(2) presenting a compelling depiction of climate change as a threat worth addressing

(3) encouraging the audience to act in pursuit of an optimal outcome.

Research

Reviewing the literature

To develop a factual foundation on which to build the narration of feasible outcomes, I consulted the current scientific literature concerning possible climate change scenarios and the cascading effects they may have on humanity and nature. The goal was to develop a thorough background history in which to situate the game—one that illustrates the gravity of undesirable climate change outcomes while remaining in the realm of reasonable probability and allowing for the exploration of humanity as a capable agent in the process. My initial research questions included:

- How far in the future will this history have taken place?
- How will climates have changed by that point?

With these questions in mind, I searched for scholarly, government, and peer-reviewed publications describing possible climate change scenarios and cascading effects on ecosystems and human society. As I uncovered reasonable predictions about the trajectory of climate change in the near and distant future, I further focused my reading by reflecting on my personal visions for the game.

- What sorts of climate-driven impacts would seem suitably moving to the player?
- How far in the future is far enough to have allowed for these impacts to have come to fruition?
- How near in the future is near enough for the player to find the image of humanity in the game relatable?

Echoing the sentiments of Dr. Mann, the process of gathering suitable data and projections from the literature was an act of balancing between maximizing emotional impact and avoiding exaggerations or irrational conclusions. Useful insights included estimated temperature shifts, sea levels, biome migrations, and even cascading socioeconomic impacts over the next handful of centuries.

Visualizing scenarios

While this data clearly indicated the possibility of drastic global upheavals due to climate change, I also wanted to be able to picture these changes. What would these theoretical futures look like? What changes could I most easily illustrate for the audience? The rising of sea levels immediately struck me as not only highly visualizable and precisely quantifiable, but also deeply concerning. Fortunately, various tools exist online to translate sea level data into images.

FloodMap.Net was particularly useful in quickly visualizing how these changes might look on a map. Tools like FloodMap use elevation data to map hypothetical coastlines based on specified sea level shifts.

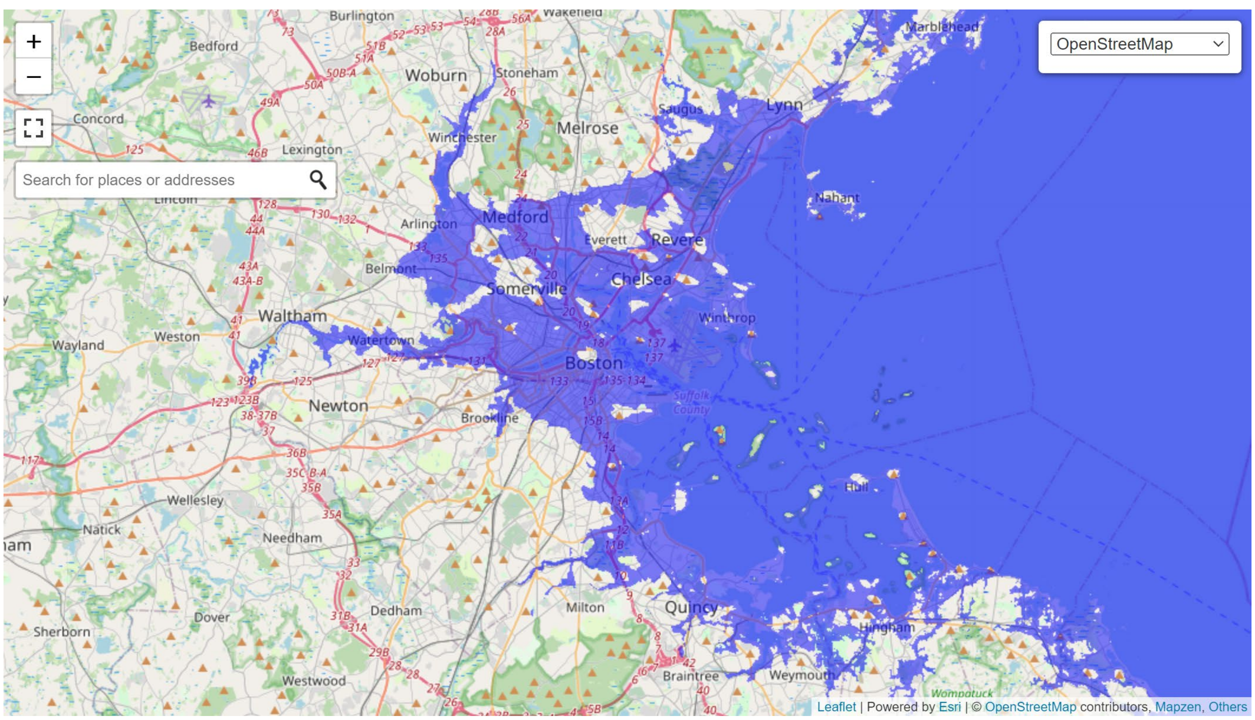


Figure 1 *A map of the greater Boston area, near where I live, generated by FloodMap.net given a water level rise of 10 meters.*

To be sure, this visualization method carried several caveats. Not only was I trying to estimate theoretical coastlines given new sea levels, but I was also trying to estimate theoretical sea levels given data on possible temperature shifts, the melting of polar ice, and many more variables. As a result, the above map cannot be relied on as a cut-and-dry map of Boston's coastline after a given number of years of project climate change. Rather, it can be seen as a general suggestion of where flood risks might be greatest, how far inland the effects could be noticed, and how seriously rising seas threaten the livability of different regions.

The *Sea Level Rise Viewer* by the National Oceanic and Atmospheric Administration (NOAA) not only calculates potential coastline maps, but also allows the user to choose from pre-entered data projected from recent NOAA research.

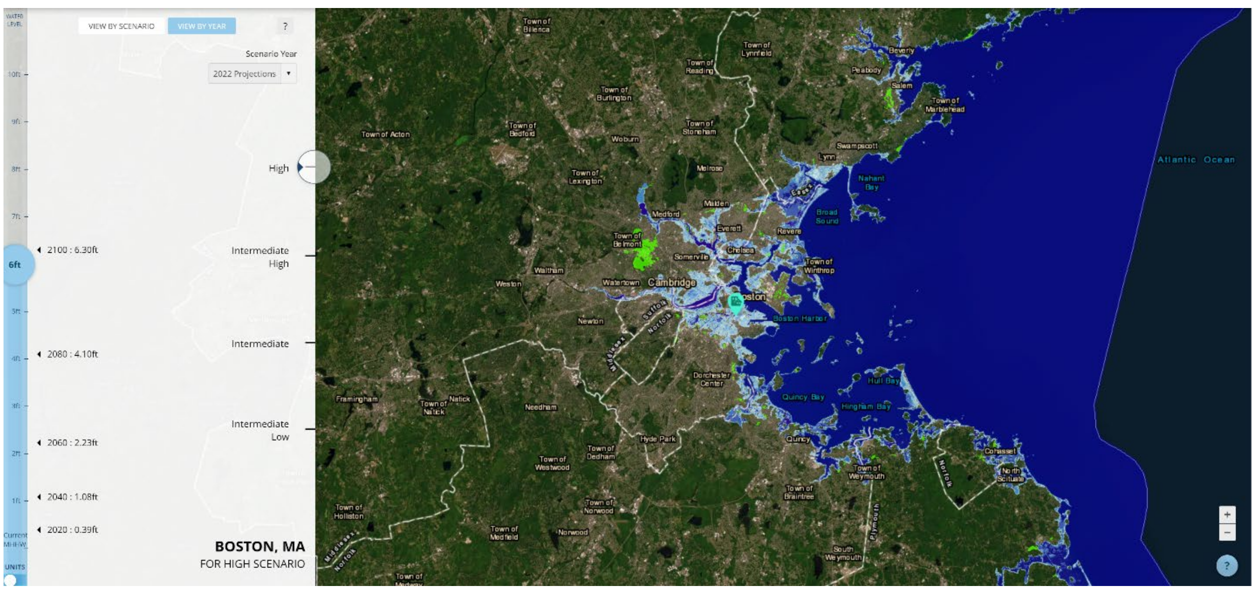


Figure 2 *A map of the greater Boston area in the NOAA Sea Level Rise Viewer displaying high estimates for 2100 sea levels based on projections made by NOAA in 2022.*

While the guaranteed rigor of input data in *Sea Level Rise Viewer* provides assurance, I felt that the available range of projections leading up to the year 2100 might not allow for a sufficiently stark post-climate change visual that would be recognizable to a broad audience. For example, the image of the waters of Boston Harbor knocking on the doors of City Hall might seem acutely troubling to a native Bostonian, but for a player unfamiliar with the city, a Boston 2 meters lower above sea level might not seem inherently post-apocalyptic in gravity.

Based on data on changes like further temperature changes (Lyon et al.), potential climate tipping points (Lenton et al.), and sea level rise estimates concerning as far in the future as 2300 (Van de Wal et al.), I decided to look beyond the year 2100 for a possible in-game present day. Taking the validity of these visualizations with a grain of salt, I plugged data from over longer timeframes—as much as 500 years into the future—into *FloodMap* to inform more far-reaching projections that could describe a world beyond 2100.

Constructing a timeline

Rather than compiling notes before writing my timeline, I consulted the literature and cited specific facts as I wrote the timeline itself. For example, when describing the temperature patterns of the 2090s, I name a specific temperature rise of 4 degrees Celsius and cite a publication that proposed this figure. When describing the continued global warming throughout the second half of the 22nd century due to feedback loops, I cite a Nature article by Lenton et al. discussing a specific cycle of irreversible changes that could be triggered by the melting of Arctic Sea ice. Importantly, these figures serve not as definitive predictions of Earth's climatic trajectory, but rather as plausible scenarios that scientists feel should be considered in climate-related decision-making.

