breach

building integrated flood protection,
addressing the inadequate response to the
flood of 1997 by the city of Grand Forks

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A Design Thesis Submitted to the
Department of Architecture and Landscape Architecture
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by

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In Partial Fulfillment of the Requirements
for the Degree of
Master of Architecture

Primary Thesis Advisor

Thesis Committee Chair

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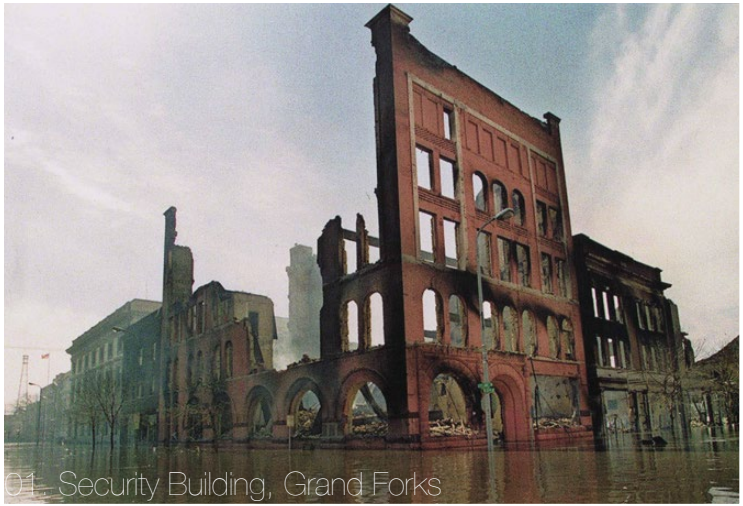
abstract

In response to The Flood of 1997, the city of Grand Forks, ND constructed a flood wall along the river. It protected the citizens from the seasonal floods but it was an inadequate solution. It created a physical, visual, and emotional disconnect from the river front. The properties along the river front, some of the most valuable in the city, were predominantly rendered useless by the wall. Thus, peace of mind was achieved but at great cost. This thesis project will investigate alternative flood protection methods that could potentially provide a more thoughtful solution to flood protection than a flood-wall and dike.



01. Security Building, Grand Forks

02. Flood Wall, Grand Forks

03. dike from river, Grand Forks

theoretical aspects narrative

The flood of 1997 violated the city of Grand Forks and its residents; erasing the past and creating doubt about the future. In response, the city constructed a $409 million flood-wall and dike along the river. It protected the citizens from the seasonal floods but it was an inadequate solution. Peace of mind was achieved, but at what cost? Emotionally, when people feel violated they tend to put up walls. These walls resist the process of healing and cause wounds to fester. An integral question underlying this thesis is how to tear down physical and emotional walls and create a mindful solution based on embrace and healing. Fiscally, a flood-wall provides the city

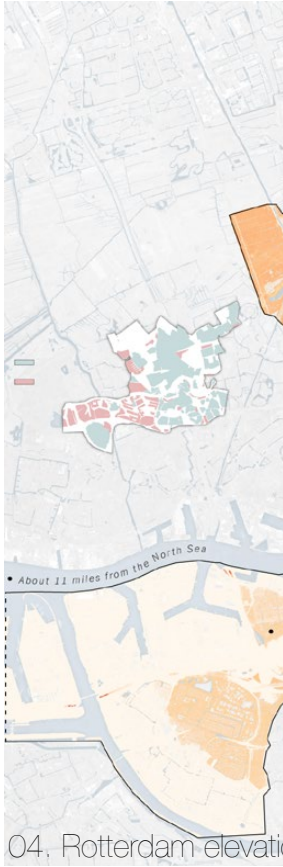
with minimal value on a massive investment. Other than the peace of mind that the wall will hold back floodwaters, a dike and a wall inject zero value into the economy. In fact, it renders valuable riverfront properties useless. Aesthetically, the wall is just that, a wall. It blocks panoramic views of the most beautiful landscapes in the city. The visual connection to the river is integral to the city of Grand Forks as the river is the only reason the city exists in the first place. By reconnecting to the river, physically and visually, this thesis project can inject greater value into the riverfront properties and promote a healthy relationship with the river and the residents.

The use of building integrated flood protection solves the issues created by the wall. It brings people closer to the river again while providing flood protection. It also injects new value into the river front properties that line the city by creating physical and visual connections. This is achieved through the design of 3 major elements: 2 mixed use buildings that bridge dry-side and wet-side of the safe flood elevation. The third element is a boardwalk, and series of "ground-elements" in the form of sloping floors, ramps, and paths that gracefully transition from street "dry-side" elevation to the top of the protective flood plain elevation and then down to the numerous grade elevations on the wet-side or river-side. The sloping ground elements are placed on top of and adjacent to the current dike/ flood wall, and host a variety of functions, such as the town's farmers market, winter carnival, holiday celebrations, music festivals, weddings, etc.

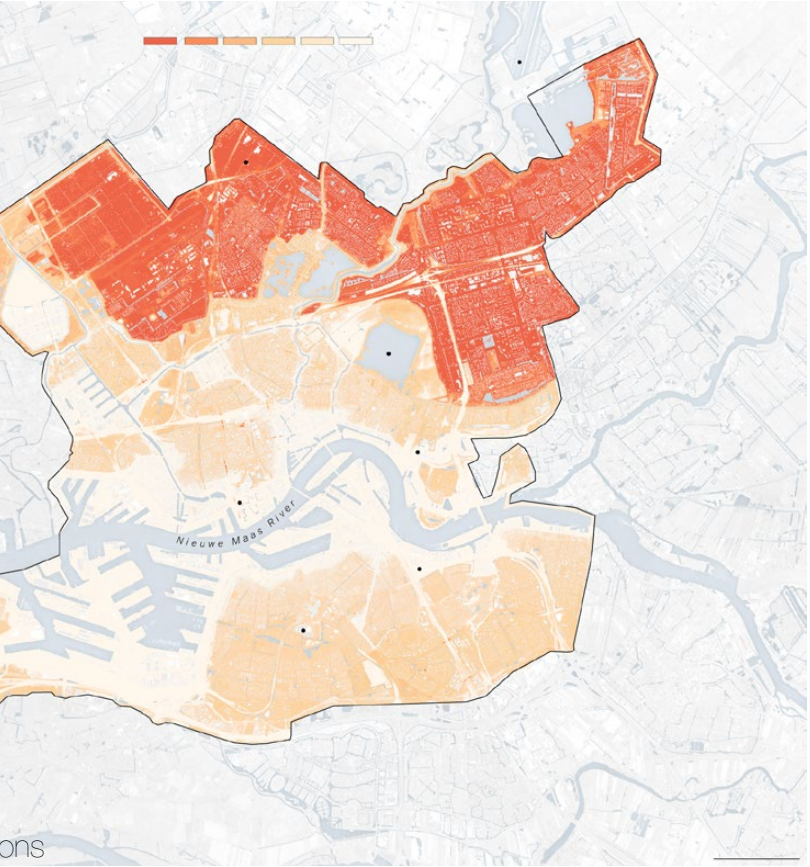
typology research

Rotterdam, NED

This Dutch city lies below sea level and has a long history of battling the water while trying to live along side it in harmony. They have a massive flood wall but also use a series of floodable parks around the city that can take pressure off of the wall in times of high water.



04. Rotterdam elevati



ons

05. Rotterdam flood

05. Rotterdam recreation

Winnipeg, CAN

Winnipeg is a Canadian metropolis that was hit nearly as hard by the Flood of 1997 as Grand Forks. They responded by constructing a $1 billion diversion. Winnipeg is a great example of a city that learned to adapt to a river that often flood and still maintain a strong communal connection to its riverfront.

06. Winnipeg recreation

07. Winnipeg flood

08. Winnipeg river-front

The BigU
New York, NY

NYC is a cautionary tale that is becoming the norm for large coastal cities. They are vulnerable to rising seas and the stakes could not be higher. There is a controversial proposal by Bjarke Ingels Group to build a flood wall that wraps around the city. Their proposed "wall" seamlessly incorporates countless outdoor community functions into the flood protection.

09. The BIG U

10. The BIG U2

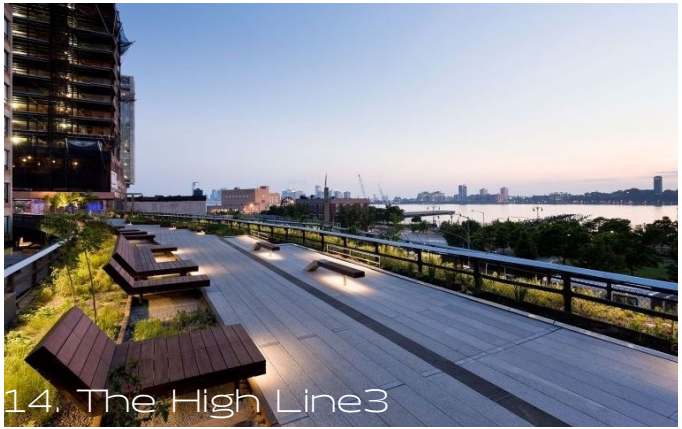
11. The BIG U3

High Line
NYC, NY

The High Line in New York City is a great example of how to meld hard urban context with the softness of vegetation. The high Line has forever changed the way New Yorkers interact with their city and has injected a much needed touch of nature in to the concrete jungle.

12. The High Line

13. The High Line2



14. The High Line3

Pike Place
Seattle, WA

Pike Place is a cultural institution for Seattle. As a community center and tourist destination it underwent a $65 million expansion in 2017. The expansion is a good example of integrating a the new with the old but is a complete failure with how it addresses elevation change through stairs.

15. Pike Place

16. Pike Place addition

17. Pike Place addition

Ghats
Varanasi, India

The Ghats in Varanasi are great examples of how the built environment can adapt to changing water levels while retaining their functionality. They also show how a program can be more successful by being less specific. The steps can support a multitude of functions for a variety of situations.

18. Ghat

19. Ghat2

20. Ghat3

Elite Brownstones Grand Forks, ND

These luxury condos are a great examples of post flood development failures in Grand Forks. The injection of premium condos into the downtown fabric was great. However, the lack of street level retail or commercial space means the condos are a hindrance to downtown street level activities. Additionally, ground level residential experiences are uncomfortable at best due to a lack of privacy.

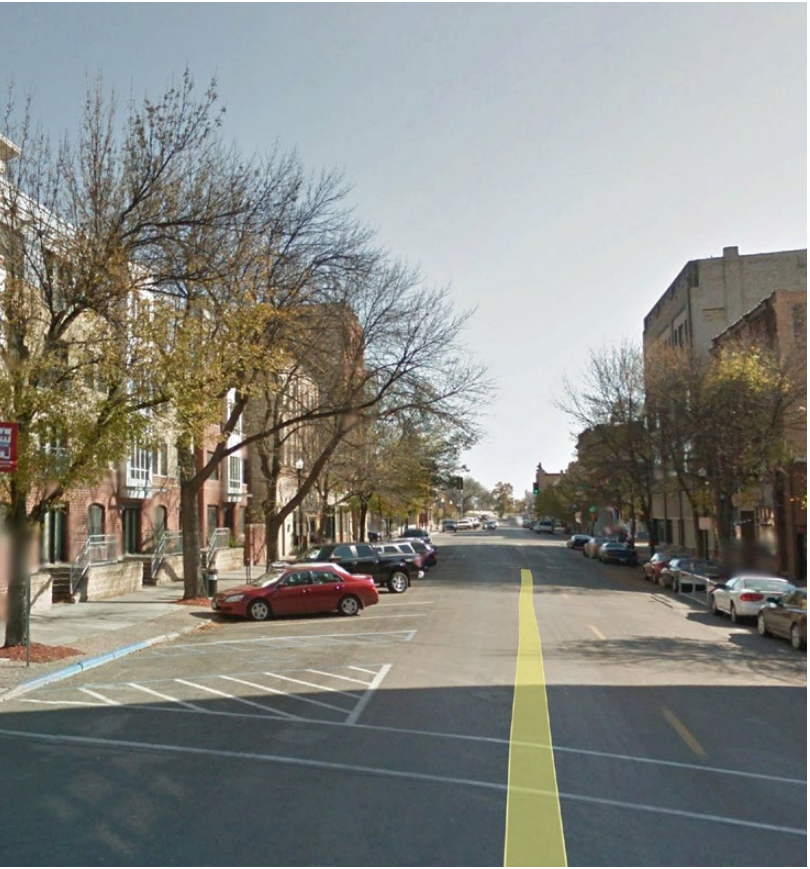
21. Brownstones corner

22. Brownstones street

Current Apartments Grand Forks, ND

Another example of post flood development failure, the Current Apartments provide much needed low income apartments to downtown Grand Forks. Much like the Elie Brownstones though, the Current Apartments lack street level retail space. Instead they offer street level residential space where blinds are constantly drawn and downtown energy is missing.

23. Current corner



24. Current street

major project elements

large

mixed use buildings
boardwalk

small

individual unit layouts
small areas of contemplation/relaxation
unit facade conditions
framing views

medium

residential unit plans
commercial space plans
public space plans
structure
landscape elements

client and audience

Primary- Residents of mixed use buildings and people who are in downtown Grand Forks often.
Secondary - Residents of the Greater Grand Forks area
Tertiary - Any visitors of downtown Grand Forks

Primary Audience Needs- mixed use buildings, transition from street level to boardwalk, a boardwalk, transition from boardwalk to riverfront, a community area with connection to the river, flexible community spaces that can hold a variety of functions and meet their unique needs.
Secondary Audience Needs- see primary needs
Tertiary Audience Needs- see secondary needs

demographics

Population in 2014: 56,057 (100% urban, 0% rural). Population change since 2000: +13.7%

Males: 28,764 (51.3%)
Females: 27,293 (48.7%)
Median resident age: 29.2 years
North Dakota median age: 35.0 years

Grand Forks Zip Code Map
Estimated median household income in 2016: $46,988 (it was $34,194 in 2000)
Grand Forks: $46,988
ND: $60,656

Estimated per capita income in 2016: $27,562 (it was $18,395 in 2000)

Grand Forks city income, earnings, and wages data

Estimated median house or condo value in 2016: $203,477 (it was $90,100 in 2000)
Grand Forks: $203,477
ND: $184,100

Mean prices in 2016: All housing units: $204,246; Detached houses: $226,995; Townhouses or other attached units: $191,116; In 2-unit structures: $62,299; In 3-to-4-unit structures: $136,695; In 5-or-more-unit structures: $97,823; Mobile homes: $20,061
Median gross rent in 2016: $767.

http://www.city-data.com/city/Grand-Forks-North-Dakota.html#ixzz5Esy4lF3f

48,192 - 83.8% White alone
2,280 - 4.0% Hispanic
2,174 - 3.8% Black alone
1,729 - 3.0% American Indian alone
1,591 - 2.8% Two or more races
1,526 - 2.7% Asian alone
37 - 0.06% Other race alone
18 - 0.03% Native Hawaiian and Other Pacific Islander alone

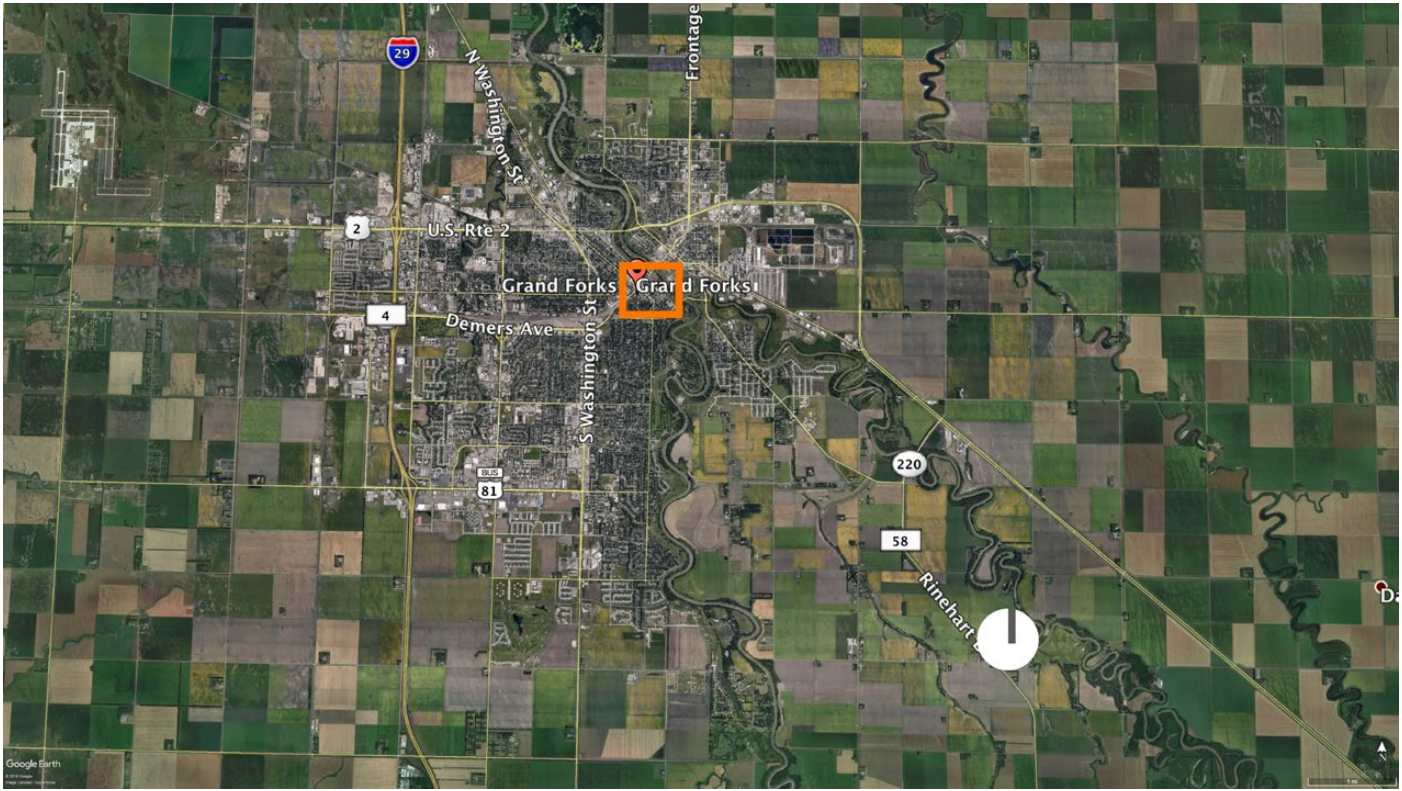
For population 25 years and over in Grand Forks:
High school or higher: 93.8%
Bachelor's degree or higher: 35.0%
Graduate or professional degree: 12.4%
Unemployed: 4.3%
Mean travel time to work (commute): 13.6 minutes

For population 15 years and over in Grand Forks city:
Never married: 42.1%
Now married: 41.3%
Separated: 2.7%
Widowed: 4.3%
Divorced: 9.6%

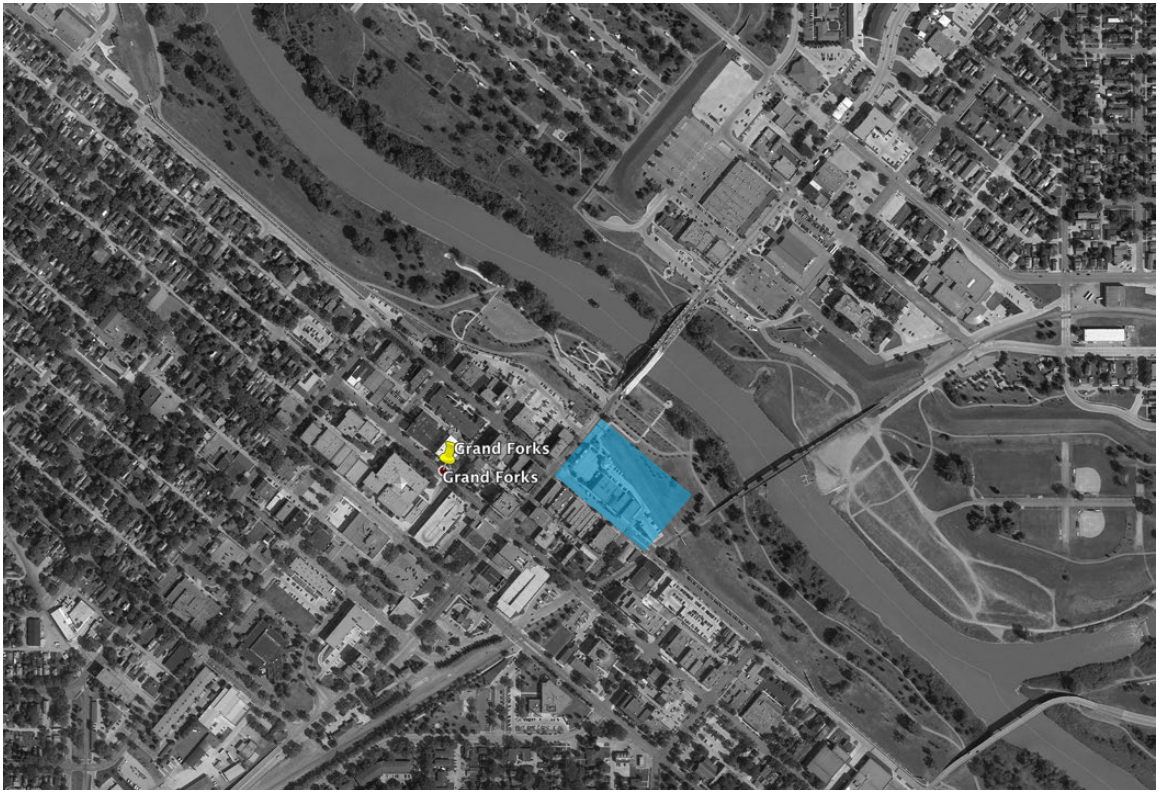
the site

the site is located at the intersection of Demers Ave and 3rd St S in Grand Forks, ND. There is a medium scale urban context surrounding the site with many old masonry buildings. The site wraps around a series of 3 story mixed use buildings.

