Executive Summary

Whisky Creek in Grand Rapids, MI separates residents of the Holland Home from the Woodlawn Ministry Center and Calvin College, forcing them to walk around long distances in sometimes treacherous conditions. The Holland Home is a retirement community, which means that the elderly are most inconvenienced by the lack of a direct path across the creek. A bridge or path project was proposed in order to provide a safe, quick, and elegant means of crossing the creek.

Challenges facing such an undertaking originate in both design and communication of the project. Logistically, many different clients could take part in the project. The creek is owned by one entity, the north bank is owned by Calvin College (with nearby land leased to the Woodlawn Ministry Center), and the south bank is owned by the Holland Home and Raybrook Estates. This requires vigilance on the part of the design team to please all parties involved and sort out responsibility for the pathway.

In designing such a pathway, the team must make some design choices. The first decision is whether or not to make a barrier-free walkway. As many people from the retirement community have physical limitations, the option to have ramps with mild slopes as opposed to stairs seems obvious. A more difficult choice is whether to build a bridge or a pathway. Some alternatives discussed are building a bridge from one bank to the other, putting
a culvert in the creek and filling the valley to create a surface for a bituminous path, or a mix of the two.

The team must complete a variety of tasks before submitting the final project. Surveying data must be finalized, as the portion of Whisky Creek which we will span is a tributary of Whisky Creek. The responsibility of the project must be decided if a bridge is to be built, with options including Calvin College, Woodlawn CRC, the Holland Home, a mixture of the previous, or a different party altogether. A final choice must also be made on the nature of the path by estimating each alternative’s worth given its possible users.
Table of Contents

1. Introduction ........................................................................................................................................... 3
   1.1 Project Location ............................................................................................................. 3
   1.2 Project Definition ........................................................................................................ 6
   1.3 Project Objectives ......................................................................................................... 9

2. Background ......................................................................................................................................... 10
   2.1 Bridge Standards ........................................................................................................ 10
   2.2 Holland Home ............................................................................................................. 11
   2.3 Ministry Center .......................................................................................................... 12

3 Site Conditions ................................................................................................................................... 13
   3.1 Elevations/Contour Map .......................................................................................... 13
   3.2 Soil Characteristics .................................................................................................... 15
   3.3 Creek Characteristics ................................................................................................. 16

4 Design Approach .............................................................................................................................. 18
   4.1 Challenges .................................................................................................................. 18
   4.2 Design Norms ............................................................................................................. 19

5 Preliminary Design ........................................................................................................................... 20
   5.1 Design Selection ......................................................................................................... 20
   5.2 Location Selection .................................................................................................... 22

6 Alternative Solutions .......................................................................................................................... 24

7 Conclusions ........................................................................................................................................ 24

Acknowledgements ............................................................................................................................ 26
References..............................................................................................................................................27

Appendices..................................................................................................................................................28

List of Figures

Figure 1: Aerial View of Whisky Creek.................................................................................................6
Figure 2: Current Path from Retirement Communities.........................................................................7
Figure 3: Proposed Solution.......................................................................................................................8
Figure 4: Topographical Map of Whisky Creek and the Surrounding Area.........................................14
Figure 5: Soil Properties of Whisky Creek and the Surrounding Area..............................................16
Figure 6: Possible Locations to Span Whisky Creek..........................................................................17
Figure 7: Vegetation around Whisky Creek.........................................................................................21
Figure 8: Location Selection for Path...................................................................................................22
Figure 9: Proposed Meeting with Ministry Center Parking Lot...............................................................23
1. Introduction

1.1 Project Location

Our project includes designing a route over Whisky Creek. The area of interest for this project is located just south of Calvin’s Burton entrance. This location was chosen for the bridge because it would create a convenient route to Calvin’s campus from the area south of Whisky Creek. The bridge will be primarily used by the retirement community on the south side of the creek. Residents that live in both Raybrook Homes and the Holland Home travel to Calvin’s campus regularly for both Calvin events and to attend Woodlawn Christian Reformed Church, which is located on Calvin’s campus. On the north side of the creek is a building called the Woodlawn CRC Ministry Center. This building is owned and operated by Woodlawn CRC. The land is owned by Calvin College and leased to Woodlawn CRC every year. At this point the bridge location can be narrowed down to about a 100 foot section of the creek. Figure 1 shows an aerial view of Whisky Creek and the area surrounding.
1.2 Project Definition and Mission Statement