The compiled timeline, including in-text citations referring to literature listed in this document's bibliography, is included below:

- **2030s**: The Arctic is practically ice-free during the summer ("Predicting the Future of Arctic Ice"). Sea-level rise becomes a significant problem, causing coastal cities like New York, Miami, and Mumbai to invest heavily in costly infrastructure to protect against flooding. Political disagreements deepen over climate policy and expenditures.
- **2040s**: Extreme weather events become the new normal, causing mass migrations and straining global food supplies ("Climate Change Indicators"). Population displacement and scarcity of resources like potable water as global population peaks (Liu et al.) lead to regional conflicts. Concerns about the vulnerable global economy inflame political disagreement over appropriate next steps, derailing initiatives for combatting climate change.

- **2050s and 60s**: Agriculture yields are significantly impacted (Lyon et al.), leading to food shortages, soaring prices, and food rationing imposed by nations around the world. Many nations start abandoning green energy projects, and projected 'business as usual' (worst case) climate change scenarios start becoming realized.
- **2070s and 80s**: Uninhabitable regions emerge across parts of the world like south Asia and equatorial South America as wet-bulb temperatures begin regularly exceeding 35 degrees Celsius (Buis). Mass migration reaches unprecedented levels, leading to border conflicts and refugee crises. As climate-induced tensions increase, global cooperation declines, and nations prioritize their own survival. Fossil fuels re-emerge as the main global energy source due to growing desperation for cheap energy, accelerating climate change and escalating international conflicts over ownership of oil reserves.
- **2090s**: Since 2020, average temperatures across the world have risen by as much 4 degrees Celsius in many parts of the world (Lyon et al.). Sea levels have risen by about 1.3 meters (Van de Wal et al.). Vast areas across the tropics are uninhabitable due to regularly fatal wet-bulb temperatures; much of the subtropics is also uninhabitable due to high temperatures and insufficient food and water supplies. Borders begin closing as climate refugees overwhelm existing infrastructure and resources in host countries. Global economic systems falter as supply chains break down due to diplomatic tensions.
- **2100s**: The world economy collapses as extreme weather events like droughts and storms derail already-struggling supply chains. The breakdown of food supply and healthcare systems cause famine and disease outbreaks. Major Antarctic ice shelves begin collapsing, setting in motion an accelerated, catastrophic rise of sea levels; over the following 2 centuries, the sea will rise as much as 8 additional meters (Van de Wal et al.). Nations begin declaring full-scale war as social unrest boils over.
- **2110s**: War becomes global and begins targeting industrial, agricultural, and population centers like New York. National governments and economies begin collapsing, leaving behind regional factions concentrated in areas with habitable temperatures and locally available resources.
- **2120s – 2140s**: Wars between remaining societies continue thinning the human population before eventually subsiding. Decades of conflict have destroyed infrastructure and caused technological development to stagnate and revert, leaving remaining societies ill-prepared to rebuild into large and complex civilizations as they struggle to establish large-scale agriculture in the new climatic conditions. Famine and disease continue to thin populations.
- **2150s – 2200**: Small pockets of human civilization continue to survive, but although human industrial activity has virtually ceased, global temperatures continue to rise due to feedback loops set off throughout the past century (Lenton et al.).
- **Post-2200**: Due to the rippling effects of past human industrial activity, the remaining human population shrinks over the course of centuries down to pre-Agricultural Revolution

levels. Humans leave behind very little evidence of their existence after 2200. It is unclear what ultimately happened to humanity.

- **In-Game Present (unknown year):** The area of the former New York City is devoid of human life and has been reclaimed by nature. Buildings, roads, street signs that haven't totally disintegrated or eroded away are falling apart, faded, and overgrown with plants resembling those of the subtropics. The average summertime temperature is now 36 degrees Celsius (97 Fahrenheit), or about 10 degrees Celsius higher than in the present day (Lyon et al.). Sea levels have risen by about 10 meters (Van de Wal et al.). Most of lower Manhattan is entirely underwater.

Considering cultural significance

In addition to gathering and visualizing quantitative data, my research consisted of considering potential game locations that would best serve my project goals. Which settings would be most recognizable to the greatest number of players? Of these, which could be used to depict specific consequences of climate change most clearly? Could any of these serve as symbols of themes like industrialism or economic surplus that describe the current state of human activity?

While I would have ideally conducted empirical research in consultation with a wide breadth of sources and subjects to address these issues, I needed to proceed swiftly into production. Through review of the data on sea level rises and discussion with friends about places of cultural significance, I identified New York City as a potentially recognizable and evocative setting for the game.

Narrowing down the location

I spent several days considering potential locations in the New York metro area that would a) clearly exhibit the effects of risen sea levels and shifted biomes, b) be recognizable to players, and c) be relatively simple to translate into a 3D environment inside Unreal Engine. After considering locations like the Brooklyn Heights Promenade and St. George Ferry Terminal as potential locations, I finally settled on setting the game (mostly) within an apartment building in south central Jersey City. Not only would a Jersey City vantage point provide a clear view of the Manhattan skyline and the surface of the Hudson River, but the setting of a residential space seemed conducive to environmental storytelling through objects that people would once have interacted with. Additionally, I felt that having the player emerge at the end of the game on an apartment rooftop could serve as an opportunity to suddenly reveal the whole truth about the game's location and provide a dramatic, unifying vista to close out the playthrough.

I synthesized the data gathered in my literature review, the visualizations of *FloodMap*, and the imagery and elevation data available in *Google Earth* to generate a final, annotated diagram of where the game would take place in relation to the greater New York metro area. Details like the approximate shoreline and visible landmarks were noted to inform the final view the player would have of the wider area.

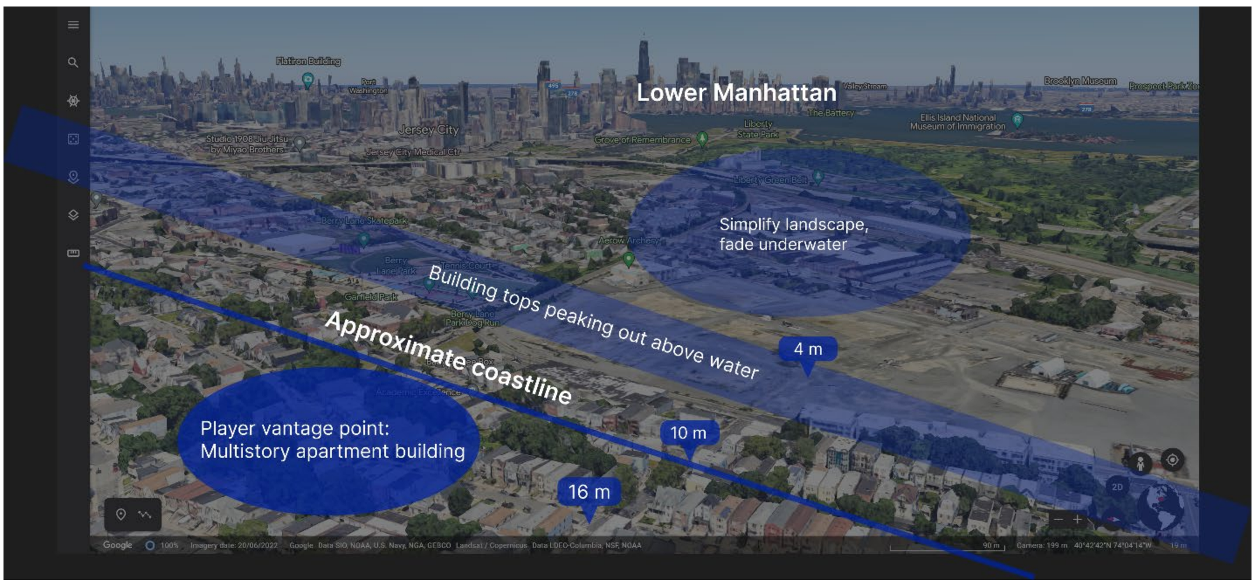


Figure 3 *An annotated view of the NYC skyline from southern Jersey City (taken from within Google Earth). Sea level information was using Floodmap.net and Google Earth's elevation data.*

Production

Once the game's setting was defined and the background timeline written, production of *Reclaimed Memory* consisted of the following general pipeline:

- Storyboarding (on paper)
- Developing the game's functional foundation (*Unreal)*
- Modeling and texturing architecture (*Blender, Unreal,* and *Photoshop)*
- Modeling and texturing the flooded waters (*Blender* and *Unreal)*
- Scripting game interaction mechanics (*Unreal)*
- Modeling furniture and artifacts (*Blender* and *Unreal)*
- Defining logic governing gameplay and progression (*Unreal)*
- Implementing sounds (*Unreal* and *Adobe Audition)*
- Building 2D user interfaces (*Unreal)*
- Gameplay debugging and optimization (*Unreal)*.

Storyboarding

To translate my research into a fully fleshed-out experience in *Unreal Engine 5*, I sketched the game's environment **(appendix A)** and storyboard the areas, interactable objects, player (and camera) movements, sounds, etc. **(appendix B)**. These low-fidelity prototypes served as useful artifacts for preemptive evaluation and reflection prior to building any actual 3D models or gameplay elements. After consulting with my advisor, Gabriel Ibias, on the viability of the 3D space and interactions I had storyboarded, I began to block out the level in *Unreal* using basic geometry and architectural assets included with the engine.

Developing baseline functionality

Before diving into artifact modeling, I decided to focus on establishing a functional baseline for the game in *Unreal*. This included defining "blueprints" (akin to "classes" in the *Unreal* visual scripting system) that would serve as the building blocks of the game's logic. For example, two of the first blueprints included "FirstPersonCharacter"—housing all logic related to the player's movements and interactions—and "GameMode," which served as a container for all the content and interactivity of the game's level. In anticipation of building the artifact inspection logic, I defined additional blueprints like 'Artifact' that would wrap the static 3D meshes in interactive functionality.