25. 3rd St

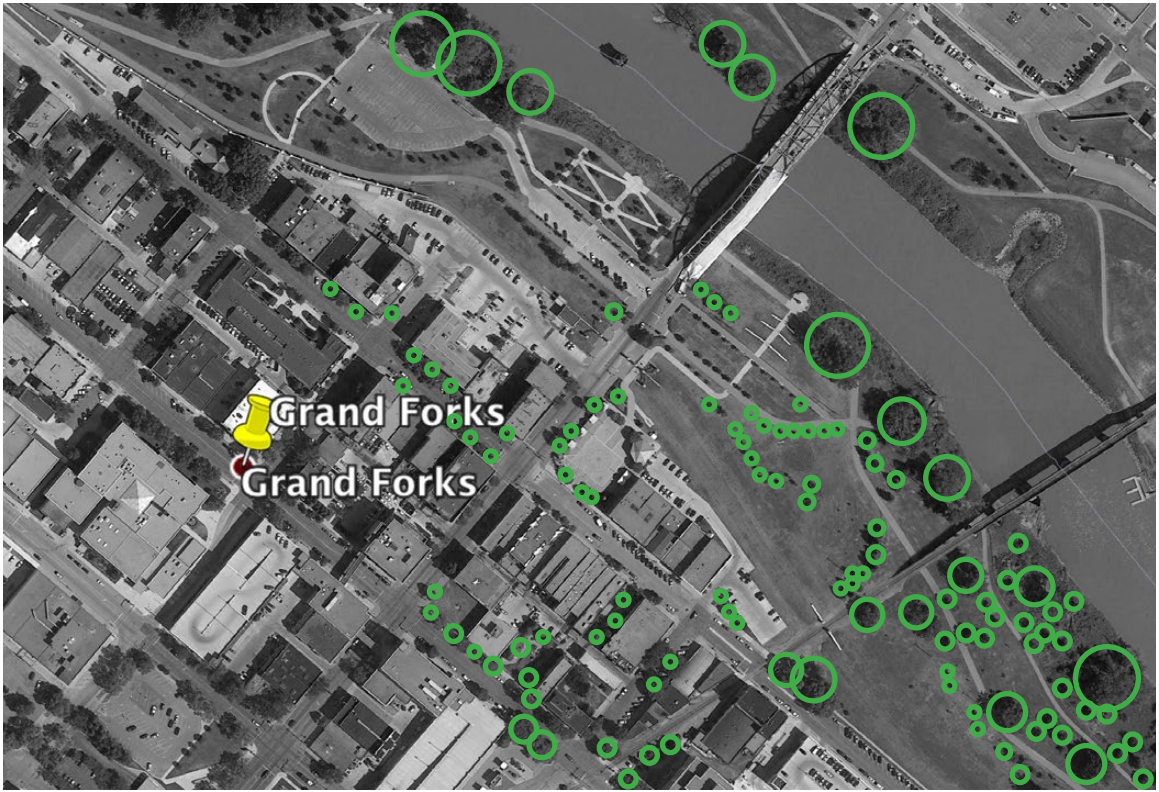


26. Site Macro



27. Site Downtown

28. Site Zoning

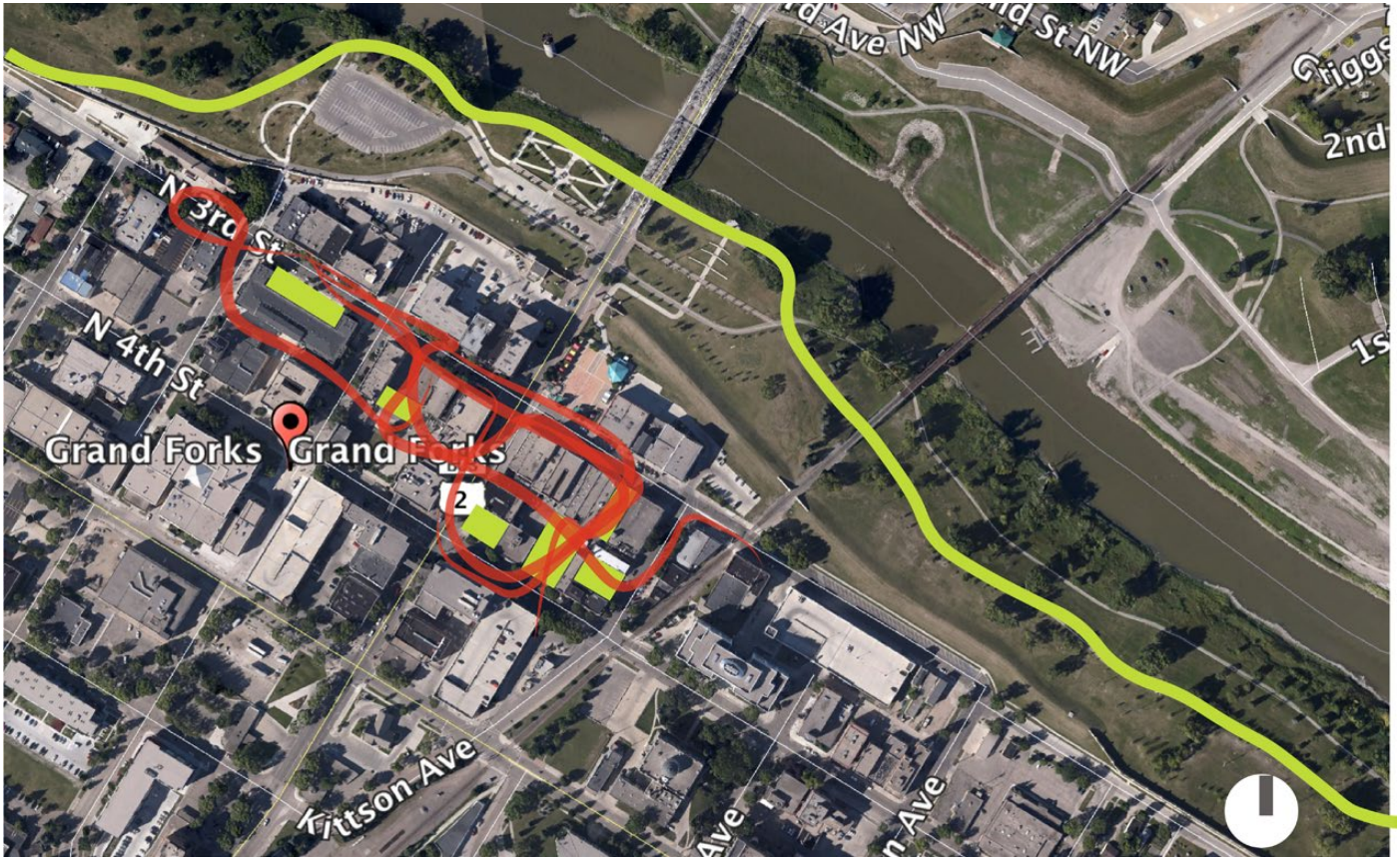


29. Site Vegetation

30. Site Traffic

31. Site Noise

32. Site Parks



33. Site Bar Circulation

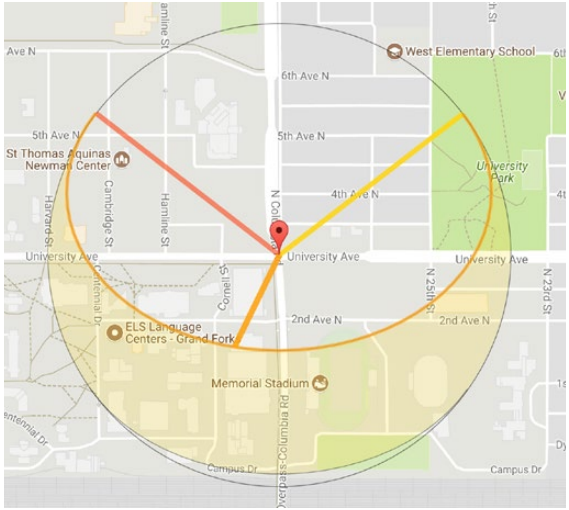
34. Site Micro

35. Site Micro

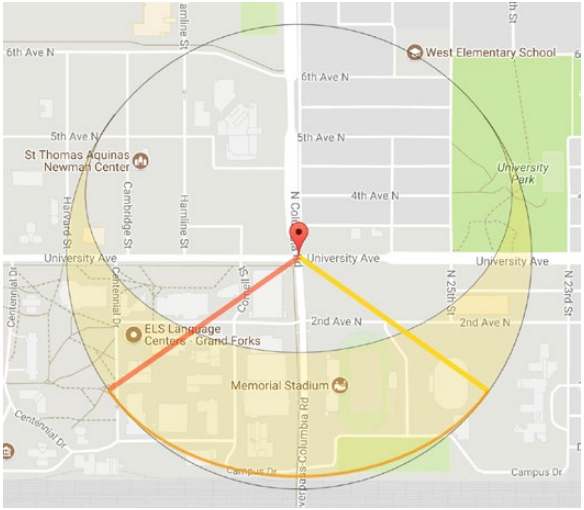
[redacted]

Sun

Summer Equinox



Winter Equinox



http://suncalc.net/#/47.9223,-97.0664,16/2017.12.20/23:40

36. Site Sun

Climate

Climate data for Grand Forks International Airport, North Dakota (1981–2010 normals,[4] extremes 1893–present[5]													[hide]
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Record high °F (°C)	52 (11)	67 (19)	83 (28)	100 (38)	105 (41)	105 (41)	109 (43)	104 (40)	103 (39)	95 (35)	75 (24)	58 (14)	109 (43)
Mean maximum °F (°C)	39.2 (4)	42.0 (5.6)	54.2 (12.3)	78.1 (25.6)	87.2 (30.7)	90.3 (32.4)	92.3 (33.5)	93.5 (34.2)	89.1 (31.7)	76.3 (24.6)	57.4 (14.1)	40.3 (4.6)	96.0 (35.6)
Average high °F (°C)	16.5 (−8.6)	21.9 (−5.6)	34.2 (1.2)	53.9 (12.2)	68.0 (20)	76.1 (24.5)	81.0 (27.2)	80.2 (26.8)	69.6 (20.9)	54.3 (12.4)	35.1 (1.7)	20.3 (−6.5)	51.1 (10.6)
Average low °F (°C)	−3.1 (−19.5)	2.1 (−16.6)	16.1 (−8.8)	30.0 (−1.1)	41.5 (5.3)	52.0 (11.1)	56.3 (13.5)	54.0 (12.2)	44.2 (6.8)	31.9 (−0.1)	17.0 (−8.3)	2.6 (−16.3)	28.9 (−1.7)
Mean minimum °F (°C)	−25.4 (−31.9)	−21.4 (−29.7)	−8.2 (−22.3)	16.2 (−8.8)	27.6 (−2.4)	40.3 (4.6)	46.0 (7.8)	41.3 (5.2)	30.1 (−1.1)	17.3 (−8.2)	−2 (−19)	−18.9 (−28.3)	−29 (−34)
Record low °F (°C)	−43 (−42)	−42 (−41)	−36 (−38)	−9 (−23)	5 (−15)	28 (−2)	30 (−1)	30 (−1)	11 (−12)	−9 (−23)	−35 (−37)	−37 (−38)	−43 (−42)
Average precipitation inches (mm)	0.55 (14)	0.52 (13.2)	0.96 (24.4)	1.01 (25.7)	2.68 (68.1)	3.48 (88.4)	3.15 (80)	2.88 (73.2)	2.05 (52.1)	1.97 (50)	0.95 (24.1)	0.61 (15.5)	20.81 (528.7)
Average snowfall inches (cm)	10.7 (27.2)	6.6 (16.8)	7.2 (18.3)	2.6 (6.6)	0.1 (0.3)	0 (0)	0 (0)	0 (0)	trace	1.5 (3.8)	7.7 (19.6)	10.7 (27.2)	47.1 (119.6)
Average precipitation days (≥ 0.01 in)	8.1	6.6	7.5	7.0	10.6	11.6	10.5	9.1	8.3	8.5	6.9	8.5	103.2
Average snowy days (≥ 0.1 in)	10.1	7.1	5.5	1.9	0.2	0	0	0	0	1.3	5.6	9.8	41.5

https://en.wikipedia.org/wiki/Climate_of_Grand_Forks,_North_Dakota

37. Site Climate

38-48. Site Visit 1

49-57. Site Visit 2

project emphasis

1. Design of a system of mixed use buildings and sloped walking paths that create a welcoming condition where the current town square sits. The new project must support all current functions of the town square and also be able to support additional functions.
2. Reconnect the downtown urban context to the river.
3. Foster a more healthy relationship between the people of Grand Forks and the river.

goals of the thesis

Define a new way of addressing flood protection for developed urban landscapes.
Find an innovative way to deal with the elevation change between the street level and top of the flood wall.
Explore a new relationship between buildings and riverfront.
Create a cohesive site experience between multiple buildings and a boardwalk.
Integrate landscape elements and the built environment.

plan for proceeding

Tools: site visits, Enscape, sun analysis, wind analysis, precedence studies.

Outcomes: innovative solution for flood protection with building integration, how a building and boardwalk can become a community epicenter.

Design Methodology

1. Obtain a grasp of what the site has to offer
2. Consider an underlying metaphor
3. Explore graphically with sketches and massing models
4. Create a massing representation of the program
5. Synthesize program massing with graphic explorations
6. Mass modeling and Sketchup modeling
7. Revit modeling and analysis
8. Renderings using Enscape and possibly a Lumion video

Documentation of the Design Process

1. Sketches and notes in sketch books and on trace paper
2. Pictures of models
3. All digital files saved together and backed up via GoogleDrive
4. Thesis book updated as needed
5. Documentation of research material and sources

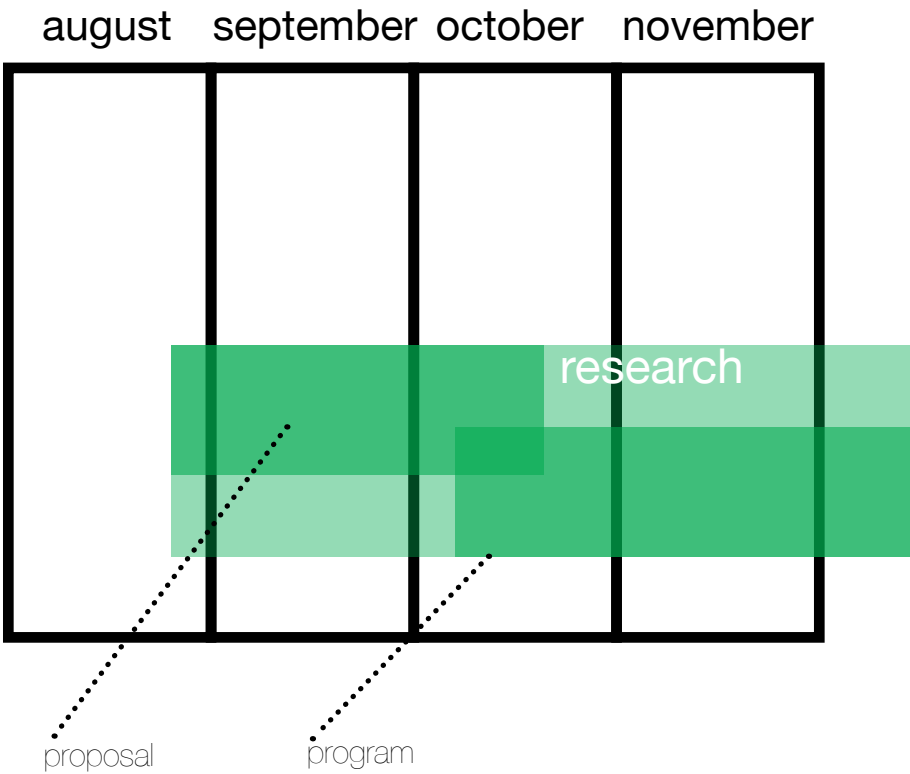
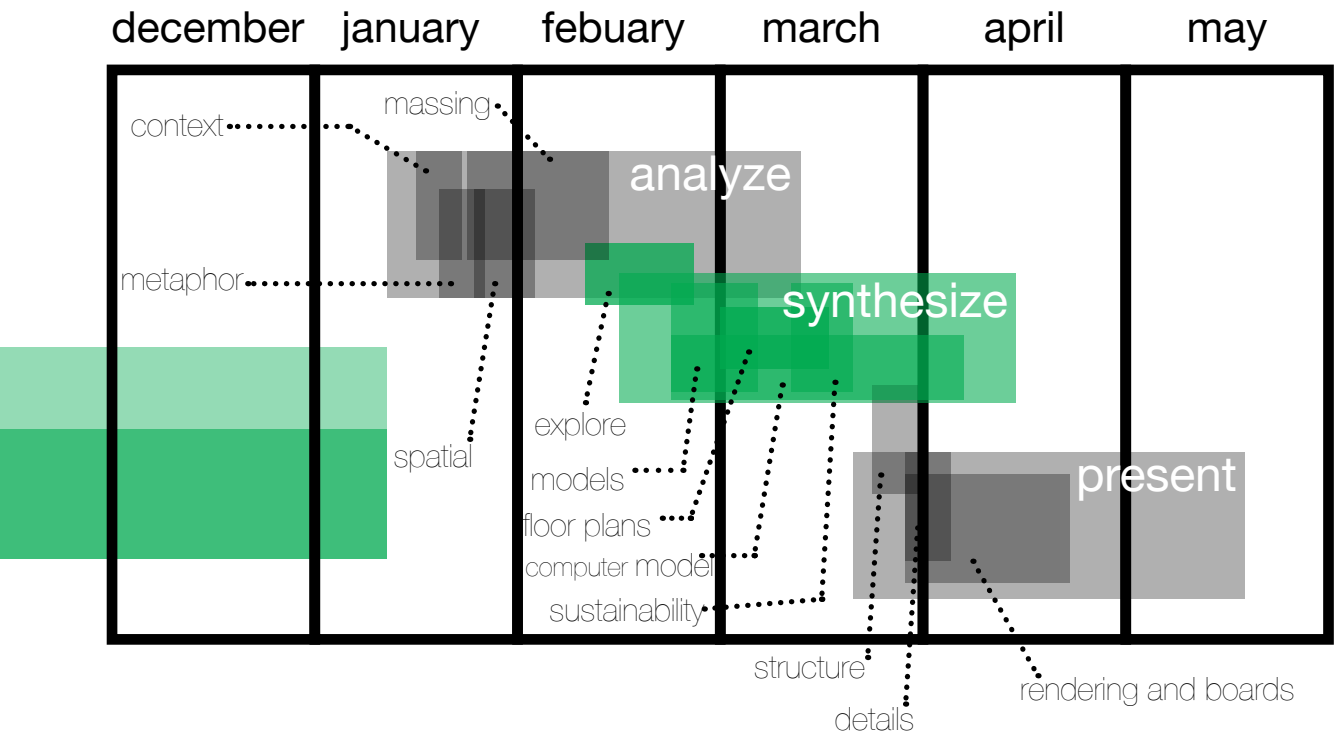