Our mission statement is to provide a safe, aesthetically pleasing, and environmentally friendly route across Whisky Creek. This route is to meet the needs of the retirement community and sufficiently provide them with a quick and safe route to commute to Calvin’s campus. Another purpose of this project is to explore the structural analysis that goes into such a project, and to design of the best and most cost efficient route for this location and clientele. The residents of the Raybrook Homes currently take alternative route to Calvin that is both long and unsafe. Figure 2 shows the current path from the retirement communities.
Figure 2: Current Path from Retirement Communities

Figure 2 shows the current path from the retirement communities to Calvin’s campus outlined in red. It requires people to walk north northeast down Raybrook Drive, then meet up with Burton St. across from Calvin’s Seminary. From there pedestrians can cross Burton St. and walk to Calvin Seminary, or walk west down Burton St. and cross at the Burton St. entrance to Calvin. Our goal is to design a safe and convenient way to travel to Calvin’s campus that will not
cost more than necessary or ruin the surrounding environment. Figure 3 shows the proposed solution.

![Figure 3: Proposed Solution](image)

Figure 3 shows the proposed solution of a route that spans Whisky Creek which follows the wooded area. It would connect either from the nearby road or by a path to be built on the south end. On the north end it would connect to the Woodlawn CRC Ministry Center parking lot. This will allow people from the retirement communities to have a shorter, safer walk to Calvin’s campus.
1.3 Project Objectives

The project is first and foremost to design a route that will sufficiently meet the needs of the retirement community of Raybrook Homes. This bridge will be primarily used by the retirement community and will therefore need to be suited best for the elderly and/or physically impaired. The route will therefore have to remain safe in the winter or when wet without causing any danger to its user. Another important factor to us is keeping the route barrier free. This means that we should have any steps as part of the route to allow for small vehicles to pass such as golf carts, wheelchairs, or bicycles. Due to our clientele we will also need to minimize the use of ramps or a slope in our bridge or path which could prove to be unsafe for the elderly to walk over.

Another big concern of this project is to keep it cost efficient. We do not want to design a route that will cost too much and make the construction of such a bridge not worthwhile. This will then decide whether steel, wood, or a culvert with a path overtop is used to design the route. Possibly a prefabricated bridge of precast concrete could be used in the design of this bridge to help cut down on the costs. Many options are being considered at this time to find the most cost effective type of bridge possible.
The bridge or path design must also meet all of the required codes and have all of the needed permits for construction. It must not disrupt the surrounding environment or ruin the scenic view of the creek for the local residents. The bridge is meant to fit in with its surroundings as much as possible.

2. Background

2.1 Bridge Standards

The project must provide safe, reliable transport from one bank of the creek to the other while neglecting to impact the area negatively. This means that any structure built must either be high enough above the creek to avoid any negative upstream or downstream effects, or the proper permits must be attained. Hydraulic analysis will be necessary using programs such as Hydraulic Engineering Center-Hydrologic Modeling System (HEC-HMS) and Hydraulic Engineering Center-River Analysis Software (HEC-RAS) to analyze the watershed and water surface profiles.

The project, whether it is a bridge or some other means of conveyance, must also safely bear the loads needed without failing. This will require determining the ultimate load which the bridge or path will need to be designed for. The loads the path must withstand depend on the usage. Since this is being designed for use by a retirement community, it is wise to assume live loads of at least people and some small equipment such as bicycles, wheelchairs, or
potentially golf carts. Also, the variable climate must be included in any design, since this project will be outside. Both snow and wind loads must be taken into account for any bridge. Expansion and contraction due to temperature changes can affect the path in various ways, depending on the materials used. If a culvert with backfill and a bituminous pathway are chosen, these factors will implicate the depth of the fill and pathway.