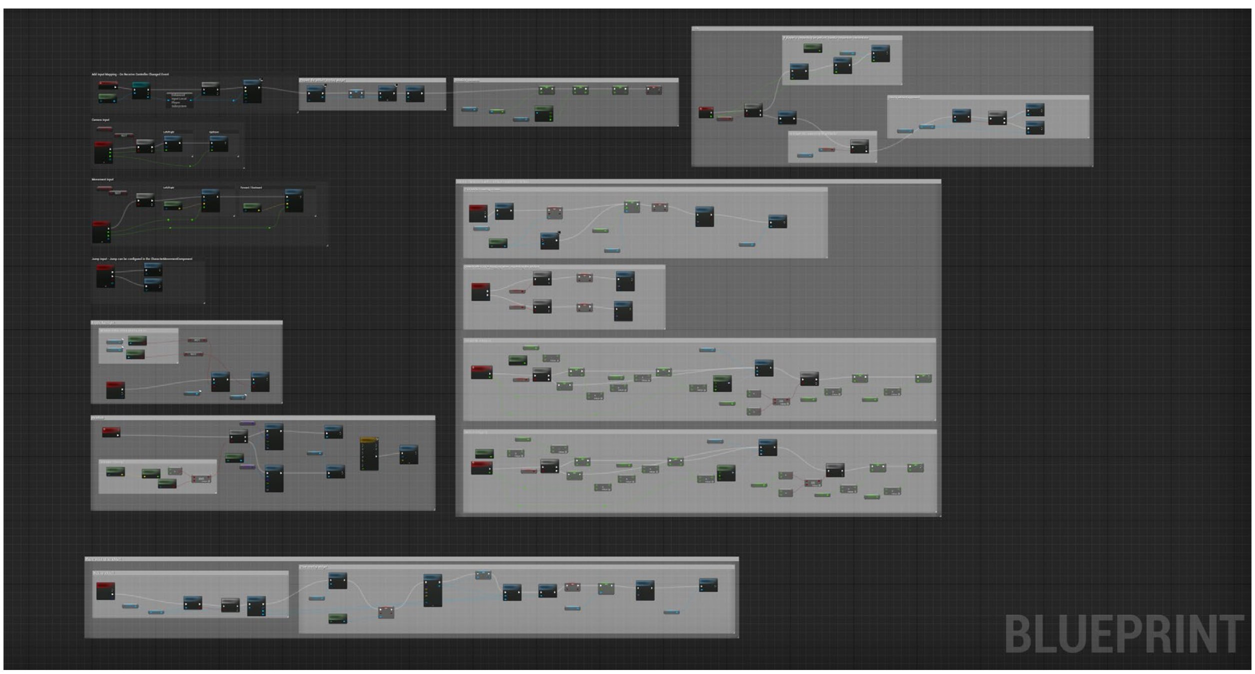


Figure 4 *A high-level view of a portion of the visual scripting for the FirstPersonCharacter blueprint.*

Establishing a functional baseline also required adding lighting elements and adjusting rendering settings to maximize playability and suit the game's atmosphere. These settings were adjusted throughout the semester as areas for improvement became apparent over the course of expanding the game and play testing. Elements like the player’s flashlight and automatic exposure adjustments became crucial for preserving playability in indoor environments.

Figure 5 *An in-game screenshot showcasing the player's flashlight and the relative darkness of the apartment interior compared to the outdoors.*

Modeling and texturing the cityscape

I was able to essentially import the actual architecture of the New York metro area as basic meshes (e.g. rectangular prisms) a *Blender* add-on called *Blosm*; essentially, it allows one to ‘download’ areas from *OpenStreetMap*, a free geographic database, as 3D meshes representing buildings, roadways, and surface topology.

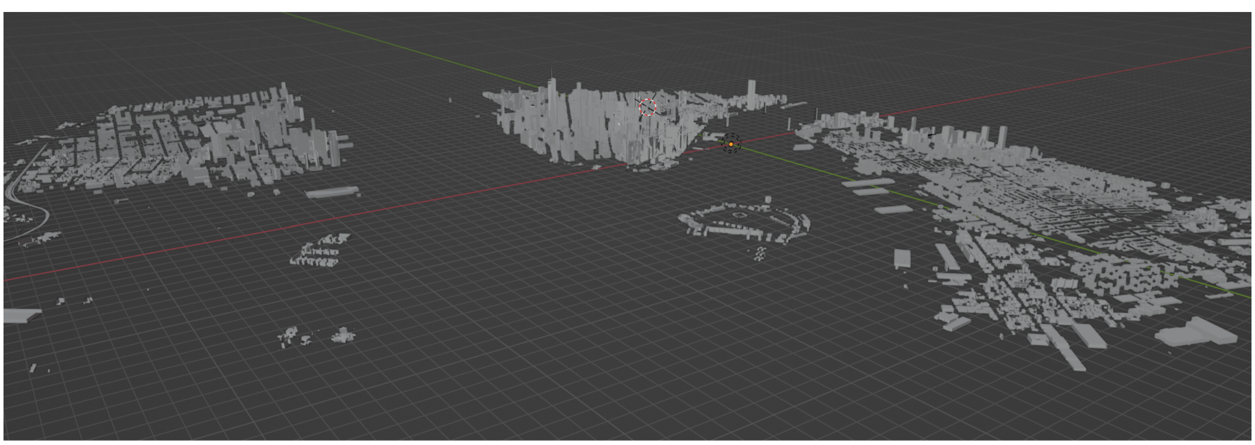


Figure 6 *The Blender workspace with the 3D models of buildings imported from OpenStreetView using Blosm. Moving left from right, one can see Jersey City, Lower Manhattan, and Brooklyn.*

After initially importing Lower Manhattan, Brooklyn, and Jersey City as separate chunks into a unified 3D space in Blender, trimmed the expanse of the cityscape based on what the player would end up seeing within the game. Because much of the initially generated urban landscape ended up being blocked from the player's view in-game, geometry was deleted from the cityscape meshes (initially in *Blender*, but later in *Unreal* itself) to eliminate unnecessary processing and storage strain on the user's device. The in-engine modeling tools also allowed me to easily depict structural damage by removing chunks from and tilting buildings. Buildings that were to be modified simply had to be isolated from the rest of the cityscape and re-meshed using automated tools within *Unreal* before. These refined meshes could easily be rotated on an individual basis and stripped of triangular faces by hand to create holes.

Two apartment structures adjacent to the building housing the game level had to be modeled manually in *Unreal.* This was accomplished by generating original texture maps (for base color, roughness, and metallics) from royalty-free images of apartment buildings using perspective cropping, AI-powered autofill, and manual layer painting and adjustment in *Photoshop*.

Figure 7 *An example of perspective cropping inside Photoshop. Original "City, Building, Heaven Skyscraper" image by 12138562 accessed from Pixabay.com unde the Pixabay Content License.*

Figure 8 An example of turning a perspective-corrected color map into a roughness map manually in Photoshop. Original image, "brown concrete building during daytime," by Edgar is used under the Unsplash License.

These textures were projected onto rectangular prisms into which I carved edge loop and extruded faces to create recessed balconies and protruding AC units and windows. To simulate chaotic damage, I used the "fracturing" toolset within *Unreal* to procedurally split the sculpted apartments into chunks that could be selectively deleted to create jagged holes.

Figure 9 A close-up view of the textures and 3D details on the adjacent apartment buildings with details like recessed windows and balconies and building fracturing visible.

For both these adjacent buildings and the distant skyline, plant decals provided a simple way to impose the appearance of overgrowth on otherwise plain building textures.

Modeling and texturing the flooded waters

To enable realistic depiction of the flooding of the Hudson River, I used a "Shrinkwrap" modifier in Blender to conform the bottom portion of the cityscape meshes to fit a 3D mesh representing an elevation map of the same geographical area (also imported using *Blosm)*. This would allow me to define the water level as a flat plane that dynamically intersects with the cityscape geometry to produce a unique coastline. With the varied elevation in place, I implemented the Hudson River as a flat "landscape" in *Unreal* to which I applied an animated, physically based water material. This material was created within *Unreal*, essentially using a single royalty-free normal map and a translucent shading system with variable opacity, refraction, etc., to mimic the optical properties of actual water.

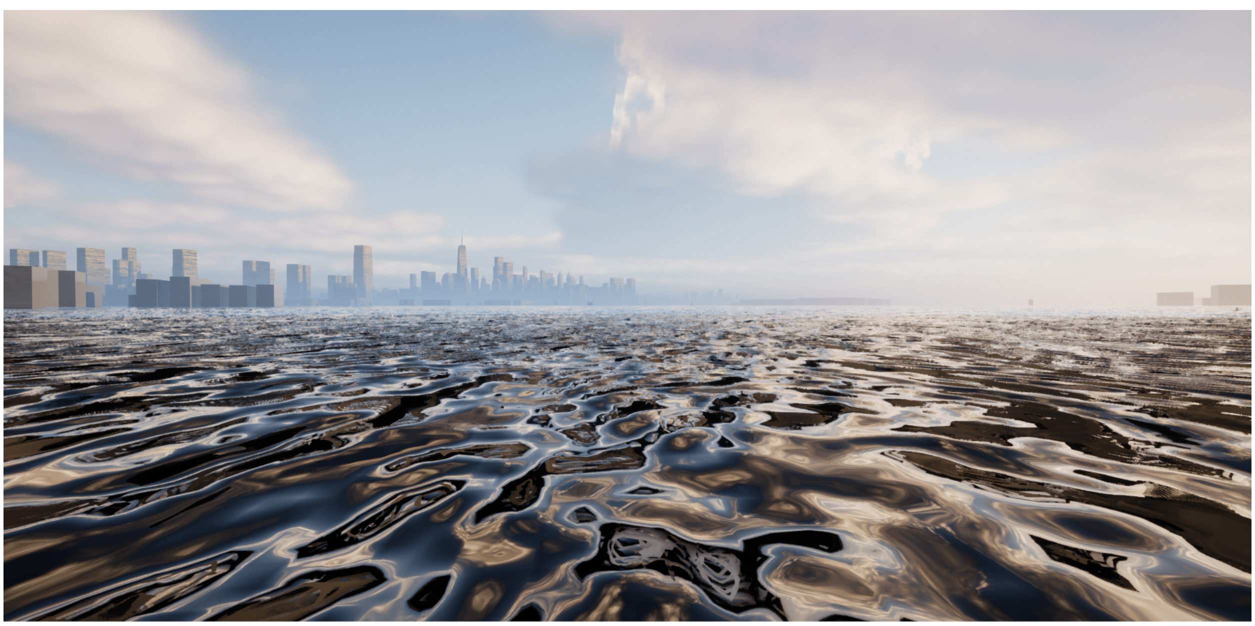


Figure 10 *A close-up, surface-level view of the water of the Hudson River.*

Building game interaction mechanics

With core logical blueprints in place, the game's interaction mechanics were scripted using a combination of variables, functions, and triggered events firing across blueprint classes to detect and respond to the player's input.