Figure 78.1 Thesis schedule


december
january
febuary
march
april
may
context
massing
analyze
metaphor
synthesize
spatial
explore
models
floor plans
computer model
sustainability
present
structure
details
rendering and boards

unifying idea research

"Landmarks with human dimensions are being torn down to be replaced by structures that appear never to have been touched by human hands. There seems to be a talent today for picking the most beautiful and personal places to destroy." (Lacitis, 2017) This quote by Artist Mark Tobey in 1950 is greatly relevant to this thesis, not so much in that this project is about not tearing down buildings but in that the construction of a flood-wall in Grand Forks destroyed the most beautiful part of the city by placing it out of sight.

It has been my personal experience that downtown Grand Forks would benefit greatly from a better connection to the river. Upon many site visits it becomes clearer that the wall truly separates the city from its genesis. The city was founded because of the river's very existence, and now they may as well be two ships passing in the night. Not only is the wall a barrier but it has a dominating presence in an otherwise pleasant context. The lush greenery of the riverfront contrasted with the rich tones of the old downtown masonry buildings is a thing of beautify, or at least it was.

The proposal of flood protection that is more than a wall is supported by BIG architects and their "Big U" proposal for New York City. "The proposal was conceived as 10 continuous miles of protection tailored to respond to individual neighborhood typology as well as community-desired amenities. The proposal breaks the area into compartments: East River Park; Two Bridges and Chinatown; and Brooklyn Bridge to The Battery. Like the hull of a ship, each can provide a flood-protection zone, providing separate opportunities for integrated social and community planning processes for each.

Each compartment comprises a physically separate flood-protection zone, isolated from flooding in the other zones, but each equally a field for integrated social and community planning. The compartments work in concert to protect and enhance the city, but each compartment's proposal is designed to stand on its own." (BIG Team, 2017)

The concept of community functions and flood protection to be a seamless melding of two distinctly different entities is fundamental to the successfulness of this thesis project and any major flood protection project in the future. By combining the two, a community can avoid the mistakes made by many communities which act too hastily to find an efficient solution instead of one that is mindful and holistic. The value, both monetarily and socially are equally as important to the long term success of the flood protect and the health of the city.

project justification

The flood of 1997 violated the city of Grand Forks and its residents; erasing the past and creating doubt about the future. In response, the city constructed a $409 million flood-wall and dike along the river. It protected the citizens from the seasonal floods but it was an inadequate solution. Peace of mind was achieved, but at what cost?

Emotionally, when people feel violated they tend to put up walls. These walls resist the process of healing and cause wounds to fester. An integral question underlying this thesis is how to tear down physical and emotional walls and create a mindful solution based on embrace and healing. Fiscally, a flood-wall provides the city with minimal value on a massive investment. Other than the peace of mind that the wall will hold back floodwaters, a dike and a wall inject zero value into the economy. In fact, it renders valuable riverfront properties useless. Aesthetically, the wall is just that, a wall. It blocks panoramic views of the most beautiful landscapes in the city. The visual connection to the river is integral to the city of Grand Forks as the river is the only reason the city exists in the first place. By reconnecting to the river, physically and visually, this thesis project can inject greater value into the riverfront properties and promote a healthy relationship with the river and the residents.

This project is important at this stage of my career because it will demonstrate my competency in a wide variety of architectural applications. I also feel it is important and valuable that a thesis project not only tackle important questions but, at the very least, attempt to do so in an innovative way.

This project will improve my architectural knowledge because I have never worked on a project that involved as many variables as this one. Not only is it two mixed use buildings for one projects but it is also the boardwalk that connects them while also connecting the downtown to the river and the river to the downtown. Not only that, but this project will be highly relevant to me professionally in the future since I plan on working in the area of my site.

This project is important to the profession because the batter with water is only just beginning. With rising seas on coastal communities, the need to develop flood protection that can incorporate beauty and community functions together is essential. It will also provide a realistic solution to a problem that also faces many smaller communities that are located along rivers.

Additionally, architects in general seem to care minimally about accessibility when designing spaces. This is not only for people in wheel chairs but it also affects able bodied people, for example a parent with their young children in a stroller is restricted in the same ways as a person that is confined to a wheel chair. The use of stairs as a means of elevation change is common and generally lazy. There are more thoughtful ways to make an elevation change that is also entirely inclusive and I believe that to be as important as any issue facing architecture today. As a result I will strive to make any elevation change fully accessible to all but using as few stairs as possible.

historical context

Post flood developments in Grand Forks have been inadequate to say the least. The Elite Brownstones and The Current Apartments appear to be short sighted at best in their attempt to fill lots left vacant from the fire that ravaged the downtown during the flood. Both projects reject the notion that a downtown should be busy and vibrant. Instead they forcefully block any and all flow from business to business by filly their street level space with residential units. Not only is this highly uncomfortable for

the residents as they have to live with their blinds drawn 24/7 to maintain their privacy but it removes the opportunity for more businesses to grow into the downtown tapestry. These two developments do provide much needed residential space, both premium condo and low income apartments, but they could aid the downtown growth and vibrancy as well as improve their own residential conditions if they would utilize the street level space for commercial uses.

The city of Rotterdam provides a very extreme and modern example of how a community can deal with the threat of water. For hundreds of years the city and its people have attempted to live in harmony with the sea while a majority of the city lies beneath sea level. The most effective strategy for flood prevention is permeability as it allows the water to be less constrained and gives the earth an opportunity to absorb the vast majority of it. Unfortunately in most western cities true permeability is not an option as infrastructure would be completely ruined and rebuilding entire cities is unrealistically expensive. The Dutch skirted this issue by constructing a system of floodable parks around the city that can be fully submerged in times of high water.

"We're really planning ahead", says Alexandra van Huffelen, Rotterdam's vice mayor in charge of sustainability. "The Dutch have lived below the sea level for centuries and are used to dykes and barriers. But today we're experiencing heavier and more unpredictable rainfalls, so behind the barriers we're turning the city into a sponge."

A crucial sponge. Surrounded by water on four sides, this delta city of some 600,000 people can't flush the sudden stormwater away. Instead, it has embarked on a climate change adaptation strategy that turns every conceivable area into water storage. "We have squares that are set lower than the surrounding streets and pavements that will function as water plazas and fill themselves up with water", explains van Huffelen.

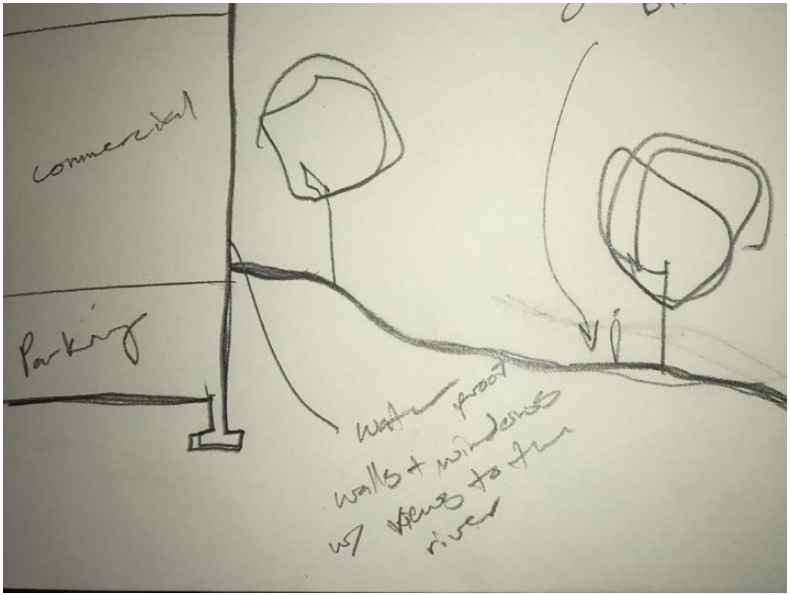
"We've also built water storage facilities, for example an underground parking garage with a basin the size of four Olympic swimming pools. And we've introduced more green areas, including green roofs and green facades, that will be able to absorb water as well." (Braw, 2013)

space allocation

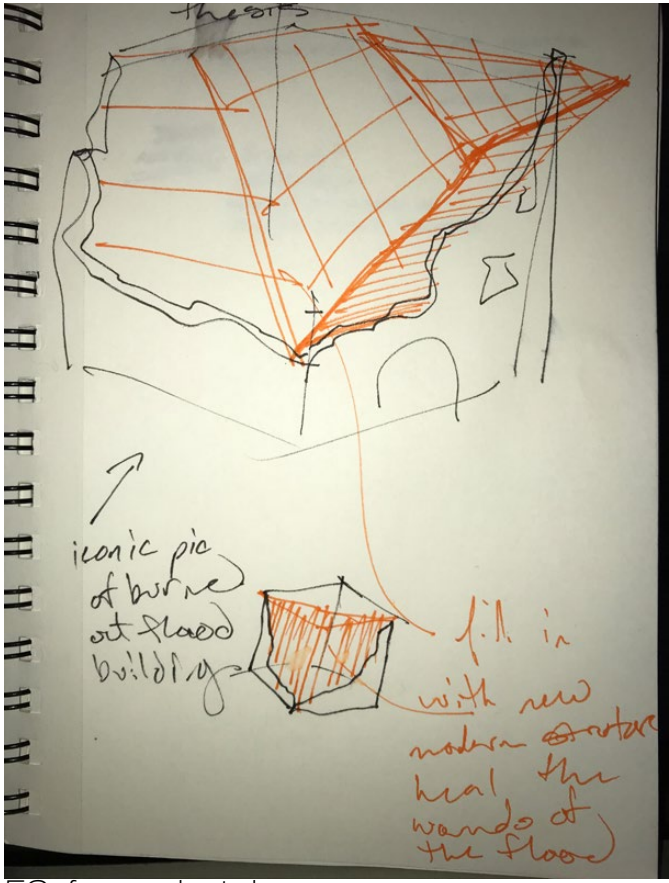
retail space - 25,000 sf
commercial space - 45,000 sf
residential space - 77,000 sf
boardwalk - 50,000 sf