In addition, longevity must be a concern of the project. This alternative to crossing Whisky Creek further upstream or downstream must be reasonably durable, so as not to waste time, money, and effort in its design and construction. It is responsible to be concerned with the lasting impact of such a project as well as the immediate benefits.

The team’s personal standards for the pathway are to create an effective, harmonious means for many different types of people to cross from the Holland Home bank of Whisky River to arrive at the Woodlawn Ministry Center. By accounting for the proper loads and choosing wise materials, the project can become of service to the community for many years to come.

2.2 Holland Home

This project exists to aid any in traveling across Whisky Creek. One of the main clients of the project is the Holland Home. The Holland Home is a retirement community on the south bank of Whisky Creek. Residents of the Holland Home have a variety of physical constraints. For this reason, the project would ideally be designed barrier-free.
By submitting a barrier-free design, the team could garner more use out of the project, allowing travel to many people who would not be able to otherwise access the passage. Scott Hull, the Director of Environmental/Facility Services at the Holland Home, has expressed that though a barrier-free design would be ideal, the Holland Home may not have the funds to finance such an undertaking. He suggested that scope of the project be variable between alternatives, with special consideration given to cost.

2.3 Woodlawn CRC

Many of the users of the path or bridge would be attendees of Woodlawn CRC. A bridge or culvert with a path overtop the creek would give some of the attendees a convenient way to get to Calvin’s chapel to attend worship at Woodlawn CRC. This is the primary client of the project. One of Woodlawn CRC’s members, Calvin Engineering Professor J. Aubrey Sykes, brought the project to the senior design team as a possibility. Woodlawn CRC tends to be very successful in raising funds for their projects, leaving money as less of a constraint than for the Holland Home.

A path through over the creek would benefit Woodlawn even though they are technically not the landowner. Calvin College owns the land the Woodlawn Ministry Center rests on and leases it to the church for very little cost for the next 99 years, according to Phil Beezhold of Calvin’s Physical Plant. Also, to reiterate, Woodlawn CRC’s services are held in the
Calvin College chapel, which further demonstrates the need to involve the college in any decision about a bridge or culvert across Whisky Creek.

With Calvin College involved in any decision regarding a bridge across Whisky Creek, it has been necessary to stay in contact with the college. As previously mentioned, Phil Beezhold has been the main contact for the project thus far, but it may also be necessary to speak with Frank Gorman, the college’s architect. He and the college may have requirements about any structure they would endorse, such as inclusion of brick colored to match the Calvin motif.

3. Site Conditions

3.1 Elevations and Topographic Maps

Due to the location of the bridge site, determining the elevations and obtaining topographic maps is an important step. The site consists of a ravine ranging from 18 feet deep on one side to 10 feet deep on the other, with Whisky Creek flowing at the bottom of the ravine. Because the creek is small at this point, there are several alternative paths between the two sides other than just a bridge from the top of one bank to the top of the other bank. The topographical data plays a key role while considering alternative bridge designs. The elevations are especially important in determining how to account for the elevation different between the two banks. If the bridge was a straight shot across the ravine, then the elevations would determine the slope of the bridge and whether a curve would be needed to increase the bridge
length and decrease the slope. Also, the contour maps would be necessary in deciding path
and steps locations if a culvert or shorter bridge was used lower in the ravine.

Topographical data was provided by Brad Boomstra from Kent County Drain
Commission. The topographical map shows two foot contours for the entire area. The
topographical map of the bridge site can be seen in Figure 4.

Figure 4: Topographical Map of Whisky Creek and the Surrounding Area
Along with the topographical map, Brad Boomstra also provided us with some hydraulogic data. This data can be found in Appendix B.