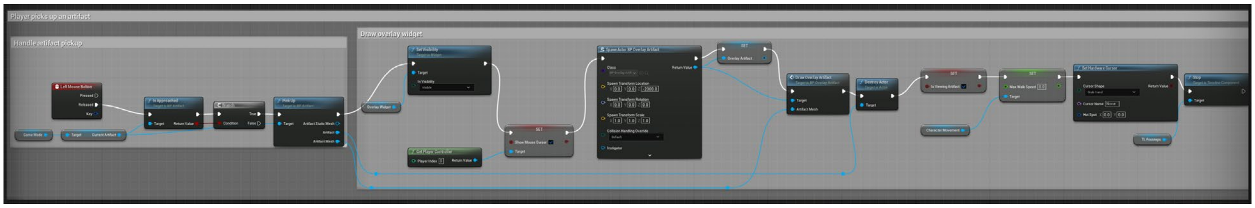


Figure 11 A zoomed-in view of the scripting executed when a player left clicks on an artifact to pick it up.

For example, to display mouse prompts when an artifact becomes clickable, the game needs to detect when the player is near an interactable object. This was implemented as a continuous scan conducted by the "FirstPersonCharacter" blueprint that would recognize nearly "Artifact" instances and store their information for the overlayed inspection view. Late in the semester, I refined the artifact approach mechanic to rely on tracing the player's gaze; essentially, the player would need to 'look' directly at an artifact to conjure the prompt for inspecting it.

Figure 12 An in-game screenshot of the player approaching the solar panel/fan artifact, with the left mouse button prompt visible.

When inspecting artifacts and viewing the distant cityscape from the rooftop at the end of the level, the player is shown overlayed interfaces displaying additional information about the object(s) in focus. Additional logic was required to extract visual and textual representations of objects to be shown in these interfaces whenever the player entered one of these viewing modes.

Modeling furniture and artifacts

Although I had initially planned on strictly using *Blender* for modeling detailed 3D meshes, I ended up also using the built-in suite of modeling tools in *Unreal* to create furniture and artifacts.

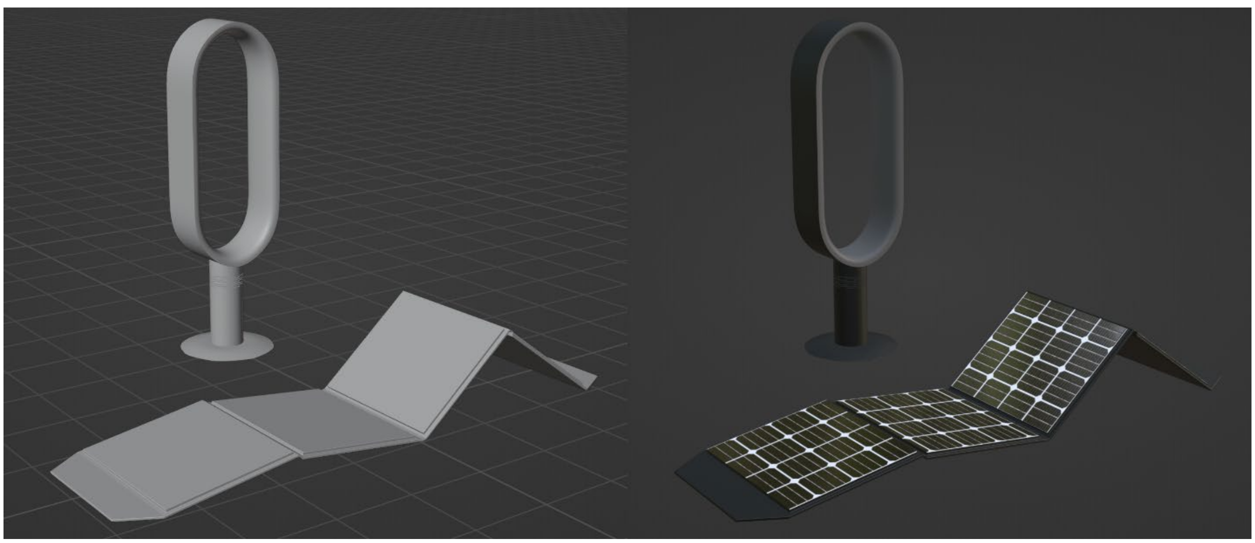


Figure 13 *Viewport render of original models of a bladeless fan and portable solar panel kit in Blender without textures (left) and with basic texturing (right). The solar cell texture by zedvenom is licensed under the CGTrader Royalty-Free License*

Early in the semester, this typically involved building geometry from scratch using reference and inspiration images, but I later transitioned toward incorporating prefabricated meshes to expand my capacity to add additional objects to the game. Obeying the original creators' copyrights, I brought prefabricated meshes into Blender and Unreal to add my own deformation (e.g. opening and warping food cans or opening a cabinet door).

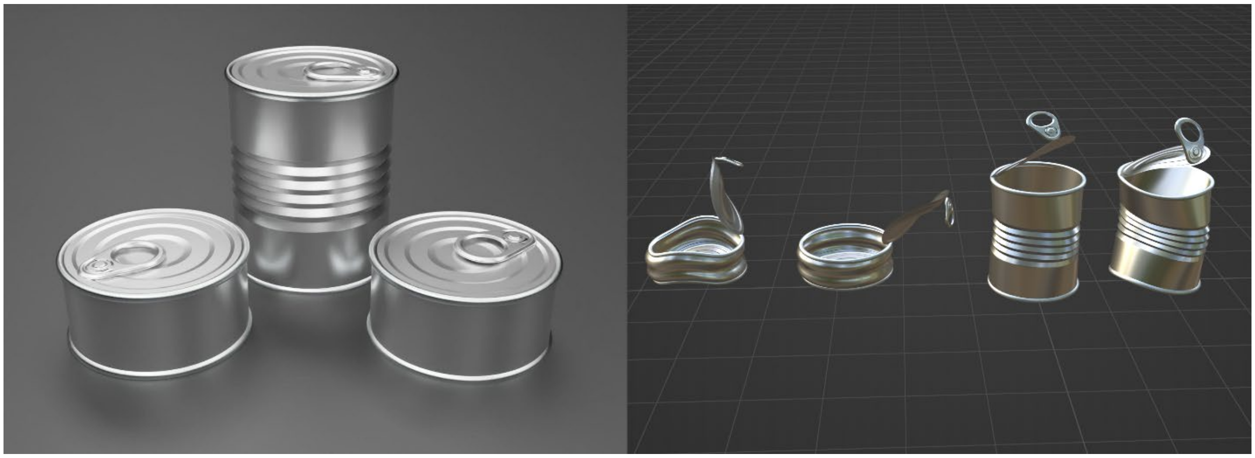


Figure 14 Pre-fabricated food ration cans before (left) and after modifying in Blender (right). Original "canned food" mesh by Volfson is licensed under the CGTrader Royalty-Free License.

Sounds

Sound effects like footsteps and ambient nature noise were incorporated from external audio sources that were edited down and brought into *Unreal.* After identifying royalty-free sound sources that I could incorporate under proper license, I brought the source audio files into *Adobe Audition*, which I used to produce streamlined packages of desired sounds (e.g. isolating individual footsteps, minimizing background rumbling by trimming from the audio's spectral frequency graph, seamlessly looping the natural ambience by duplicating segments of audio and fading them into one another).

Edited sounds were exported as Waveform audio files that were then brought into *Unreal* and incorporated in the game using "sound cues" and "Metasound" objects that would play audio at specific times and places in the game and with additionally defined behaviors like attenuation over distance or dampening behind large barriers.

Building 2D user interfaces

UIs like the artifact inspection overlay, binocular view, main menu, and credits page were implemented as "Widgets"—a built-in class of 2D user interface screens within *Unreal.* As with interactable "Artifacts," these interfaces were treated as functional objects that would be defined and referenced within the game's logical flow.

Figure 15 *An in-game screenshot of the artifact inspection overlay interface when the player is viewing the solar panel and fan artifact.*

Elements like icons for control prompts were created using basic vector work in *Figma*, with refinements being made over the course of the semester based on usability feedback from my advisor. The artifact inspection interface, in particular, required considerable additional scripting to stream an interactive 3D view of the a variable artifact mesh onto a 2D widget.