project process documentation

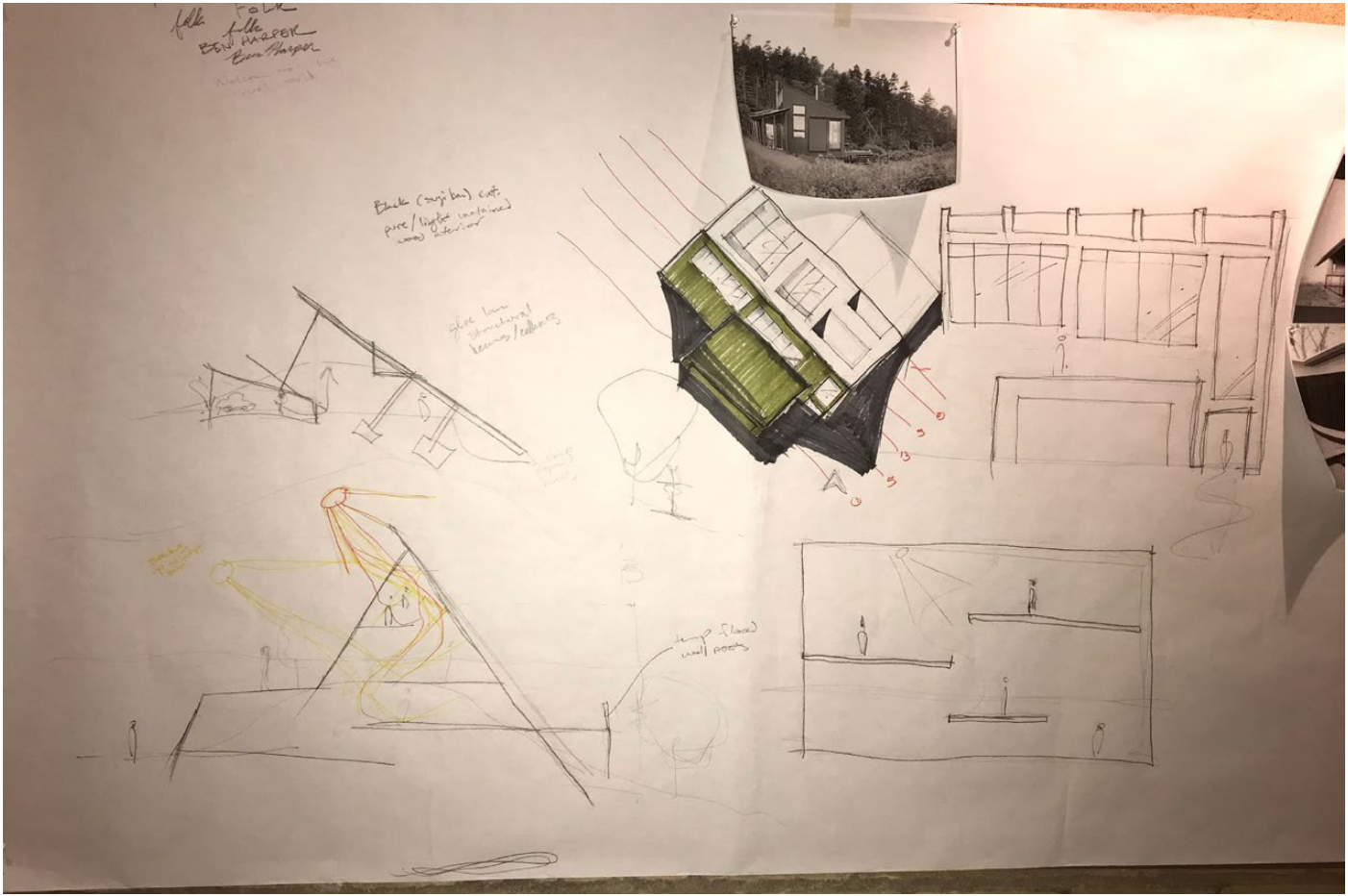
process sketches



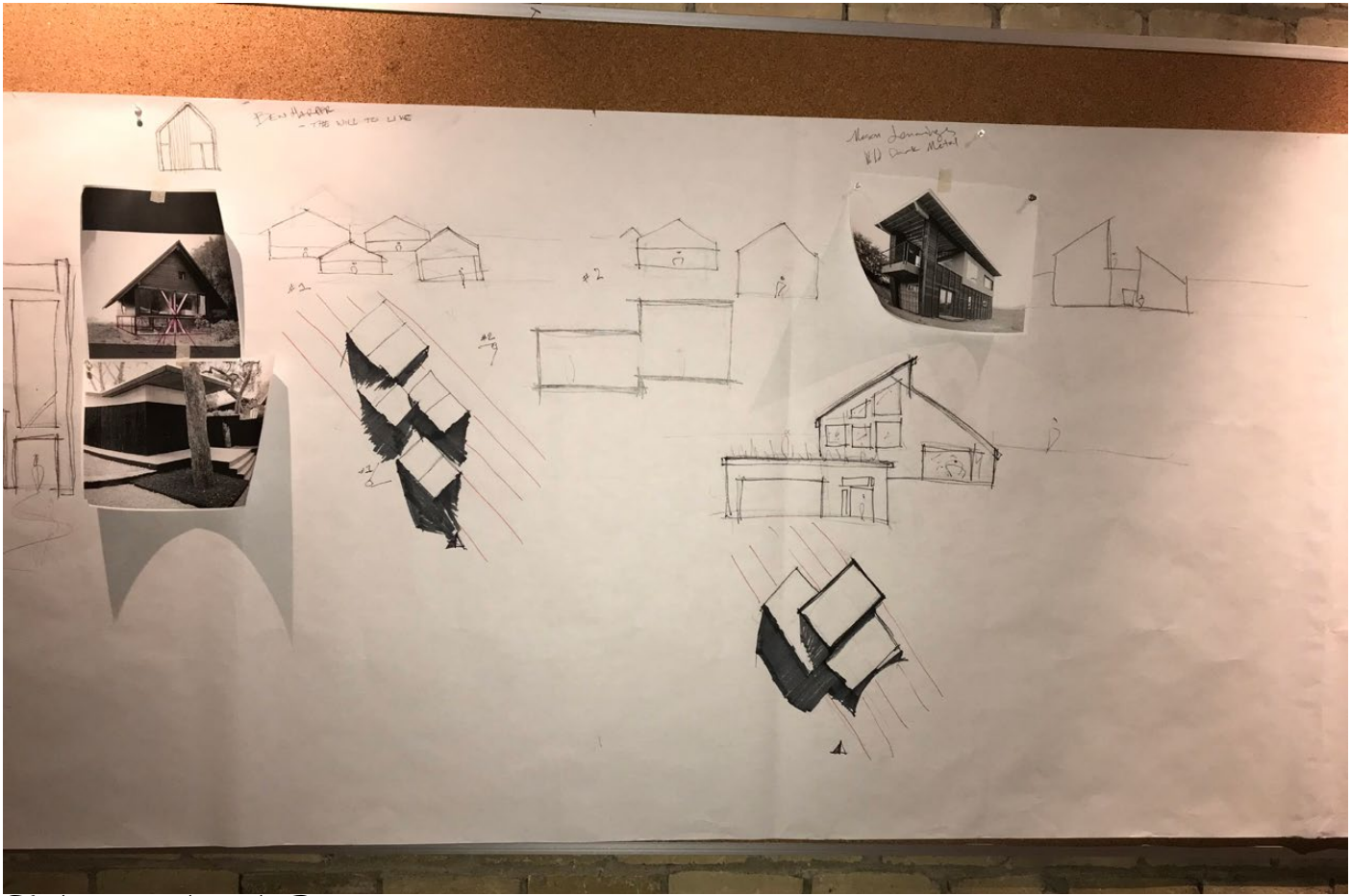
58. section sketch



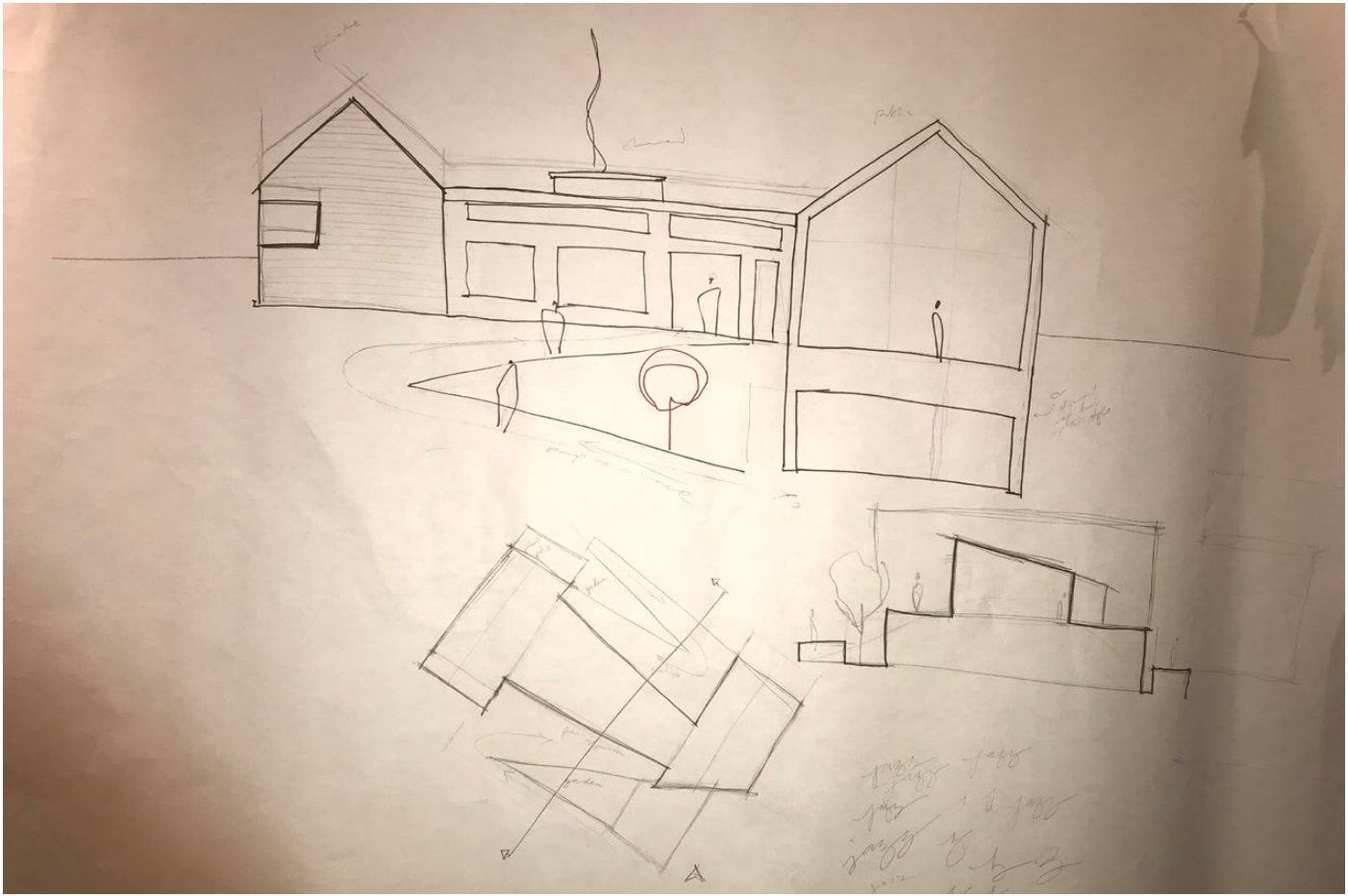
59. form sketch



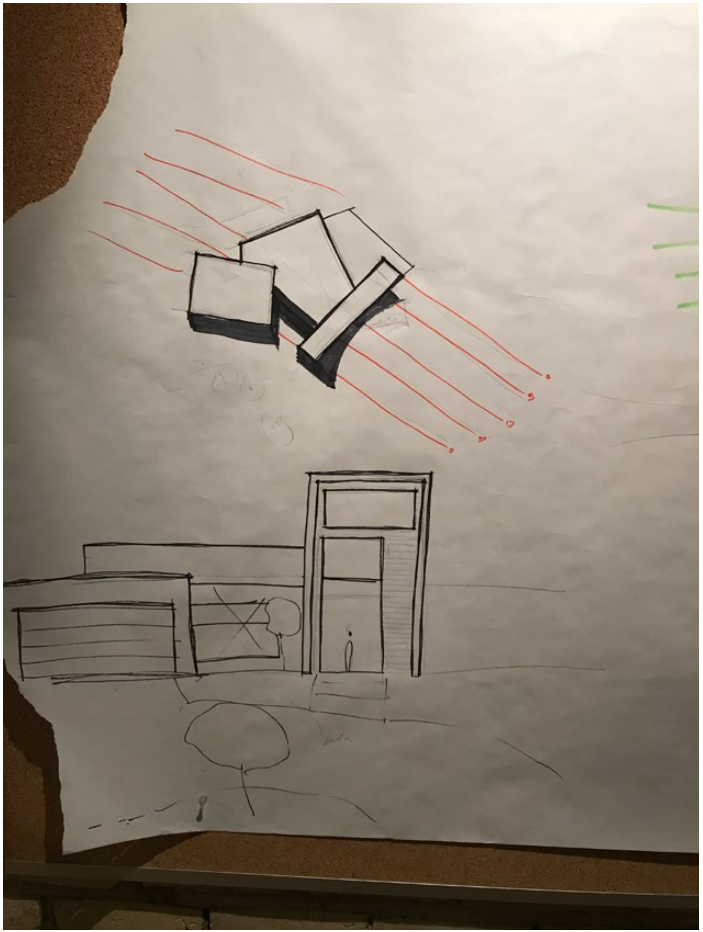
60. home sketch 1



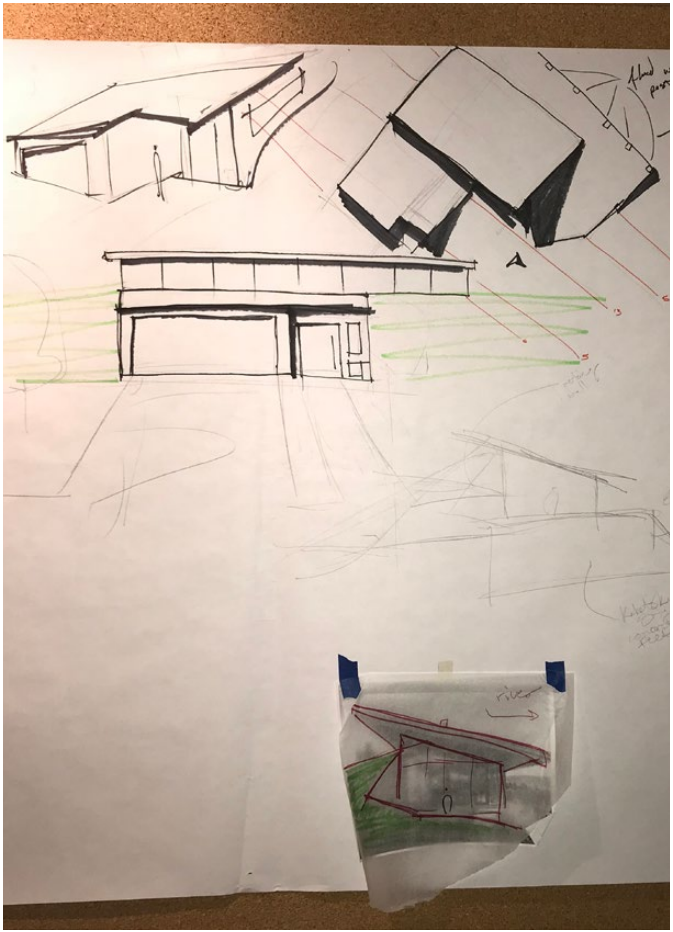
61. home sketch 2



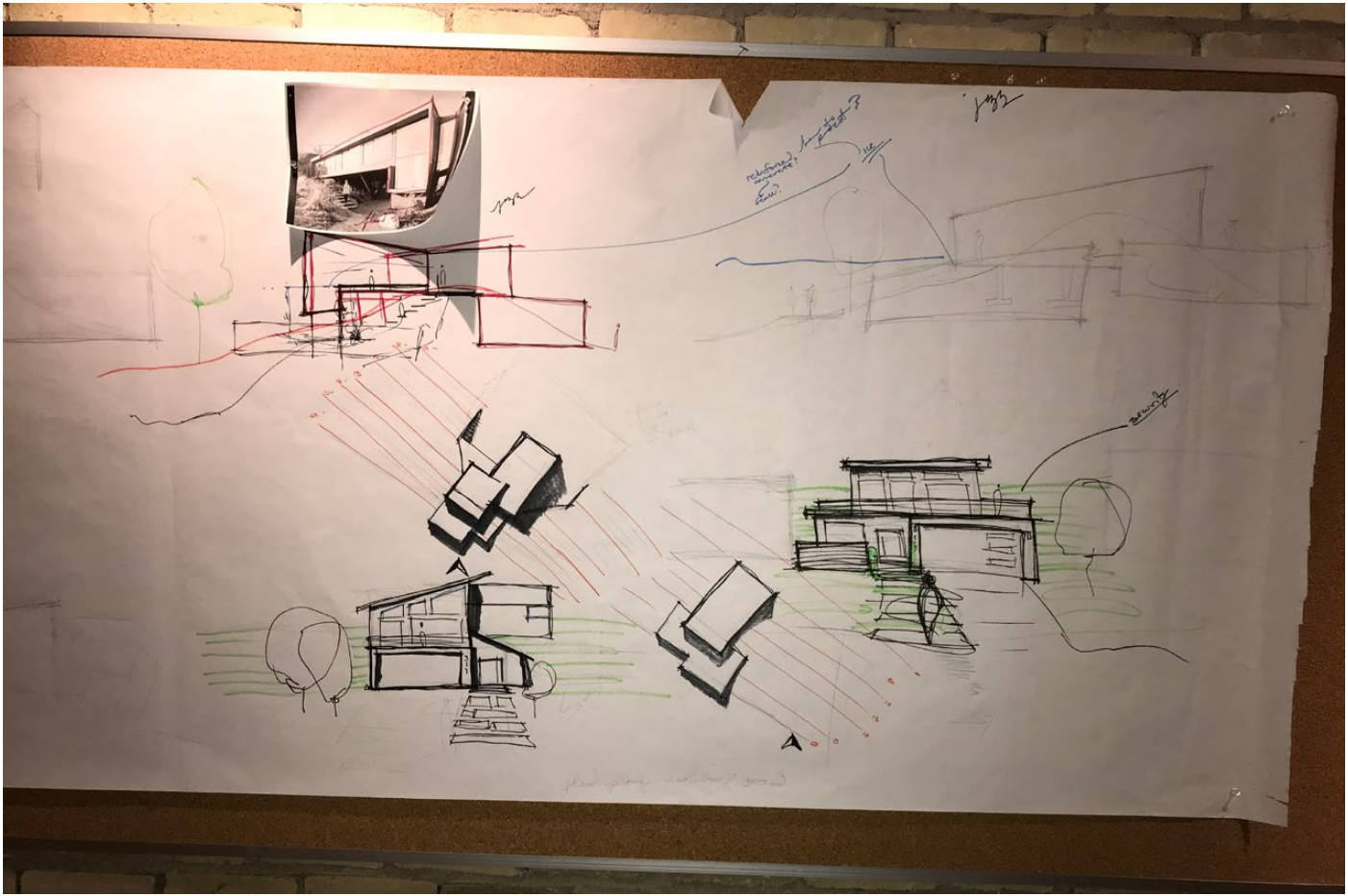
62. home sketch 3



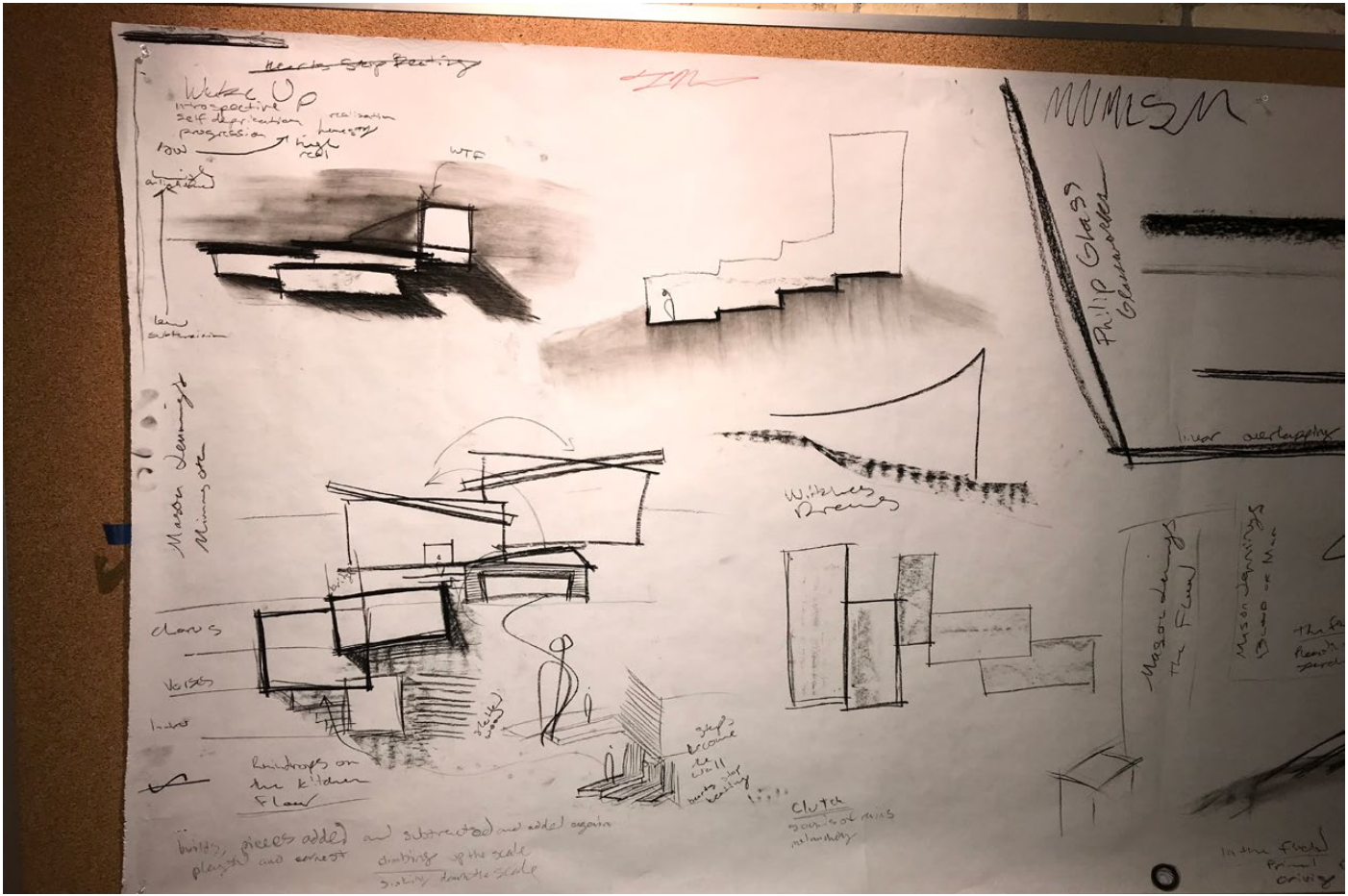
62. home sketch 3



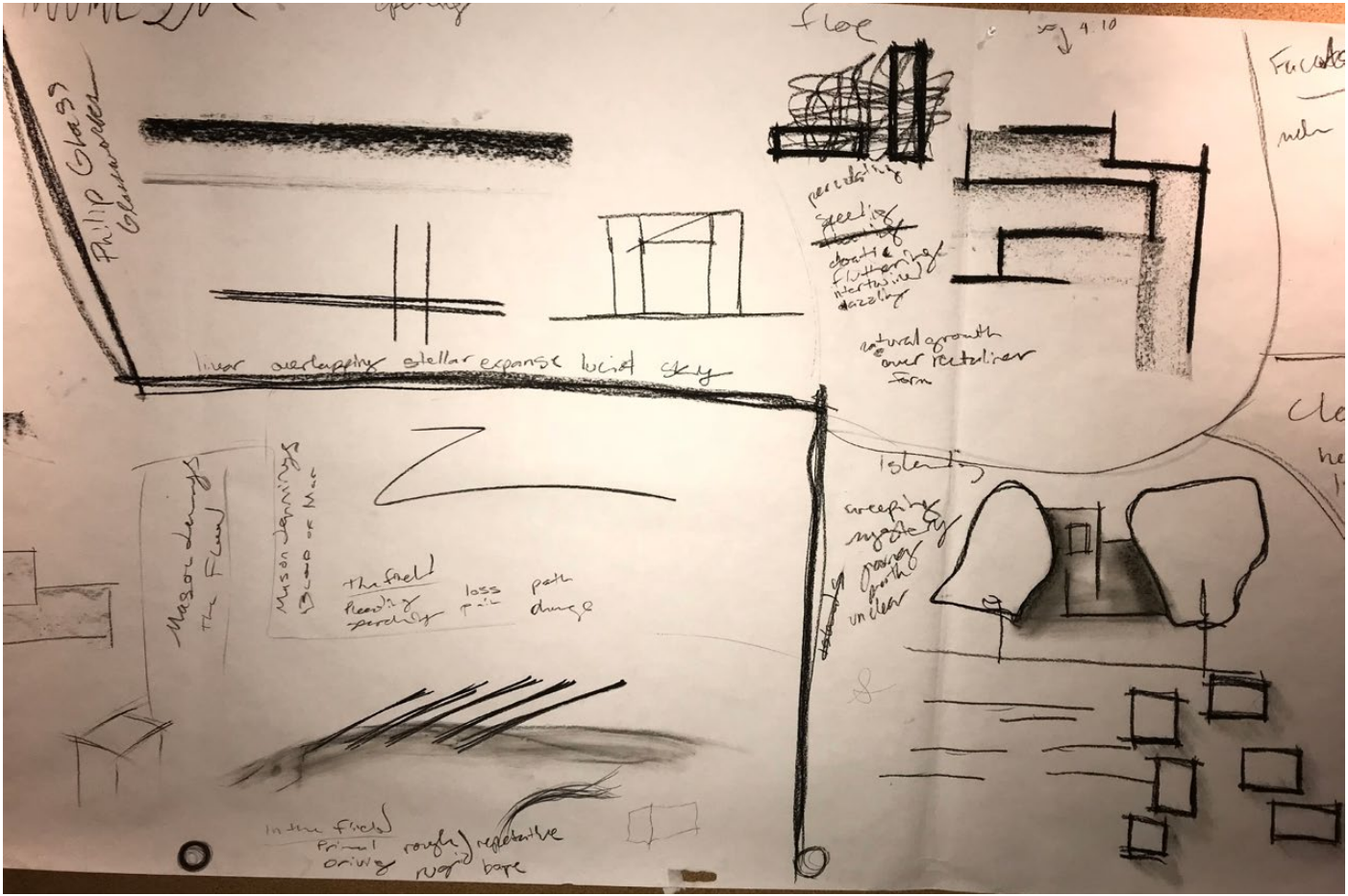
63. home sketch 4



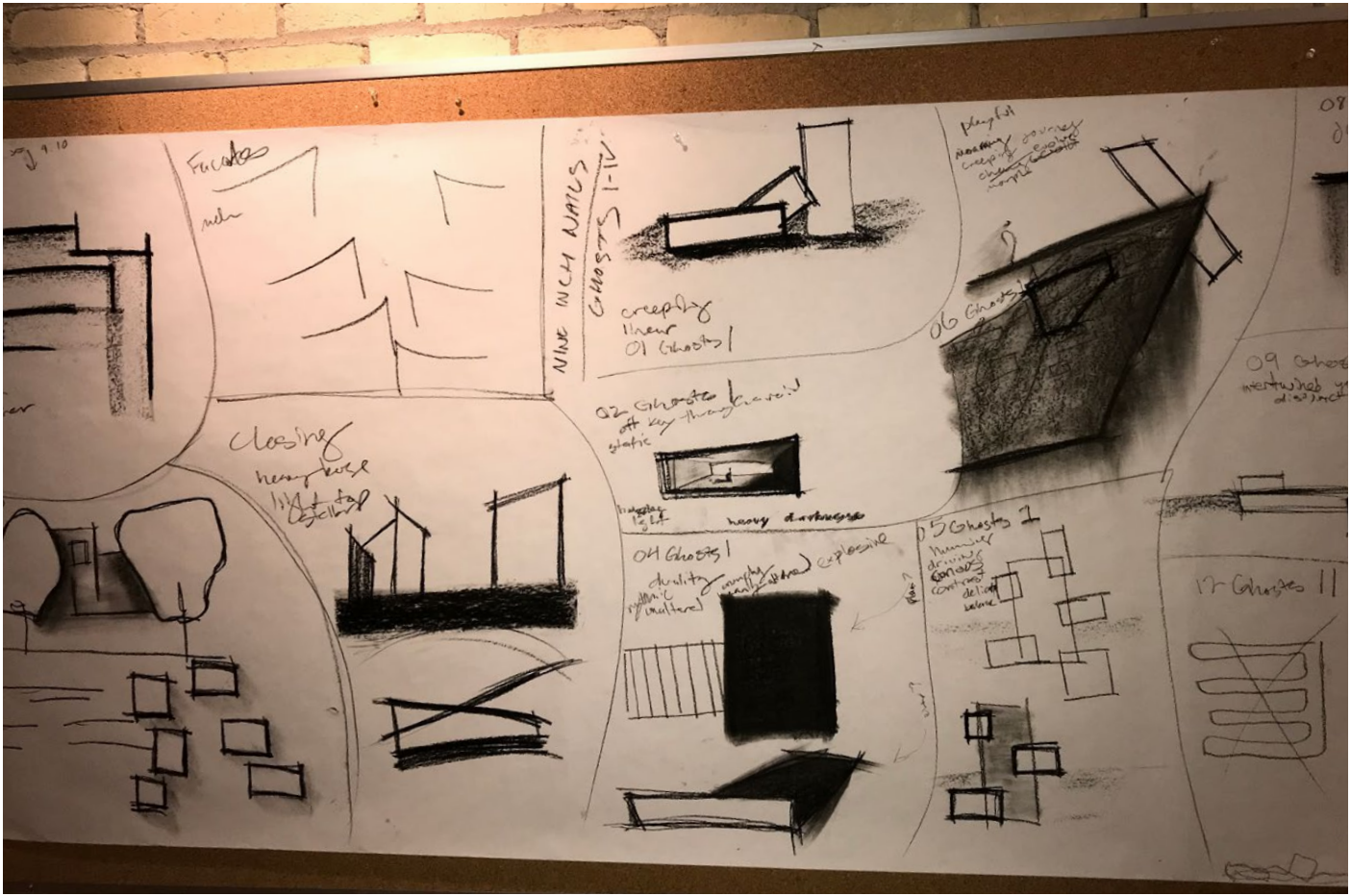
64. home sketch 5



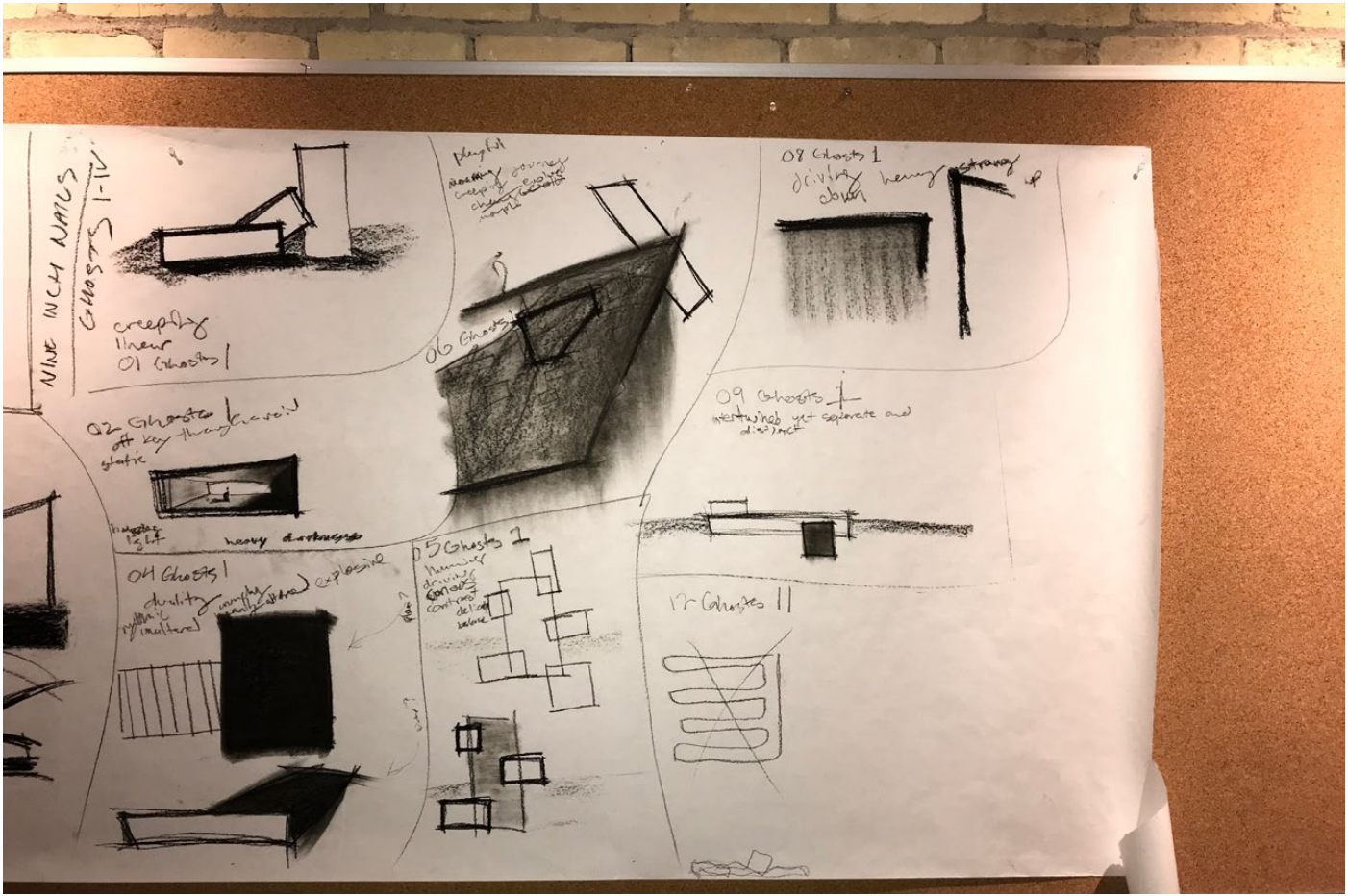
65. music form 1



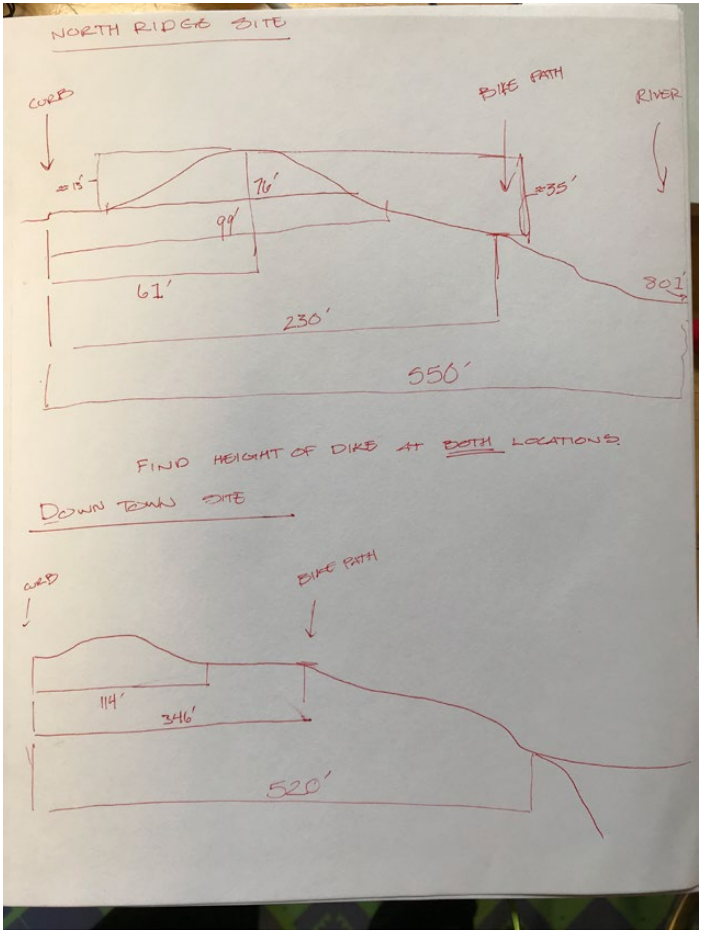
66. music form 2



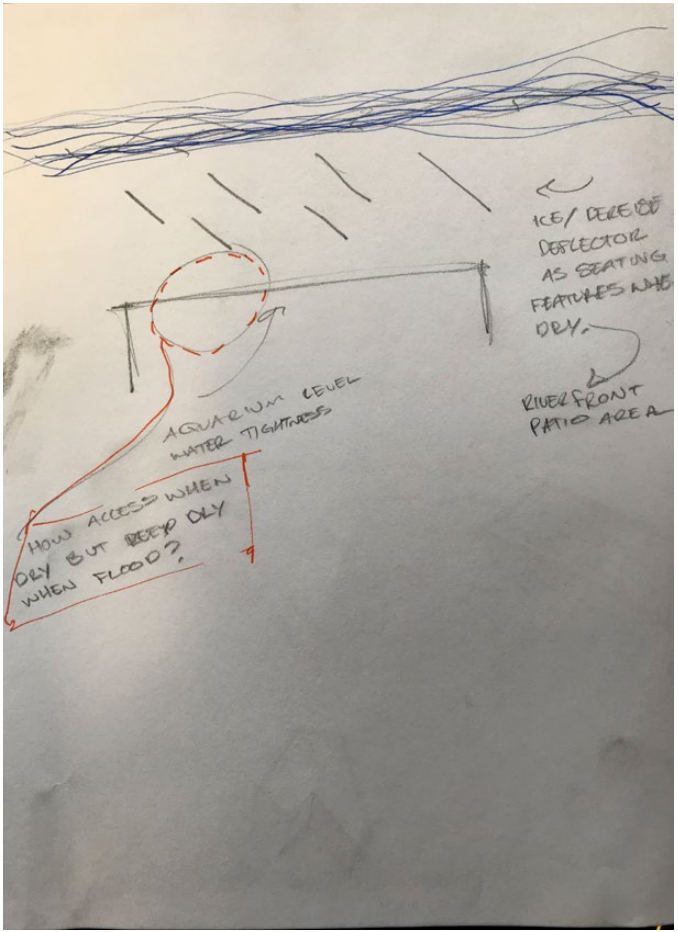
67. music form 3



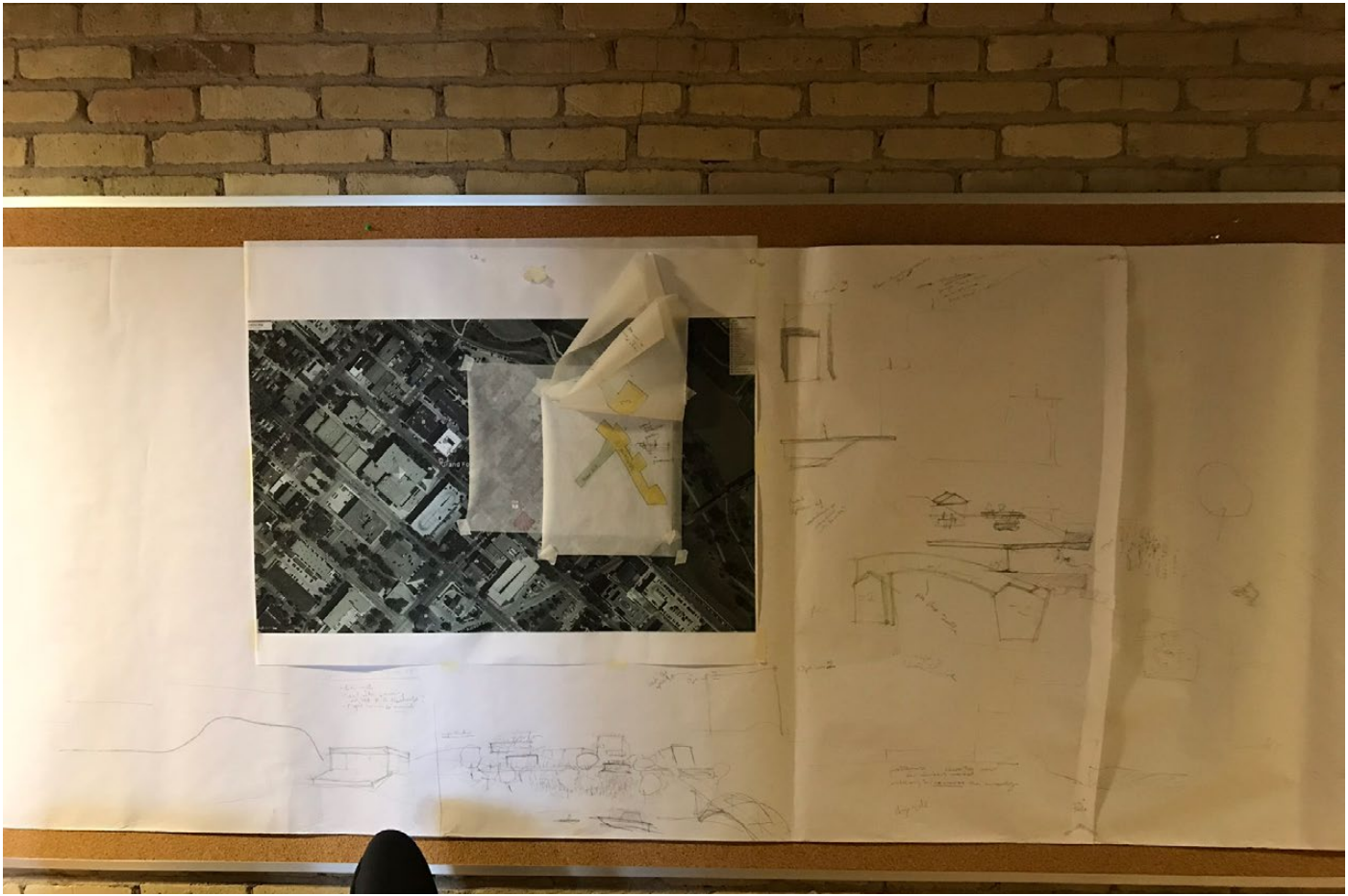
68. music form 4



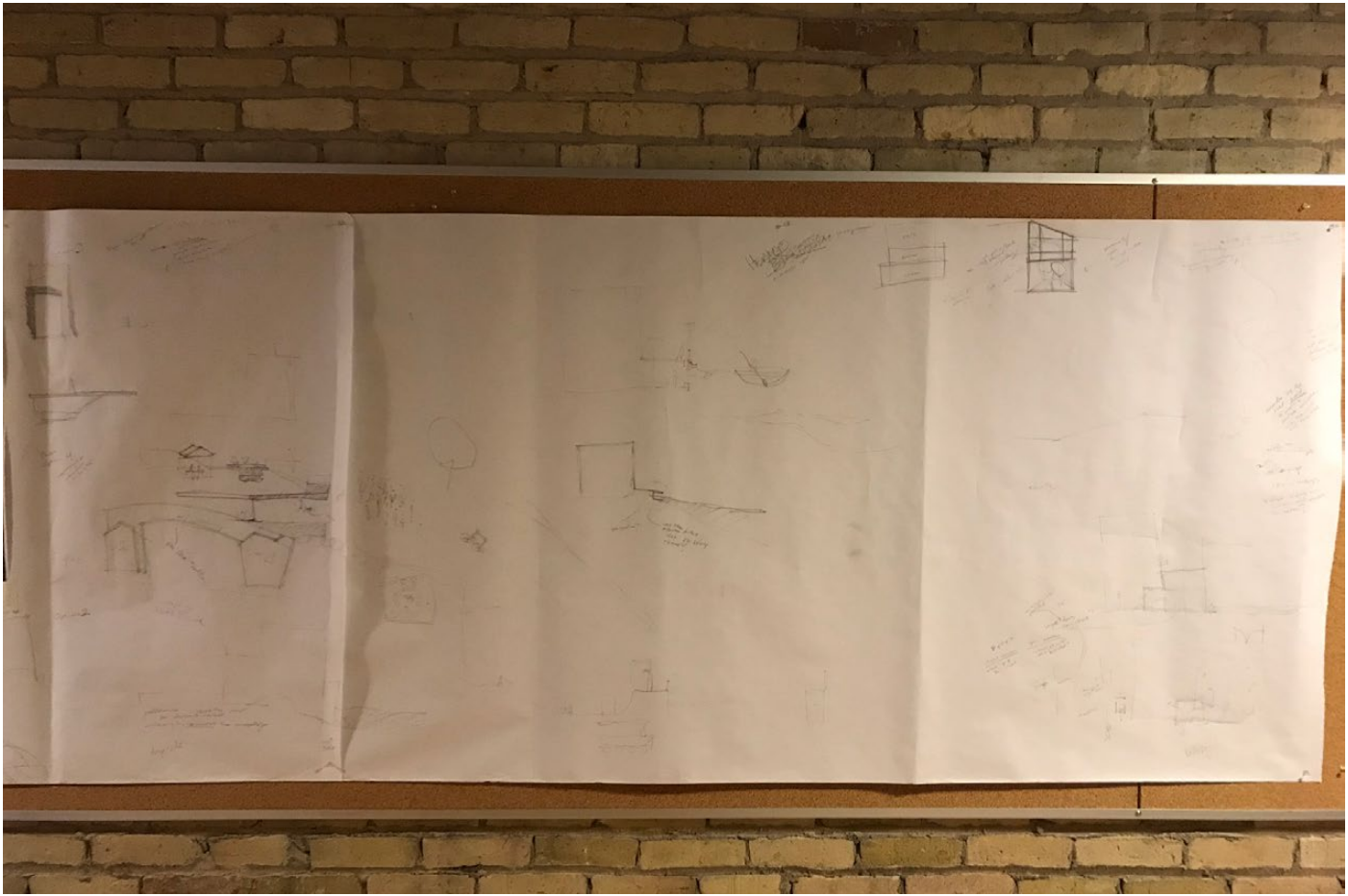
69. river section



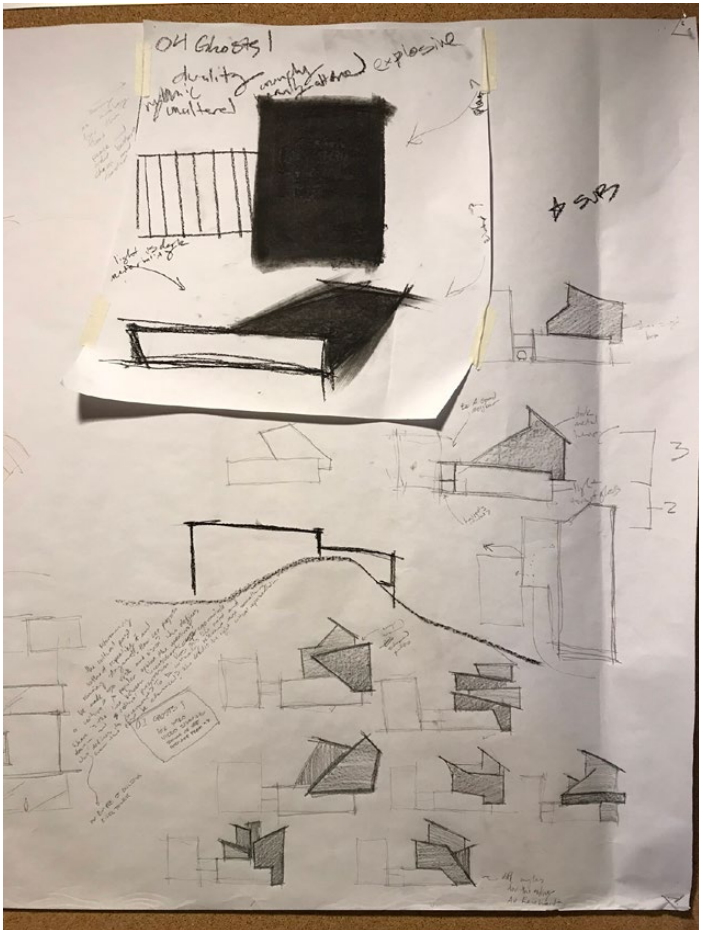
70. plan sketch



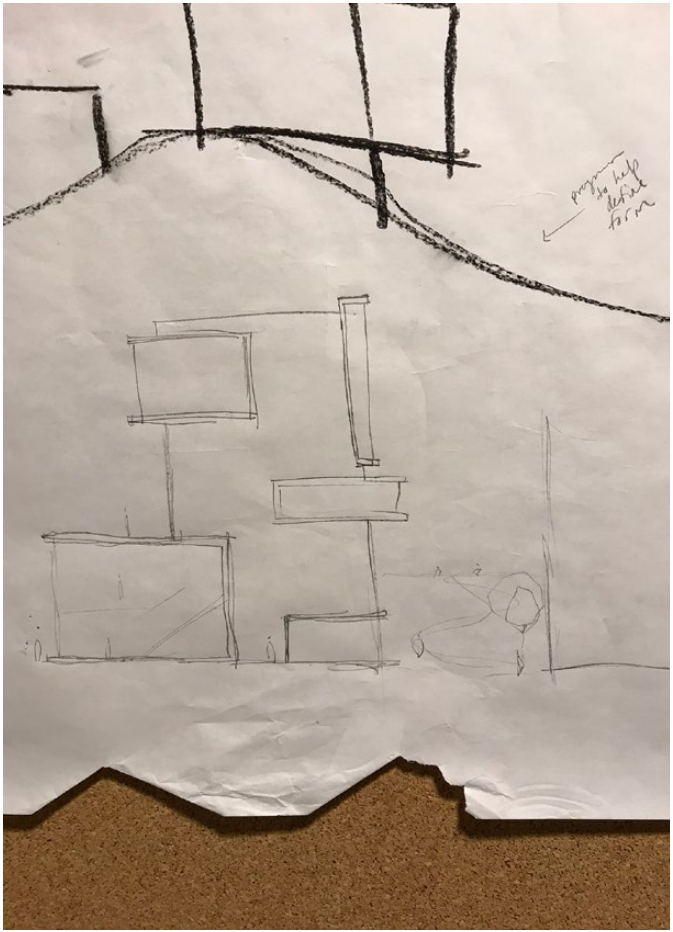
71. process sketch 1



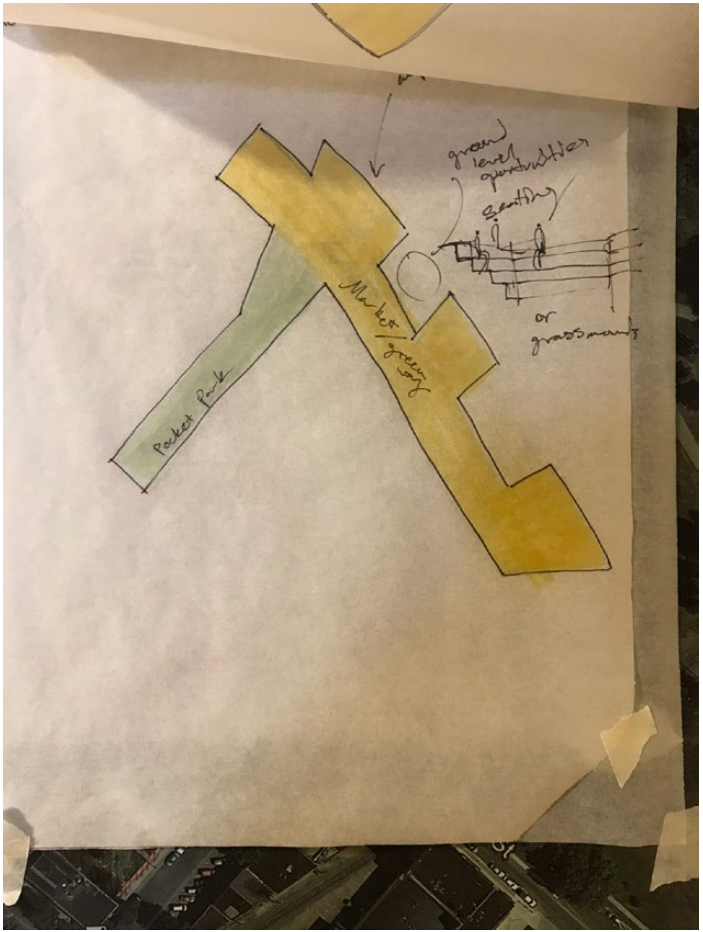
72. process sketch 2



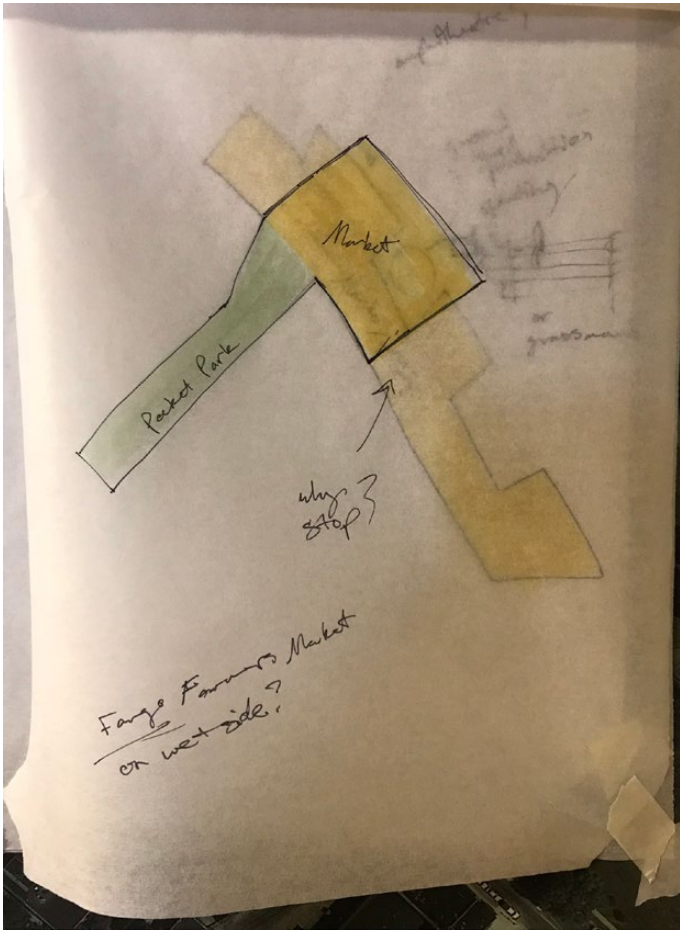