### 3.2 Soil Characteristics

The soil characteristics of the bridge location were also necessary information while designing the bridge. This information will help determine the bearing capacity and the necessary columns and supports. It will determine the piers of a bridge or the fill above a culvert. The soil characteristic of the site was approximated from nearby well boring information, which can be found in Appendix A. From the soil boring data found in Appendix A, it is seen that the areas surrounding Whisky Creek and Calvin College have very thick clay layers. The team’s industrial consultant Roger Lamer confirmed these results by suggesting this area consisted primarily of clay. Figure 5 displays the soil approximate soil characteristics, showing that the area for the project is primarily covered by 18B and 18C loam, which is comprised mostly of clay with some sand and other materials.
3.3 Creek Characteristics

The section of Whisky Creek that applies to this project is located just south of Burton Street. The Creek flows east at this point. Whisky Creek itself ranges in width from 3 to 8 feet with typical water surface elevation up to 1 foot. Detailed hydrological data from Kent County Drain Commission can be seen in the appendix. This data is needed if the team decides to use a culvert which would alter flow or if the bridge supports were near enough to the creek itself. If a bridge is built high enough and is unaffected by the flow and does not affect the flow, then this data is less necessary.
The ravine is completely overgrown with bushes, shrubs, and several large trees. There are several considerations that must be made when deciding which path to take through this landscape. The path across the creek must be aesthetically pleasing; therefore limiting the number of trees that are removed for the project is ideal. Cutting a straight line through the trees as is done for power lines is not desirable. This would both eliminate the isolation of the apartments from the busy Burton Street as well as detract from the natural feel of the site. The project must provide safe, reliable transport from one bank of the creek to the other while neglecting to impact the area negatively. Figure 6 shows possible locations to span Whisky Creek.

![Possible Locations to Span Whisky Creek](-figure6.jpg)

**Figure 6: Possible Locations to Span Whisky Creek**

As seen in Figure 6, the area is quite heavily wooded. However, as the seasons changed it became clear that locations “B” and “C” were more heavily wooded than location “A” shown in
Figure 6. In Figure 6, locations to the left are on the east. This will likely be a determining factor in choosing a location to span Whisky Creek.

4. Design Approach

4.1 Challenges

There are two main design challenges that surround this project. The first and most important challenge is providing a safe route across Whisky Creek. Providing a safe passage for people of all ages and capabilities is a key design consideration. This includes everything from material selection to path selection. In order to provide a safe route, elevation changes must be considered. If a bridge were chosen as the solution, depending on the path chosen, the elevation change over the span of the bridge could be as much as 15 feet for a bridge, or as little as 2 feet if we followed the topography. However, to attain an elevation change across the bridge span either stairs or ramps would need to be added.

The problem with stairs is that they are not wheelchair accessible and are dangerous in the winter. Stairs can also be difficult for the elderly to maneuver. However, ramps are also dangerous in the winter, but provide wheelchair accessibility. One possible solution to this problem is that the bridge could be closed off for the winter.
The second main challenge surrounding this project is logistical. The land on the north side of Whisky Creek is owned by Calvin College, and leased to Woodlawn CRC. However, the land to the south of the creek is owned by the Raybrook community. This provides a unique challenge of gathering input of all the involved parties, and coming up with a design solution that pleases everyone. If Calvin were the main source of funding, typical Calvin architectural features would likely need to be incorporated into our design. Coupled with the challenges of coordinating between the three parties is the issue of funding. In talking with a representative from the Raybrook community, funds there are scarce, so they requested an economical solution. However, in talking with a representative from Woodlawn CRC, were they to find the solution feasible and to their liking, raising fund would likely not be an issue. In the end, the design will hopefully please all parties involved and successfully handle these challenges.

4.2 Design Norms

There are two main design norms which we have considered for this project. The first is trust. The final product must be something that is sturdy and reliable. Whether a bridge is chosen or a pathway with a culvert is chosen, there are safety concerns. If the bridge is poorly designed or constructed, people could get seriously injured or even killed. If the culvert designed does not properly handle flooding conditions, the backfill could be compromised. There are many scenarios in which safety becomes an issue. The final design must be one that has accounted for every possible safety concern so that potential users of the bridge are confident in its reliability and trust the design.
The second main design norm we have considered is caring. It is very important that we consider the consequences and ramifications of our design. Considerations such as proper design fall into caring as well; however, caring encompasses more than just safety and trust concerns. We must consider the potential users of the bridge, particularly the elderly. Our design must account for those who cannot transport themselves as easily as they once might have been able to. The design must also account for those with disabilities and provide wheelchair access. Also, we must consider the environmental impact of our bridge. Our preliminary design calls for clearing a lot of trees; however, since the design is primarily made of compacted backfill, layers of compost and topsoil could be placed on top to re-plant some of the vegetation lost. This design also must also consider being stewards of the resources given to us. We must make our design cost effective and efficient to properly use the funds given to us, especially in such economic times as these.