Gameplay debugging and optimization

Throughout the project timeline—and particularly in the final weeks of the semester—I conducted rigorous play testing in collaboration with my advisor to uncover gameplay bugs. Identified bugs included difficulties clicking on artifacts, unexpected behavior of overlay interfaces, and ease of traversing and exiting the game. Due to the fairly realistic art style, massive area occupied by the background cityscape, and density of foliage that defined the game from the beginning, smooth performance on less powerful devices like laptops was always a concern. Throughout the semester, I monitored and refined project rendering settings, the detail and number of models and textures used, and the efficiency of the gameplay scripting (for example, eliminating unnecessary condition checks and calculation loops). Throughout production, I also utilized *Unreal*'s built-in benchmarking capabilities to automatically test the user's system and apply appropriate graphics settings at runtime. While this may not result in perfectly smooth performance, it serves as a convenient method of varying the game's rendering settings to support pleasing visuals and smooth performance on the user's specific device.

Conclusion

I was able to turn *Reclaimed Memory* into a playable experience with about 15 artifacts, text descriptions exposing the player to the key parts of my in-game history timeline, and functioning inspection interface modes. In collaboration with my advisor, I framed the gameplay experience as a sort of virtual museum tour occurring in an unknown time in the future looking back on the history of humanity in the 21st and 22nd centuries. Indeed, anchoring the gameplay in this manner providing the player with an explanation for their character's motivation (whoever, or *whatever*, their character is) was a challenge right until the end of the semester.

Using a combination of original design work and properly-attributed external media, I was able to explore aspects of game development—like sound systems, 2D interfaces, and performance optimization—that I had yet to experience through my previous coursework and personal exploration within *Unreal Engine 5.* I was met with new puzzles like defining the logic for climbing up ladders, displaying rotatable close-ups of 3D models, and playing variable footstep noises based on terrain type, and I was able to solve them using a combination of official and unofficial online resources and persistent troubleshooting. *At* the same time, I was able to do a great deal of 3D modeling (the kind of work that originally made me gravitate toward this project space) not only in *Blender,* but also in *Unreal* by learning how to use its built-in modeling toolset.

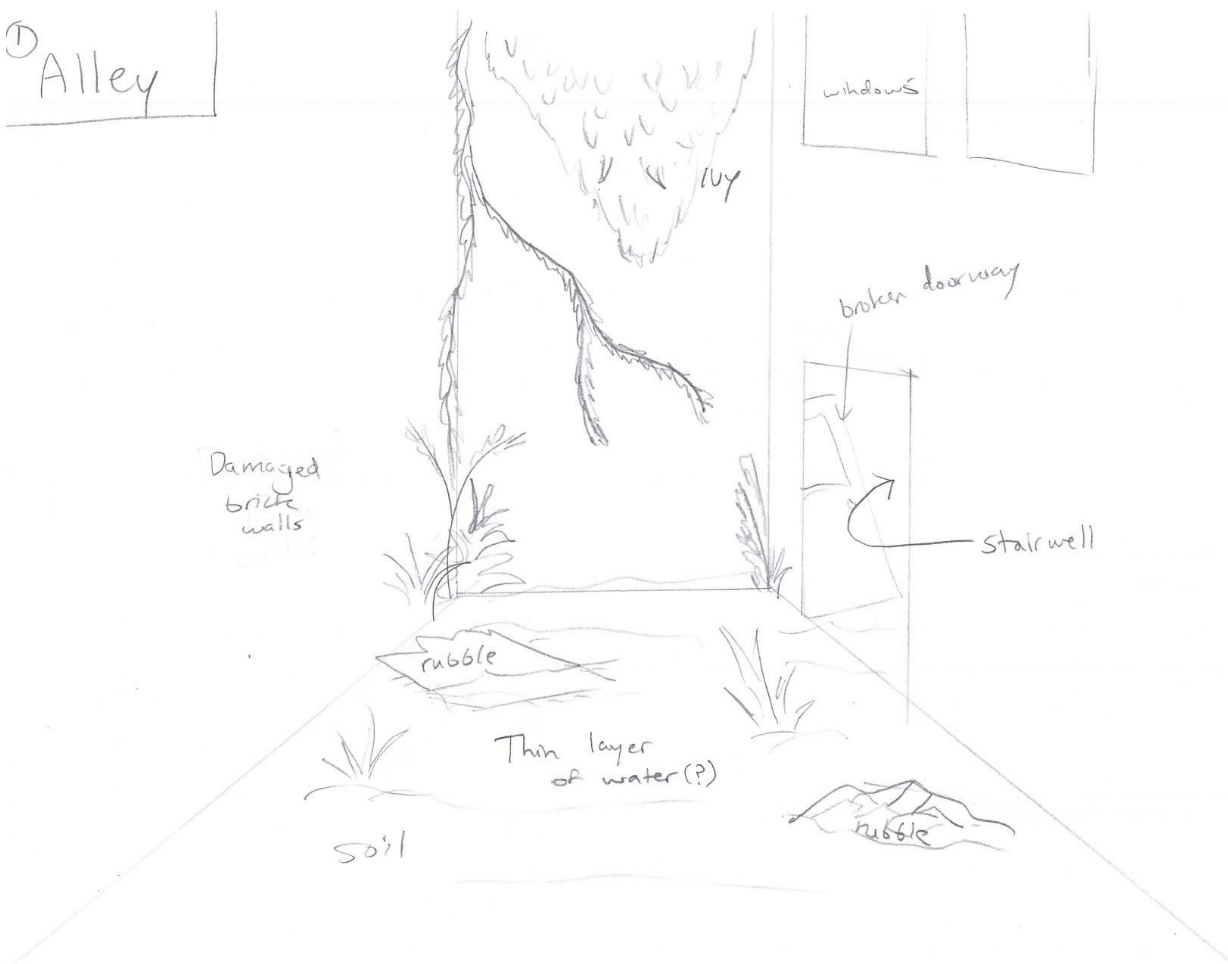
Ultimately, I felt that I succeeded in creating a playable experience that **1)** conveyed real insights about how climate scientists understand our current environmental trajectory, **2)** humanized this story through artifact- and environment-based storytelling to maximize emotional impact, and **3)** bring attention to the role of human action in the greater progression of climate change. With more time to dedicate to 3D modeling and writing, though, I would have expanded my work in several aspects:

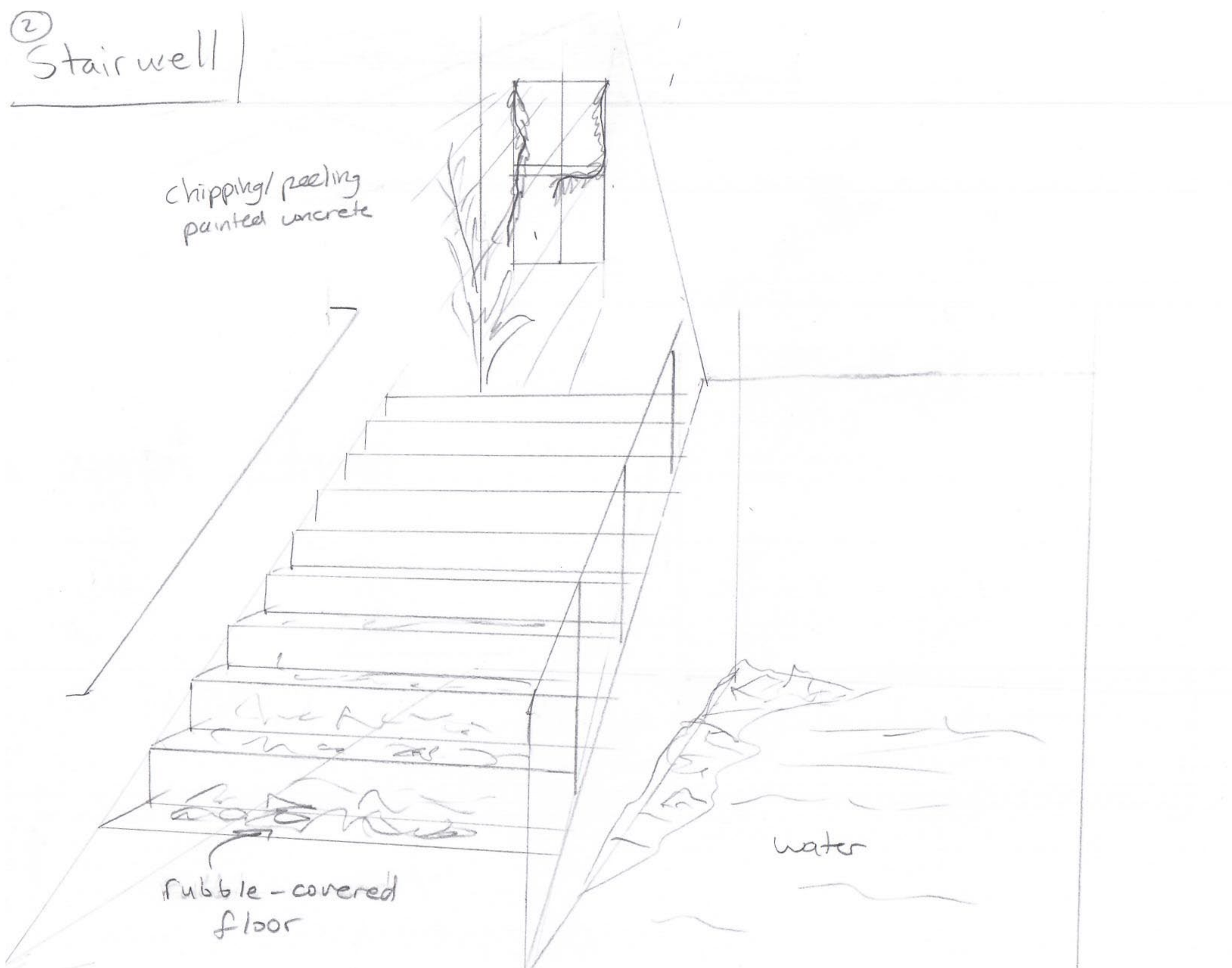
- Provide more of a sense of closure at the 'end' of the game (perhaps at the rooftop) centered around the underlying lesson of the game—that this future can be avoided and that the player's real-life actions will help determine the trajectory of our actual planet's climate
- Including more artifacts to tell a detailed and nuanced story without relying as much on lengthy and overt text descriptions to provide exposition
- Further developing the 'virtual museum exhibit' idea, as is done in *The Talos Principle*, a video game series by Croteam
- Adding both artifacts and environmental detail to the apartment to create a more 'lived-in' feel
- Refining the cityscape view from the rooftop to include more mid-distance details like collapsed roadways or non-standard buildings