73. music as form iterations



74. music as form iterations 2

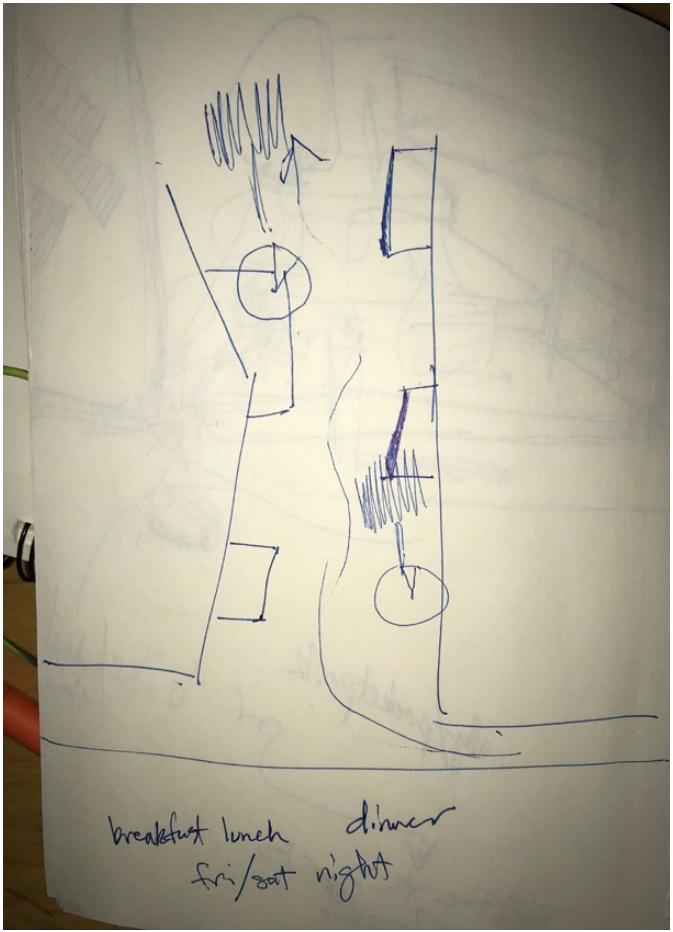


75. boardwalk sketch 1



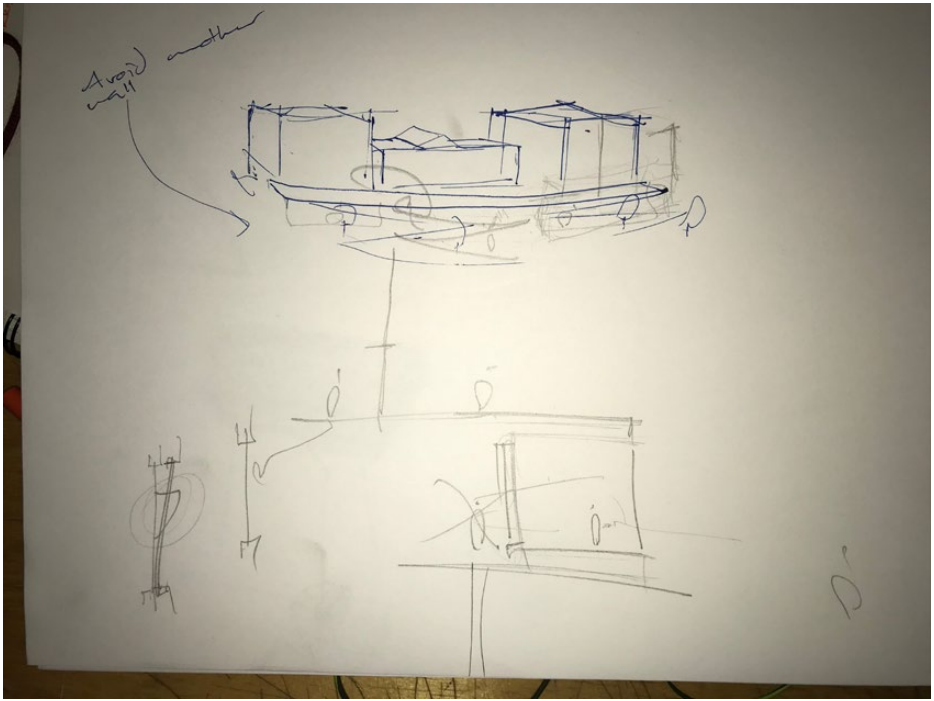
76. boardwalk sketch 2

77. pocket park sketch 1



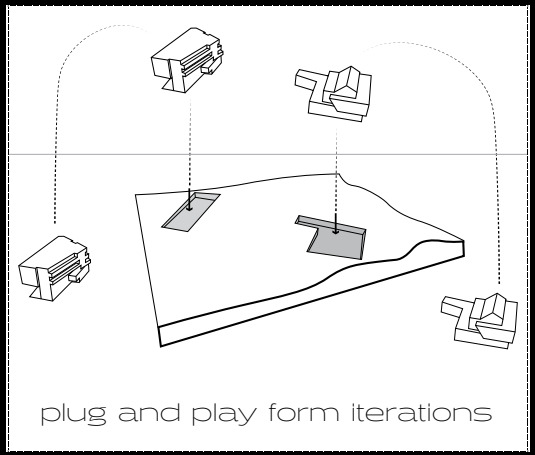
78. pocket park sketch 2

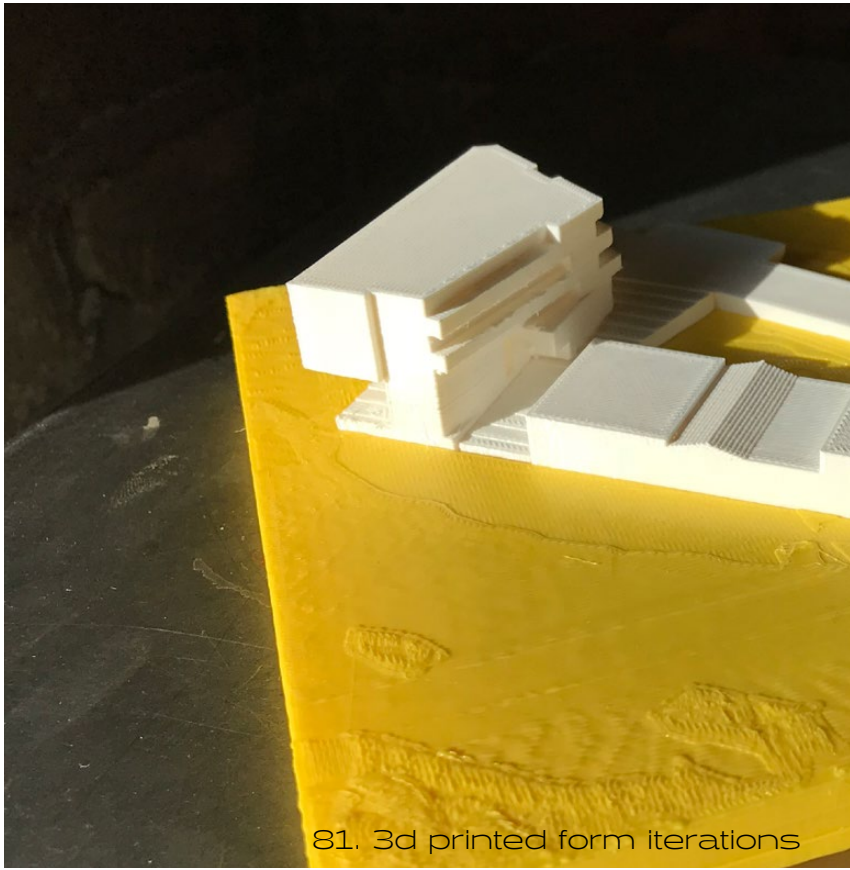
79. pocket park sketch 3



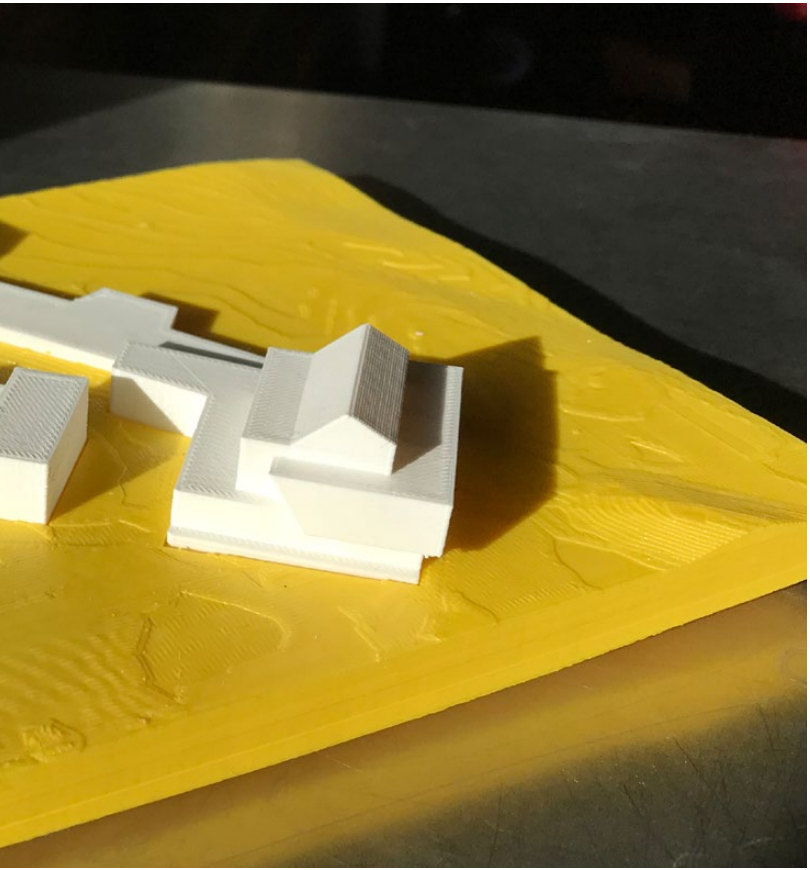
80. boardwalk sketch 3

form studies

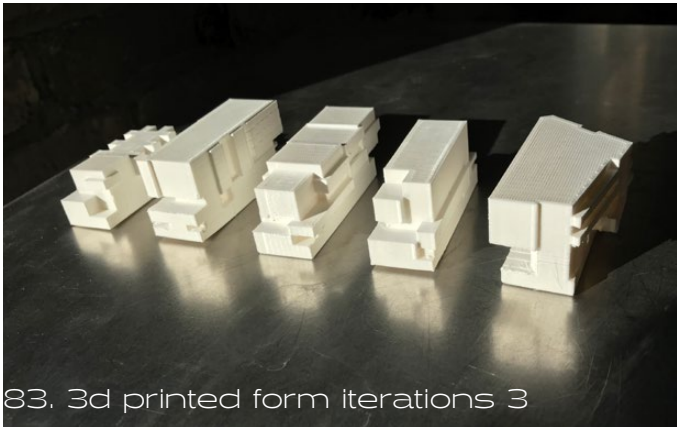




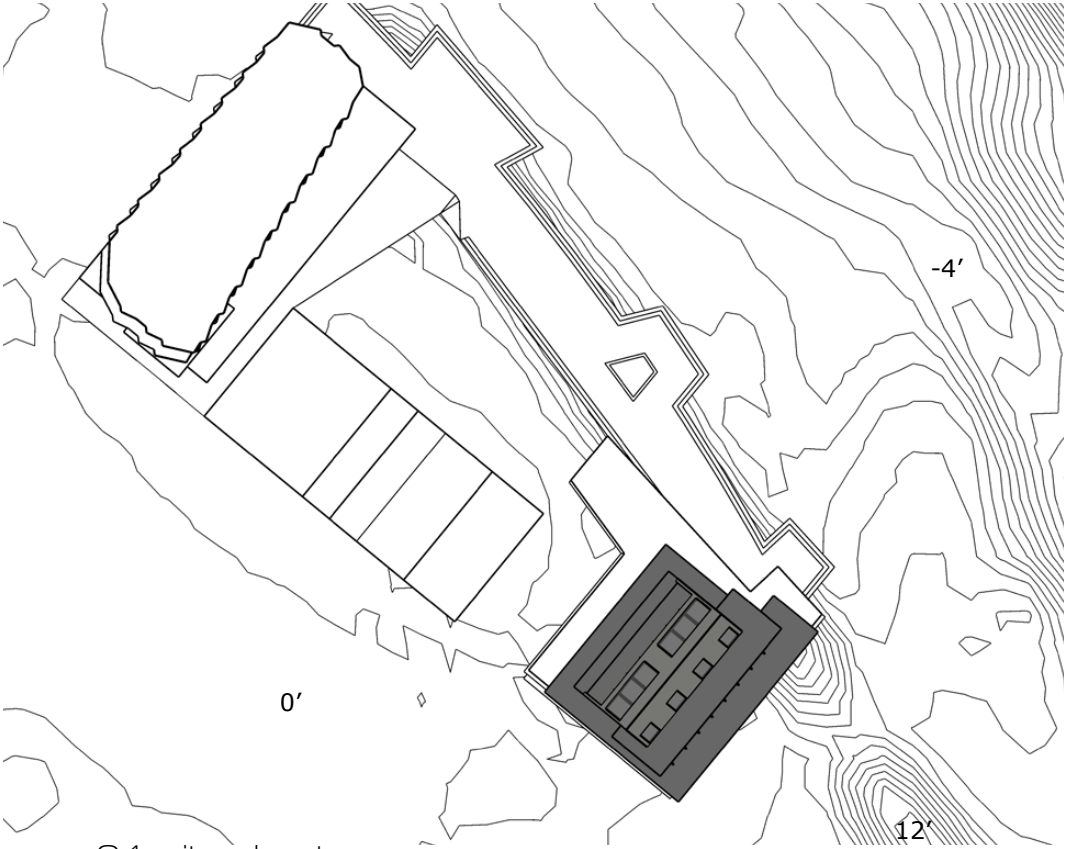
81. 3d printed form iterations



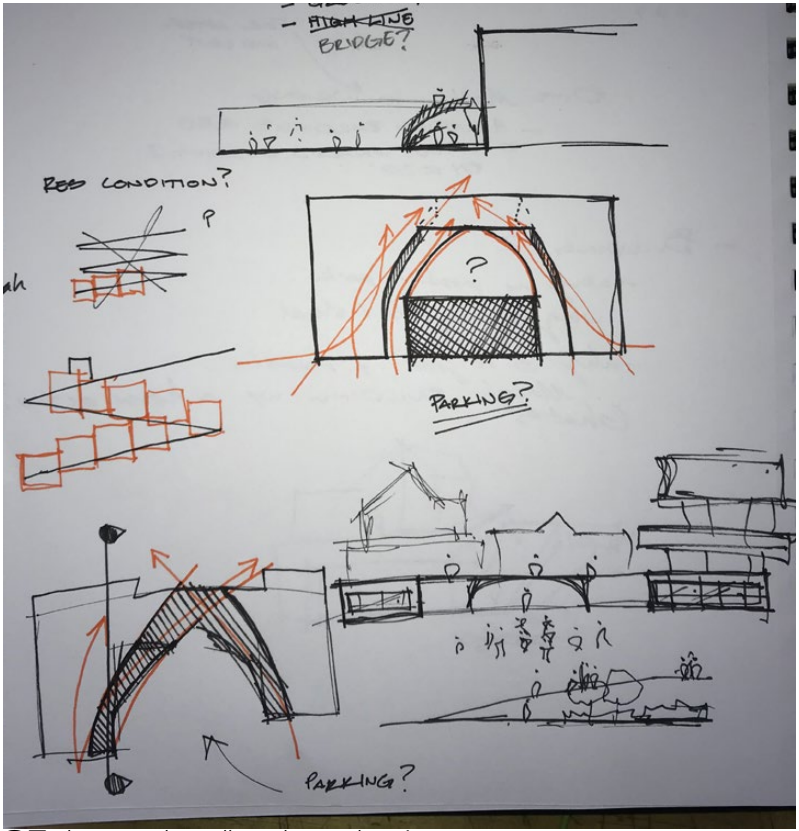
82. 3d printed form iterations 2



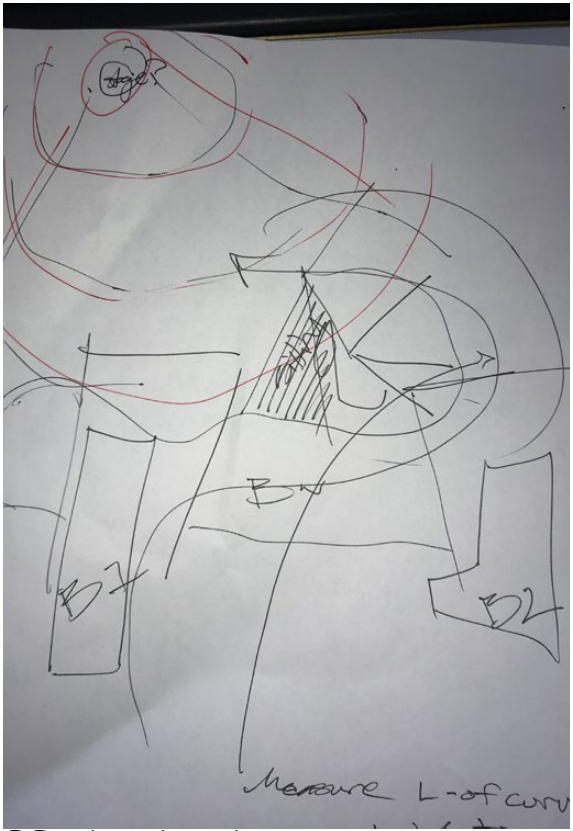
83. 3d printed form iterations 3



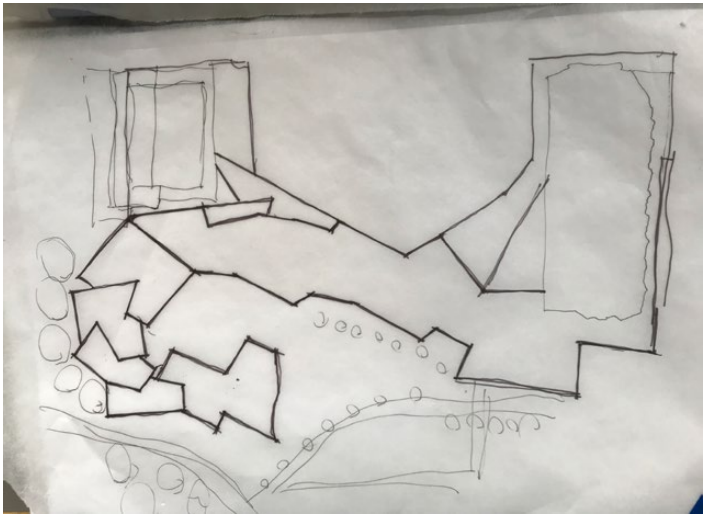
84. site plan topo



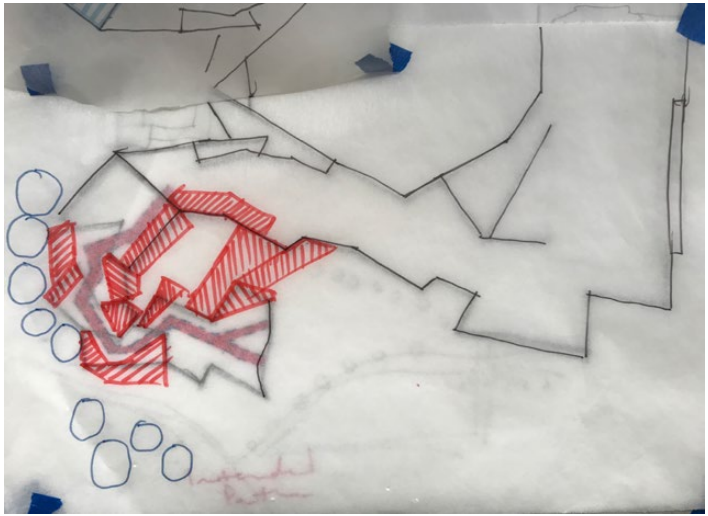
85. boardwalk sketch 4



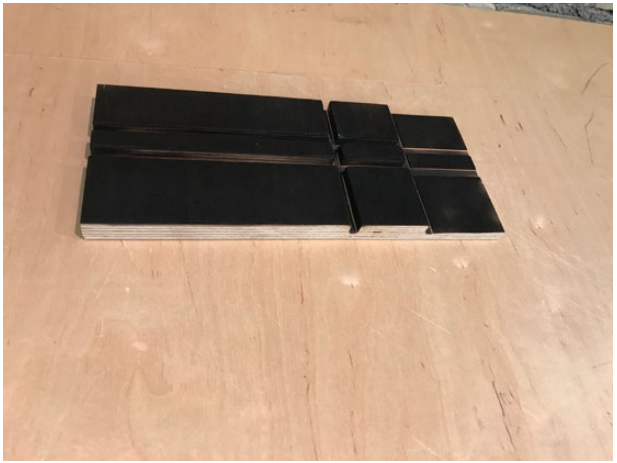
86. site sketch

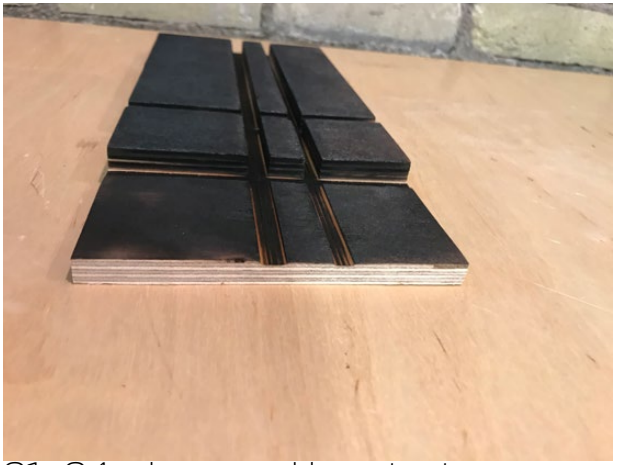


87-90. walking paths sketch

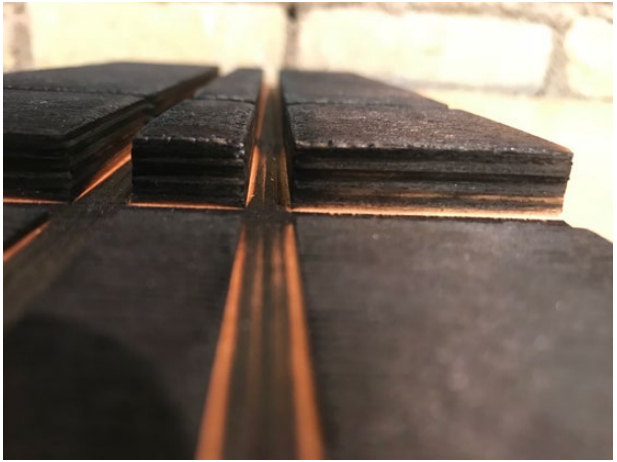


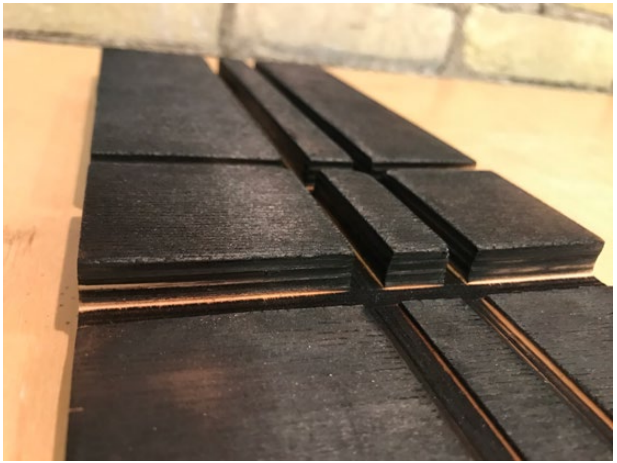

seating
resting
relaxing
areas

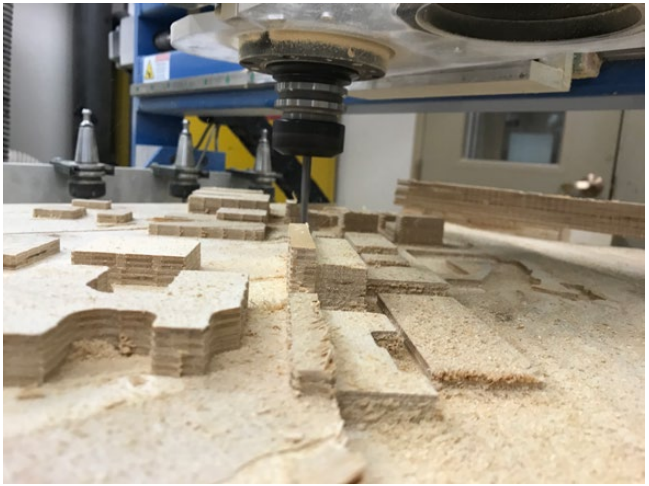