5. Preliminary Design

5.1 Design Selection

The preliminary design will involve a placing a culvert or multiple smaller culverts in Whisky Creek and backfilling a portion of the creek. HEC-HMS and HEC-RAS would be used to determine flood water surface elevations and water surface profiles. Asphalt would then be placed on the backfill to create a path across the creek. This design would properly deal with
the cost issue. Compacting backfill of the creek and placing culvert is a much cheaper option than erecting a steel bridge structure. The majority of the cost of this alternative would come from asphalt to build the path, but this cost is minimal compared to concrete. This path also addresses our design norms. The path will provide a safe passage in the winter as it will be barrier free, allowing for salting and shoveling during the winter months. If maintenance is an issue the bridge could also be closed off for the winter. Depending on where the bridge is placed, there may need be a lot of space to be cleared, as the backfill will need to be sloped properly to handle the loading of the path. Figure 7 shows a portion of Whisky Creek to give an idea of how highly vegetated the area is.

Figure 7: Vegetation around Whisky Creek
As shown in Figure 7, wherever the path is designed, there will be a lot of brush and vegetation that will need to be cleared. However, geo-tech fabric/erosion control blanket could be placed and the side slopes seeded to make the path look as natural as possible. New, young trees could also be transplanted as well to create a more natural look. Benches could be placed as well to create a peaceful seating area.

5.2 Location Selection

The location chosen for the path is further east down Whisky Creek, near location “A” shown in Figure 4. This location can be seen from an aerial view in Figure 8.
Figure 8 shows the proposed place for the path to join with the parking lot of the Woodlawn Ministry Center. This location would require little or no trees to be removed. This would allow for the area around the creek to maintain its natural appeal while still providing a sufficient route across Whisky Creek. Since one of the design norms is caring, this was an important factor in choosing the route as it allows for good stewardship of the environment. Also, it allows for the least change in elevation change between the banks. This will make it easier to make the path barrier free and safe for all its users. Figure 9 shows the proposed meeting place with the Woodlawn CRC Ministry Center parking lot.

Figure 9: Proposed Meeting with Ministry Center Parking Lot
Figure 9 shows the proposed beginning of the path from the Ministry Center parking lot. Some of the curb and gutter will likely need to be removed and replaced. The amount to be removed will depend on how wide the final path design ends up being.

6. Alternative Solutions

The alternative design would consist of a bridge made of pre-cast concrete, steel, or timber. There would need to be ramps or stairs incorporated in this design to keep the span of the bridge small to minimize the cost. This design would likely be more expensive than the preliminary design. However, the design would require less clearing of the vegetation currently around the creek if we decided to place it further west along the creek. It would also be difficult to make the path barrier free, especially if stairs were used. The bridge would also likely need to be closed off during the winter months for safety reasons. However, one solution to this problem would be to make a covered bridge. This would make the bridge more intimate and could be more attractive than an open bridge or our preliminary design. However, it would be difficult to make this design blend in with the surrounding environment, which is an important aspect of our project.