- Incorporating music to reinforce the emotional impact of the game
- Telling a longer, more nuanced story of societal upheaval that more clearly rejects climate alarmism but still provides clear explanations for an unfortunate future
- Optimizing graphics performance beyond a cursory, automated user device benchmark (ideally, incorporating a distinct graphics options menu that allows the user to play the game on a wider range of devices)
- Creating 2D artwork for the title screen and other user interfaces to provide the game with a greater sense of aesthetic personality

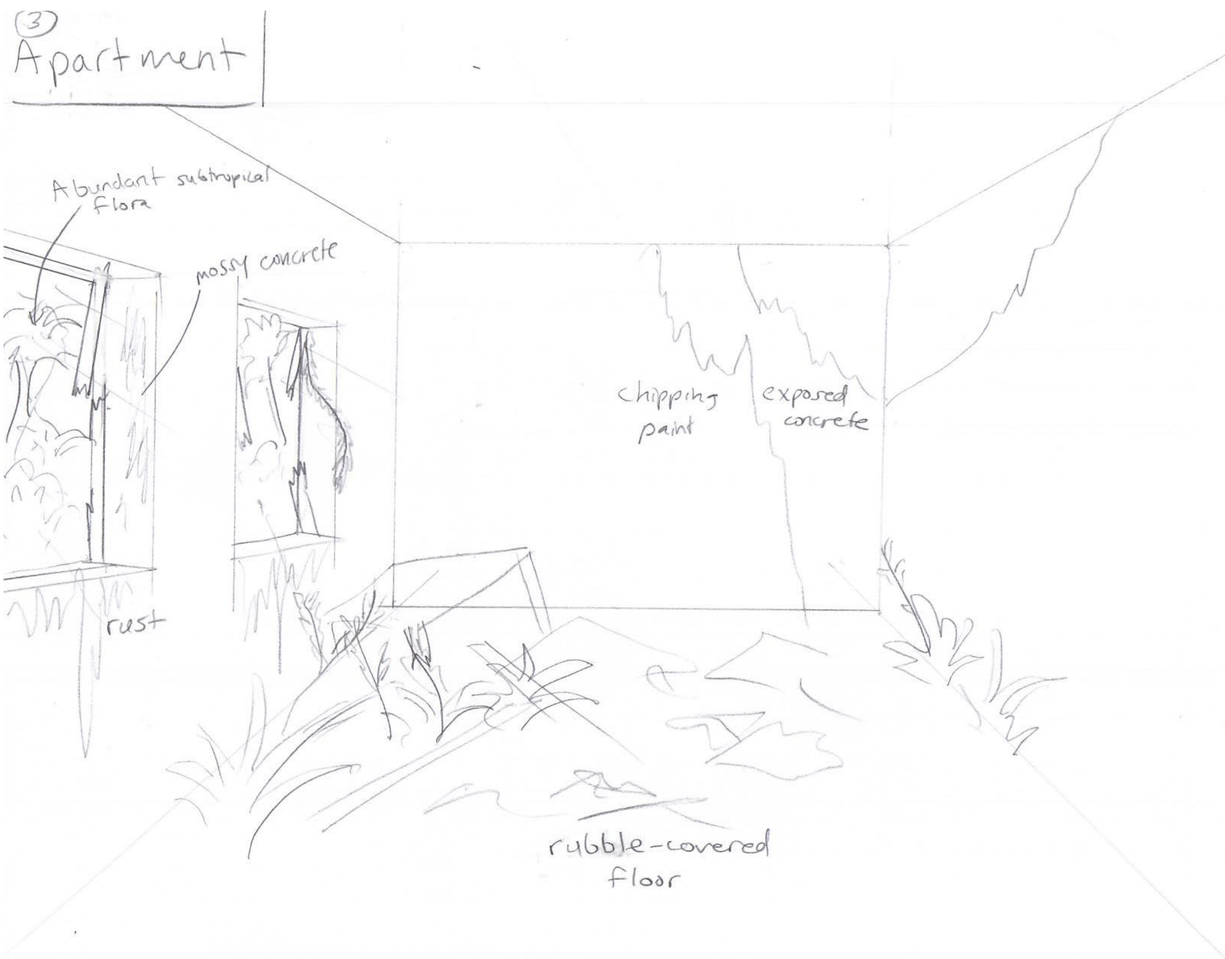
Going into this project, I knew that I would be asking a lot of myself to work through this entire production pipeline, but I did my best to reign-in my expectations to maintain a steady pace so as not to lose out on time for steps later in the semester. However, consistent difficulties with scripting bugs, coming up with artifact and environment design ideas, second-guessing my underlying game history timeline, and exploring unfamiliar aspects of *Unreal* forced me to continually revisit and refine my production scope and timeline. In hindsight, this was an invaluable experience in exercising flexibility to ensure the fulfillment of an underlying design goal despite hiccups and limitations encountered along the way. Overcoming last-minute gameplay bugs to simply package the game successfully was a major challenge and a rewarding experience in teamwork with my advisor (who played through the game as I created new builds). Overall, I am incredibly proud of the research I conducted, the design work I did in pursuit of educating and influencing my audience, and simply having been to deliver a working final product.