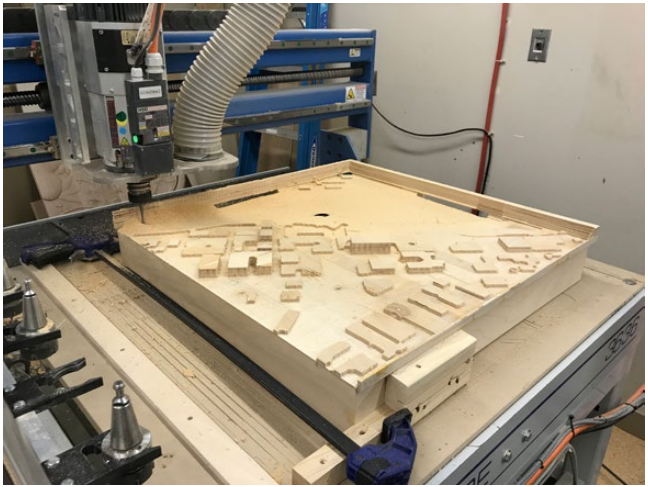
91-94. shou sugi ban test



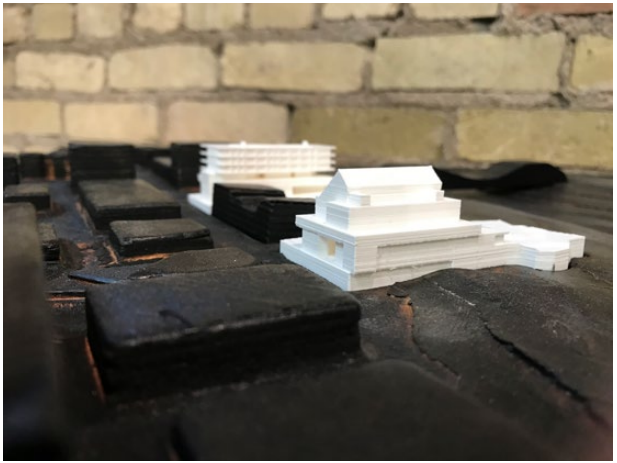


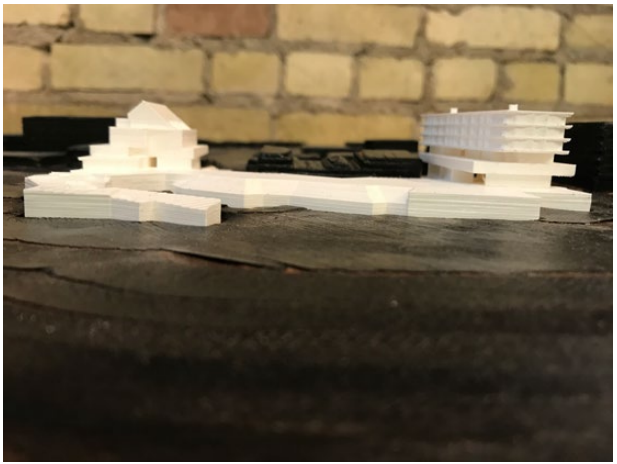


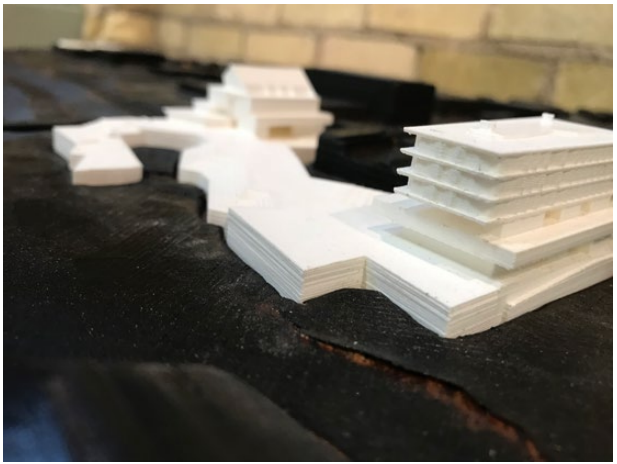
95-102. CNC model



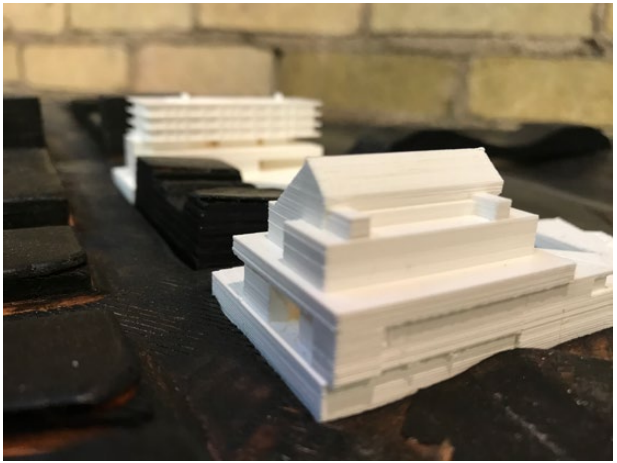

HSD

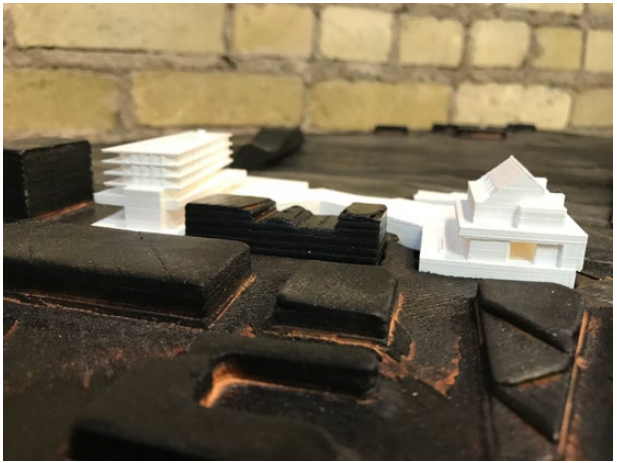


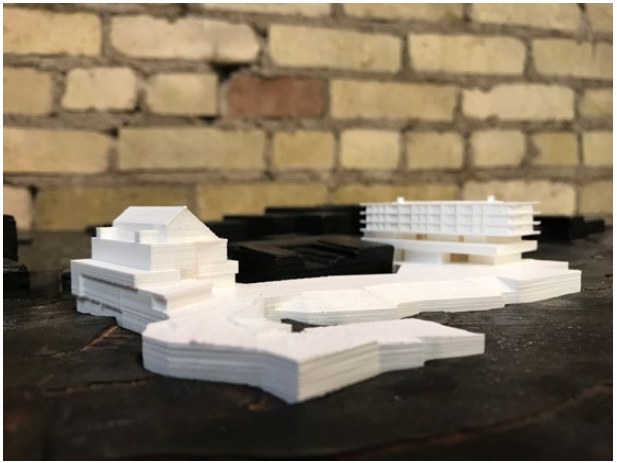




 103-110. final model







current iteration

Can building integrated flood protection provide a more mindful and holistic response to the flood of 1997 by Grand Forks, ND?

The use of building integrated flood protection solves the issues created by the wall. It brings people closer to the river again while providing flood protection. It also injects new value into the river front properties that line the city by creating physical and visual connections. This is achieved through the design of 3 major elements: 2 mixed use buildings that bridge dry-side and wet-side of the safe flood elevation. The third element is a boardwalk, and series of "ground-elements" in the form of sloping floors, ramps, and paths that gracefully transition from