Appendix A– Jersey City Environment Sketches



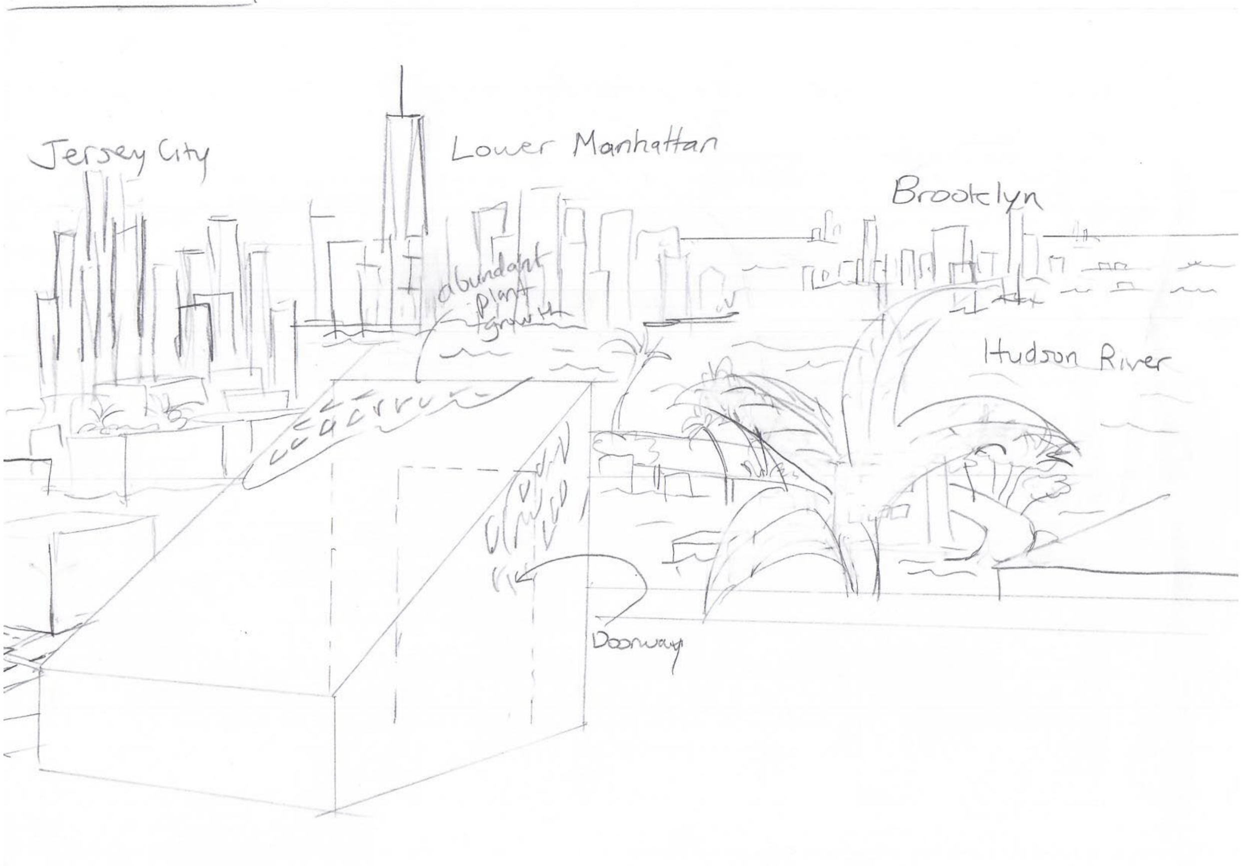


② Stairwell
chipping/peeling
painted concrete
rubble-covered
floor
water



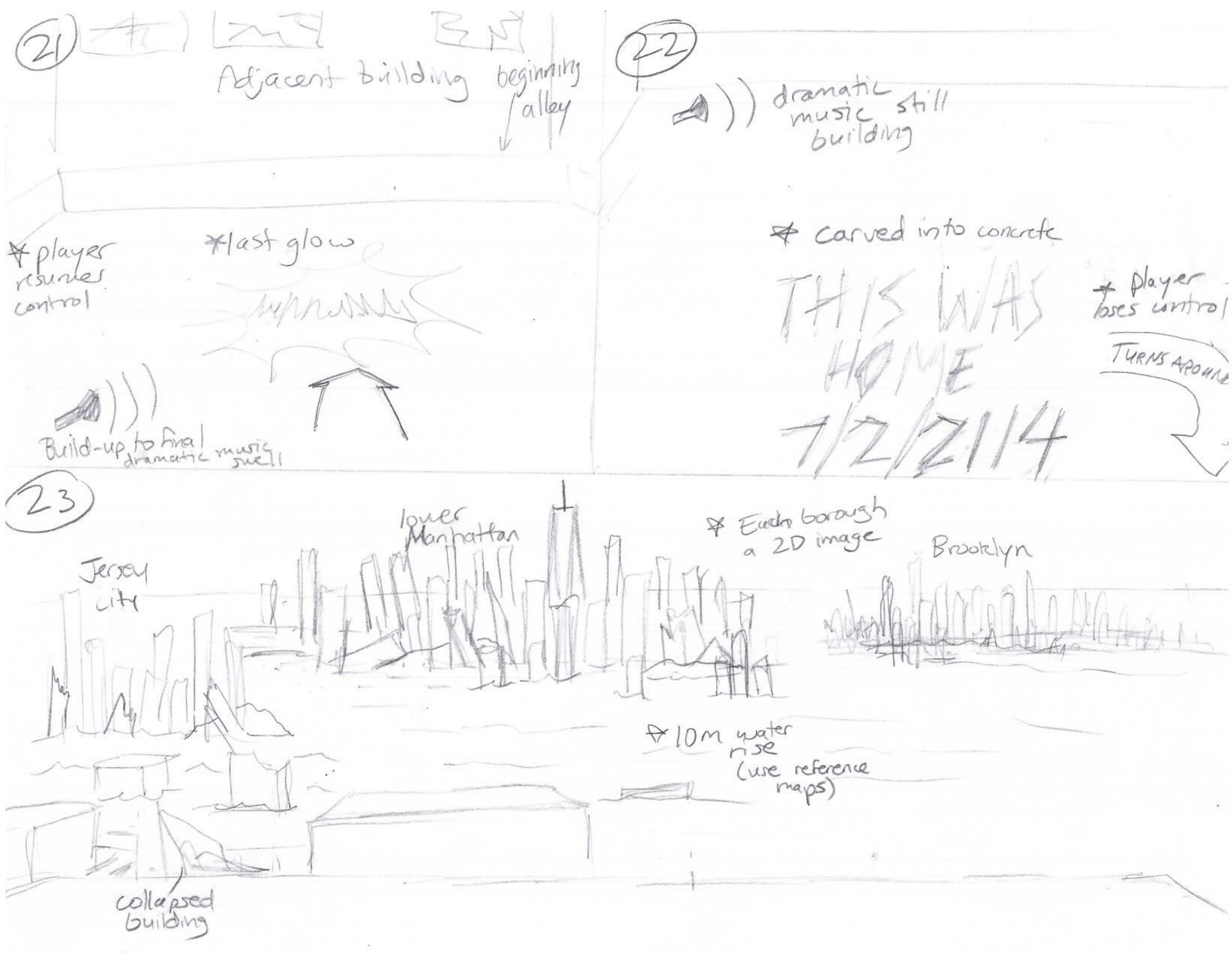
(3)
Apartment
Abundant subtropical flora
mossy concrete
chipping paint
exposed concrete
rust
rubble-covered floor