street "dry-side" elevation to the top of the protective flood plain elevation and then down to the numerous grade elevations on the wet-side or river-side. The sloping ground elements are placed on top of and adjacent to the current dike/flood wall, and host a variety of functions, such as the town's farmers market, winter carnival, holiday celebrations, music festivals, weddings, etc.


breach
building integrated flood protection, addressing the inadequate response
to The Flood of 1997 by the city of Grand Forks, ND.

111. exhibit

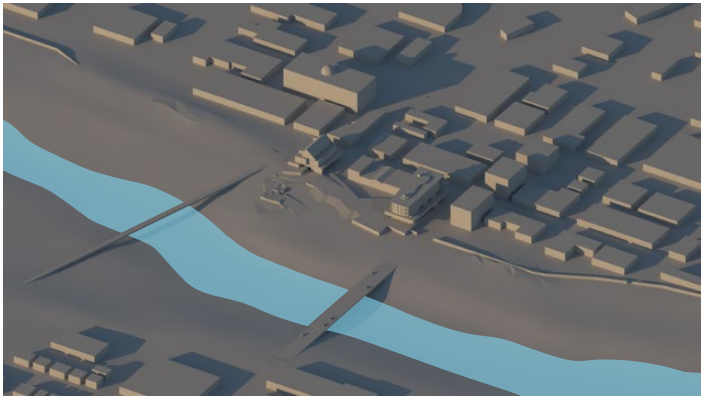
112. section model

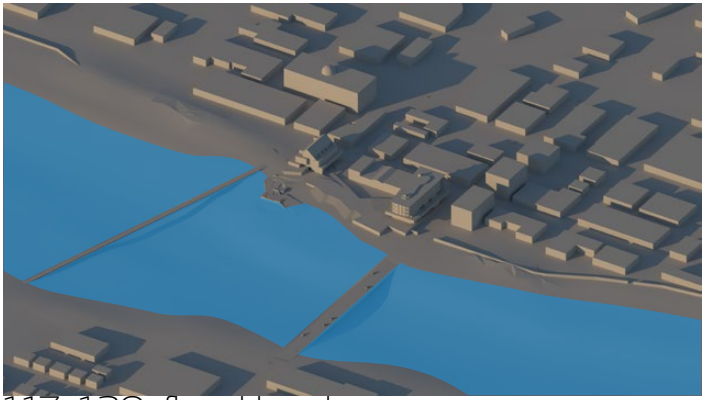
113. models

114. full model

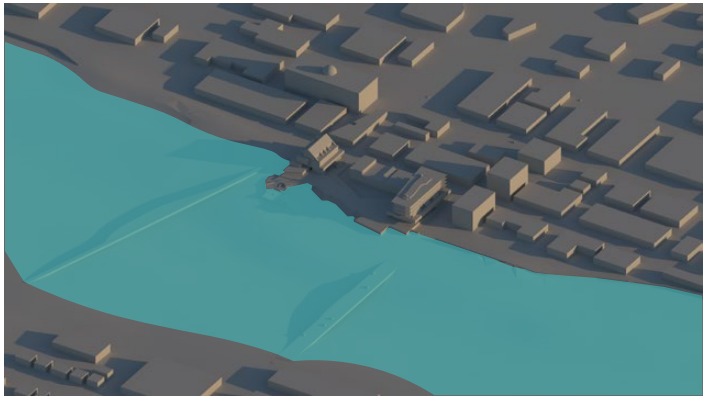
115. site plan 1

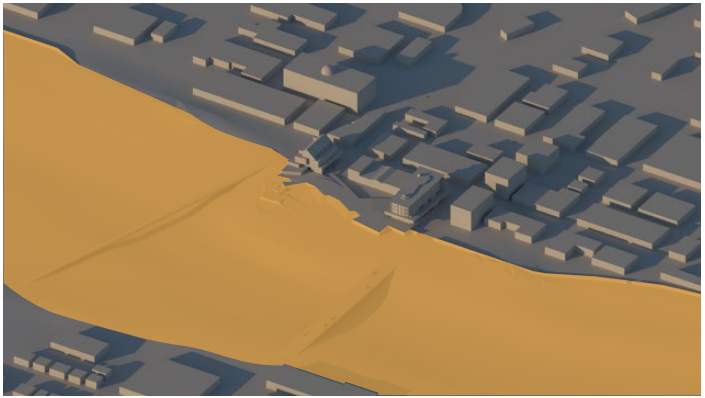
116. site plan 2



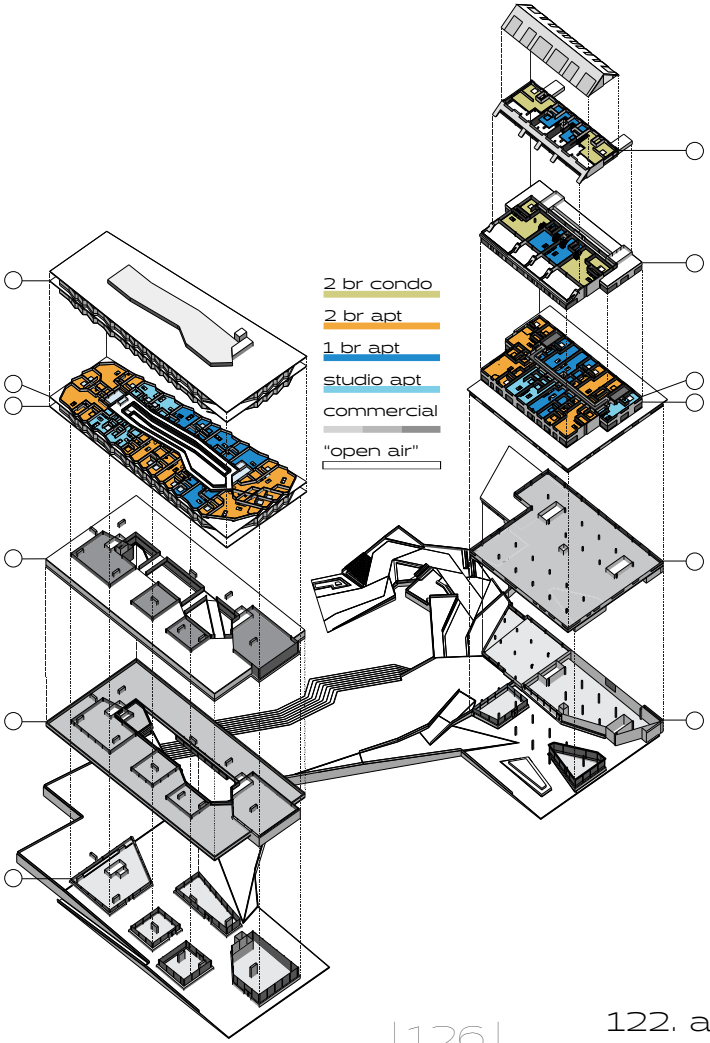


117-120. flood levels

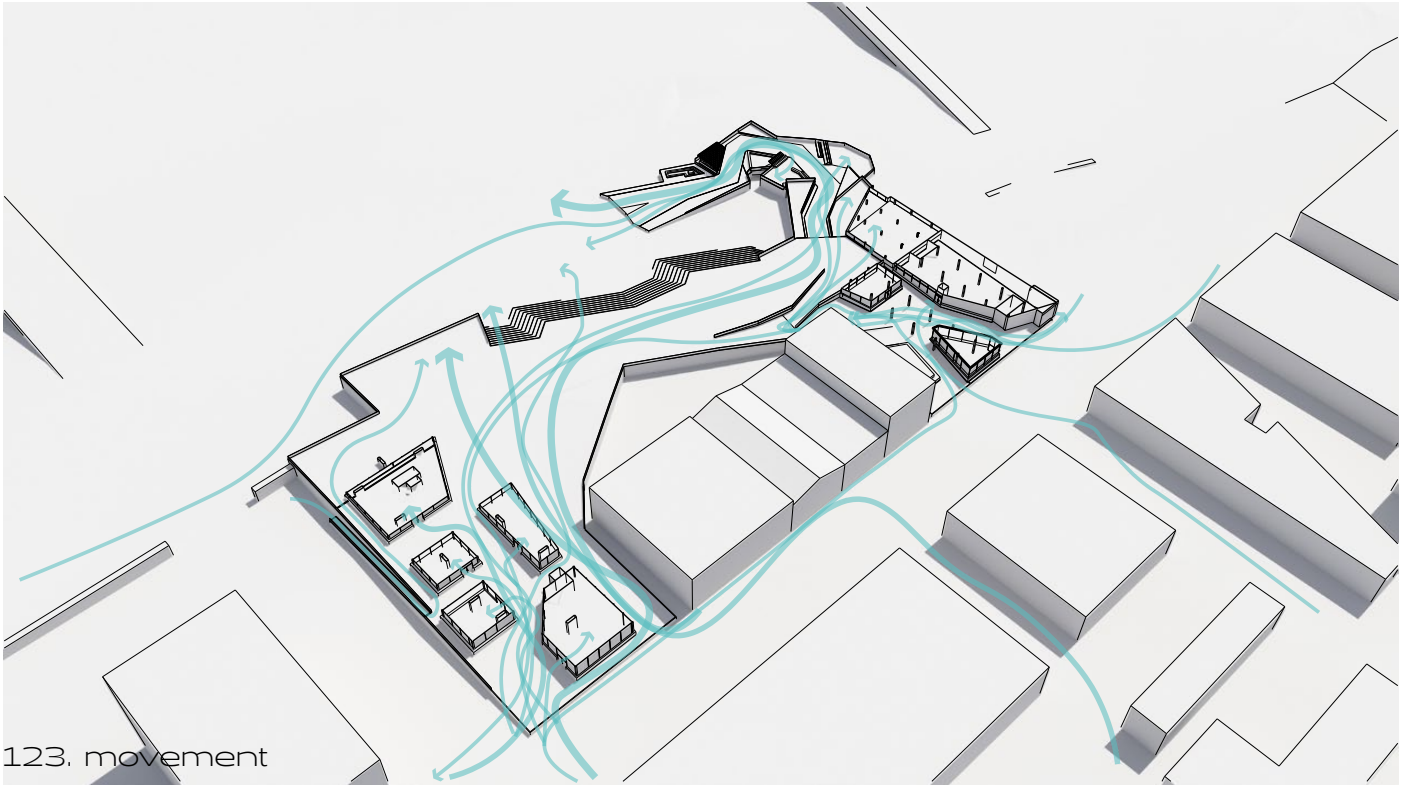




121. sections



122. axon



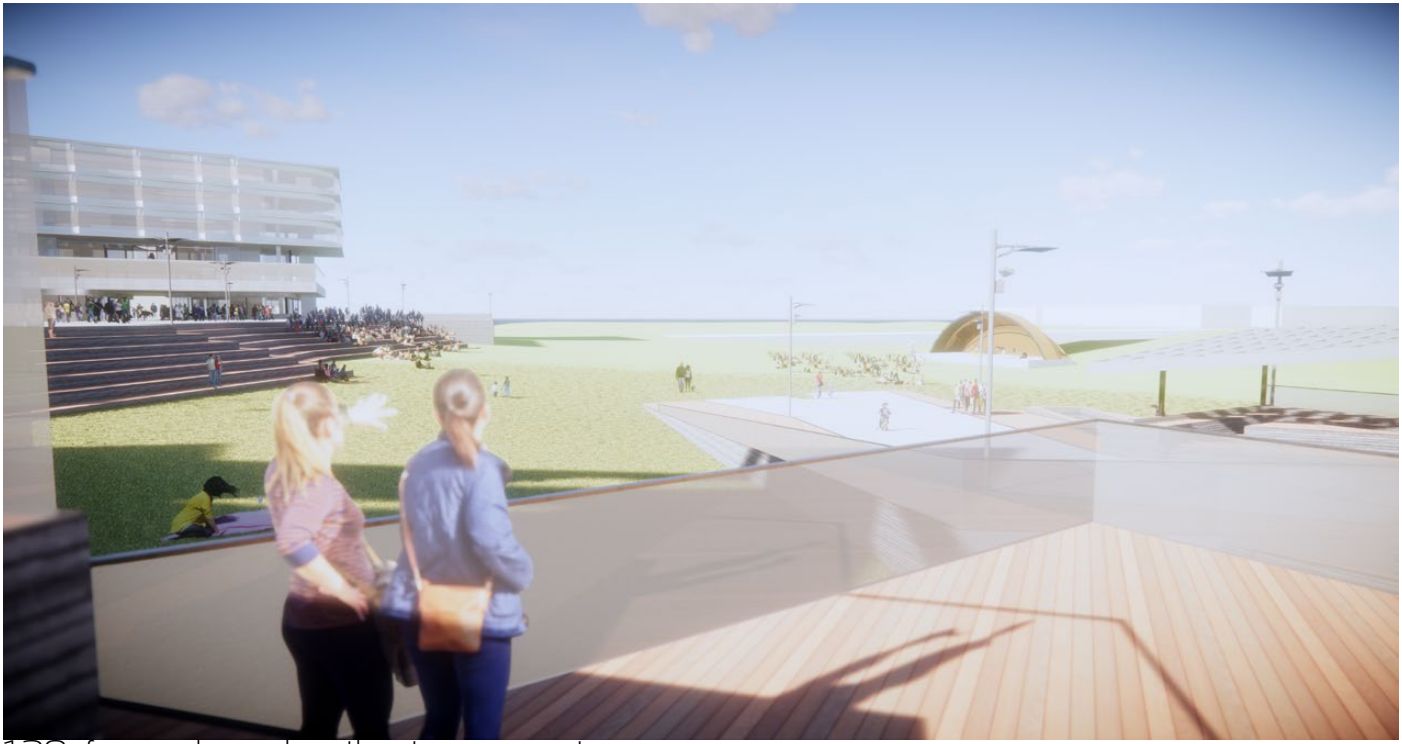
123. movement

124. atrium render

125. pocket park render 1

126. from river night render

127. from sloped paths



128. from sloped paths to concert

129. busy

130. pocket park 2

131. winter

132. to B1

133. corner render

Tanner Naastad
Grand Forks, ND
218-791-6602
tanner.m.naastad@gmail.com

2nd year
Fall - **Cindy Urness**
Tea House - Fargo, ND
Minneapolis Boat Club - Minneapolis, MN
Spring - **Darryl Booker**
Montessori School - Fargo, ND
Birdhouse - Fargo, ND
Dwelling - Cripple Creek, CO

3rd year
Fall - **Steve Martins**
Firehouse - Dell Rapids, SD
Duluth After School - Duluth, MN
Spring - **Regin Schwaen**
Basic Competition - Nekoma, ND
Kür Reborn - Berchtesgaden, DE

4th year
Fall - **Don Faulkner**
Highrise - San Fransisco, CA
Spring - **Ron Ramsay**
Marvin Windows Competition - Fargo, ND
Furniture Design - NDSU Wood-shop

5th year
Fall - **Mark Barnhouse**
Wetland Research Facility - Hawley, MN
Spring - **Malini Srivastava**
Thesis - Grand Forks, ND

Kimmelman, M., & Haner, J. (2017, June 15). The Dutch Have Solutions to Rising Seas. The World Is Watching. Retrieved November 9, 2017, from https://www.nytimes.com/interactive/2017/06/15/world/europe/climate-change-rotterdam.html

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