④ Rooftop

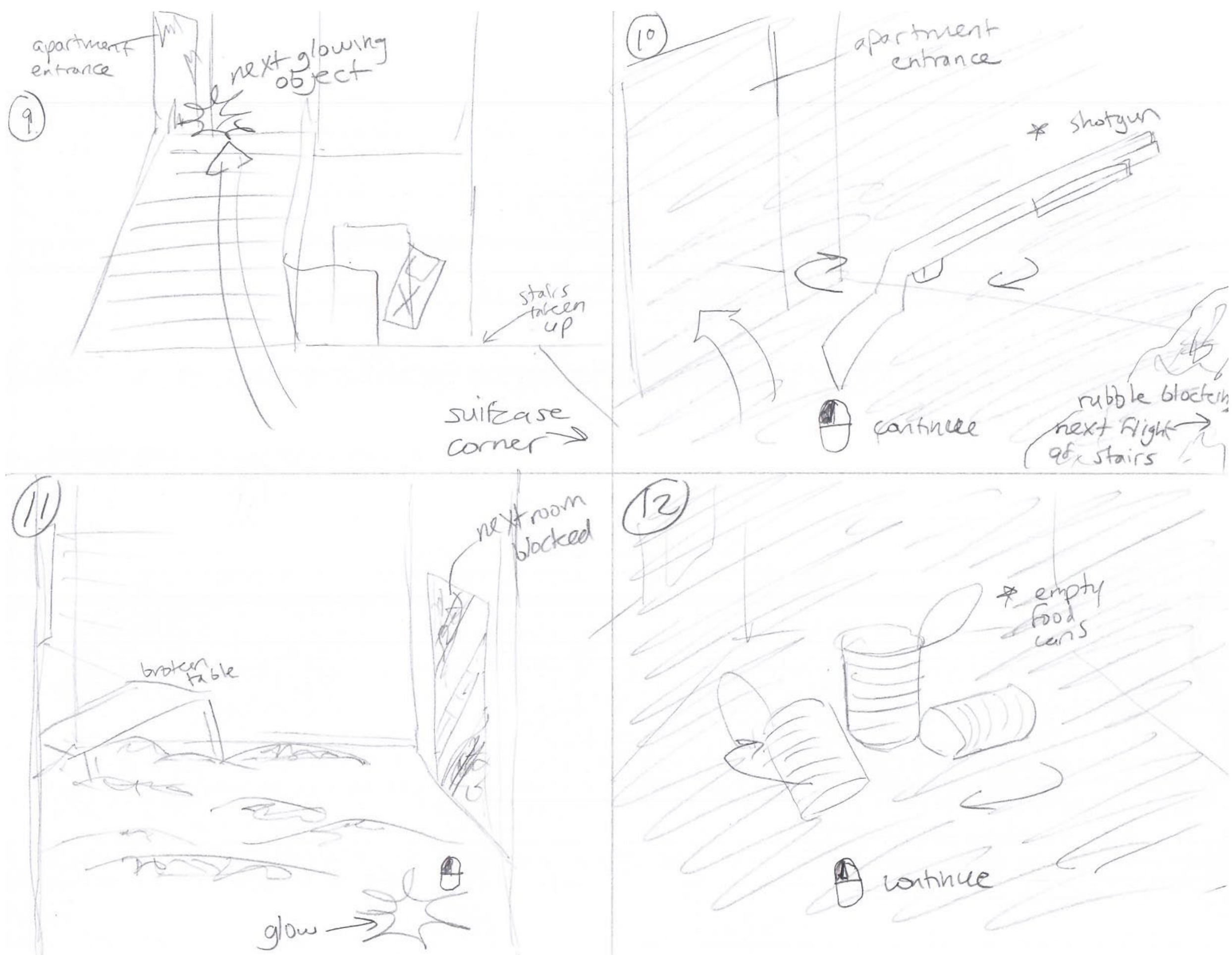


Jersey City
Lower Manhattan
Brooklyn
abundant plant growth
Hudson River
Doorway

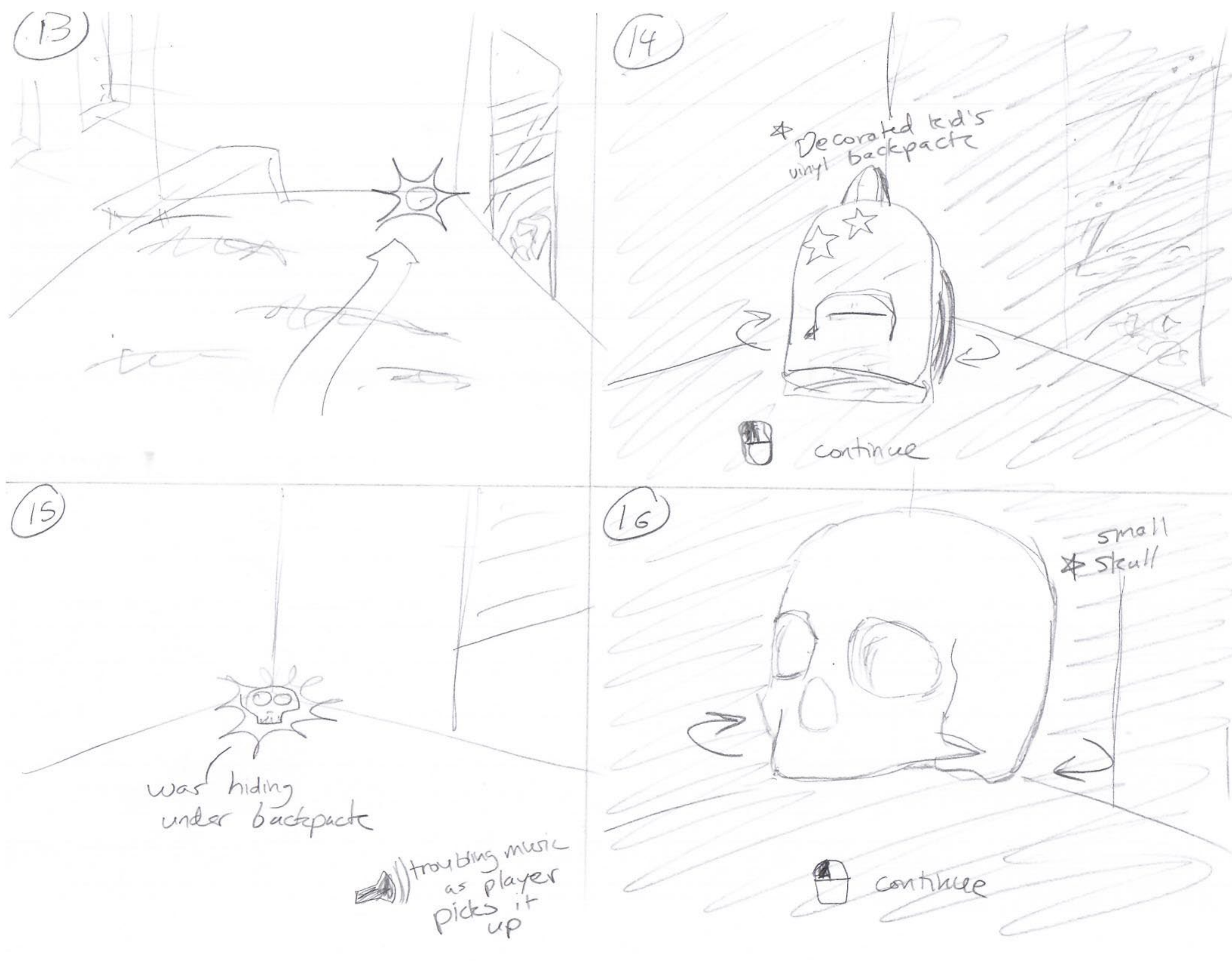
Appendix B – Gameplay Storyboard Panels

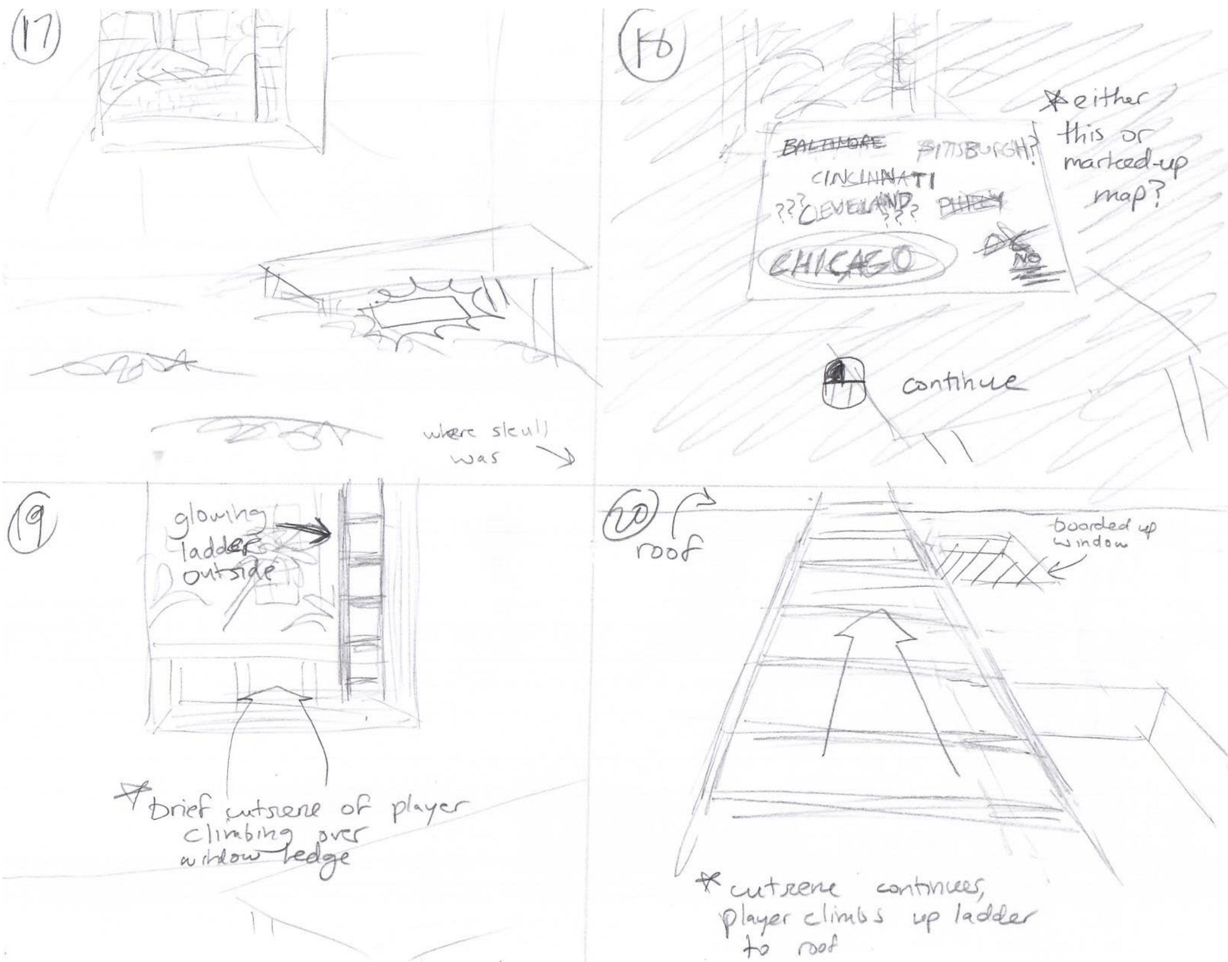


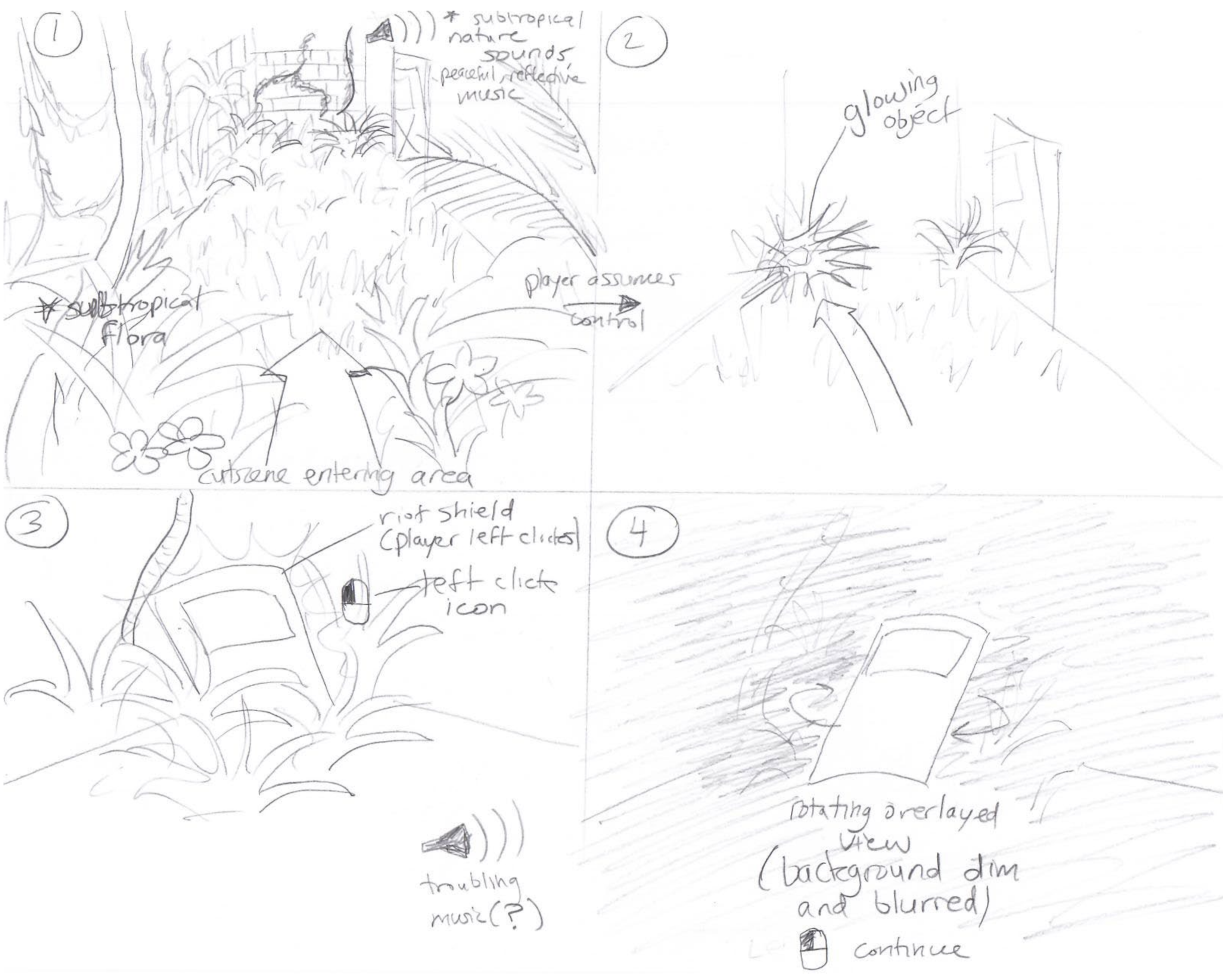

5
next item glows now
riot shield corner
6
gas mask
continue
7
8
hard shell suitcase
continue



apartment entrance
next glowing object
9
stairs taken up
suitcase corner
10
apartment entrance
shotgun
continue
rubble blocking next flight of stairs
11
next room blocked
broken table
glow
12
empty food cans
continue


13
14
* Decorated kid's vinyl backpack
continue
15
was hiding under backpack
troubling music as player picks it up
16
small * skull
continue


(17)
where skull was
(18)
BALTIMORE PITTSBURGH?
CINCINNATI
???CLEVELAND??? PHILLY
CHICAGO
NO
either this or marked-up map?
continue
(19)
glowing ladder outside
brief cutscene of player climbing over window ledge
(20)
roof
boarded up window
cutscene continues, player climbs up ladder to roof



1
* subtropical nature sounds, peaceful reflective music
* subtropical flora
cutscene entering area
player assumes control
2
glowing object
3
riot shield (player left clicks)
left click icon
troubling music(?)
4
rotating overlayed view (background dim and blurred)
continue

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