7. Conclusion

This project shows the importance of communication and care throughout a design. The final project must demonstrate a balance between elegance and functionality. We are
confident that the preliminary design selected will adequately provide this balance. The design properly cares for the surrounding environment, provides the best route to make the path barrier free, and will be aesthetically pleasing.
Acknowledgements

Team Bridge would like to thank:

- Professor J. Aubrey Sykes for proposing the project and remaining as a contact from Woodlawn Christian Reformed Church.
- Professor Leonard De Rooy for advising the team throughout the process.
- Mr. Roger Lamer for aiding the team as the industrial consultant.
- Mr. Phil Beezhold for acting as the team’s contact from Calvin College’s Physical Plant
- Mr. Scott Hull for being the project’s contact from the Holland Home and Raybrook Estates
- Mr. Brad Boomstra from the Kent County Drain Commissioners Office for providing pertinent information about Whisky Creek.
8. References

Soil Boring Logs:

http://www.deq.state.mi.us/well-logs-data/Kent/07N11W26%20KENT.pdf

http://www.deq.state.mi.us/well-logs-data/Kent/07N11W27%20KENT.pdf

http://www.deq.state.mi.us/well-logs-data/Kent/07N11W33%20KENT.pdf

http://www.deq.state.mi.us/well-logs-data/Kent/07N11W34%20KENT.pdf

http://www.deq.state.mi.us/well-logs-data/Kent/07N11W36%20KENT.pdf
Appendices

Appendix A: Soil Boring Logs

Appendix B: Hydrologic Information

Appendix C: Budget Estimate

Appendix D: Gantt Chart
# Appendix A: Soil Boring Logs

## Figure A1: ¼ Mile East of Beltline, 200 ft. South of Fulton

<table>
<thead>
<tr>
<th>TAX NO.</th>
<th>PERMIT NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## WELL DATA

- **Location of Well**: ¾ Mile East of Beltline, 200 ft. South of Fulton
- **Principal Contractor**: Team Bridge

### Soil Boring Logs

<table>
<thead>
<tr>
<th>Log No.</th>
<th>Date</th>
<th>Depth</th>
<th>Material</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1/8</td>
<td>5</td>
<td>Sand</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1/8</td>
<td>10</td>
<td>Clay Clay &amp; Gravel</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1/8</td>
<td>20</td>
<td>Brown Clay</td>
<td></td>
</tr>
</tbody>
</table>

### Remarks

- **Date of Observation**: 7-8-1999
- **Date of Completion**: 7-8-1999
- **Drilled by**: Team Bridge

---

## Appendix A: Soil Boring Logs

### Figure A1: ¼ Mile East of Beltline, 200 ft. South of Fulton

- **Date**: 7-8-1999
- **Operator**: Team Bridge
- **Location**: ¾ Mile East of Beltline, 200 ft. South of Fulton

### Soil Boring Logs

<table>
<thead>
<tr>
<th>Log No.</th>
<th>Date</th>
<th>Depth</th>
<th>Material</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1/8</td>
<td>5</td>
<td>Sand</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1/8</td>
<td>10</td>
<td>Clay Clay &amp; Gravel</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1/8</td>
<td>20</td>
<td>Brown Clay</td>
<td></td>
</tr>
</tbody>
</table>

### Remarks

- **Date of Observation**: 7-8-1999
- **Date of Completion**: 7-8-1999
- **Drilled by**: Team Bridge
Figure A2: ½ Mile West of Crahan on Michigan
Figure A3: 150 ft. SE of I-96
Figure A4:  1 Mile West of East Beltline, 75 ft. South of Midland
**Figure A5: 250 ft. East of Glenview Dr., 2807 Cascade Road**

<table>
<thead>
<tr>
<th>Team 7:  Team Bridge</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLAY + STONES</td>
</tr>
<tr>
<td>SAND</td>
</tr>
<tr>
<td>CLAY</td>
</tr>
<tr>
<td>SAND</td>
</tr>
</tbody>
</table>

**Formation:**
- Clay and stones: 31 ft.
- Sandy clay: 5 ft.
- Clay: 21 ft.
- Sand: 20 ft.

**Remarks:**
- Clay ball in sand between 86 and 87 ft.
Figure A6: 100 ft. West of Lakeside Dr., 900 ft. North of Lake Drive
Figure A7: 200 ft. South of Franklin, 75 ft. East of Plymouth
Figure A8: North Side of Reeds Lake, 2638 Reeds Lake Blvd. SE.
Appendix B: Hydrologic Information

Figure B1: Flow of Whisky Creek
Figure B2: Hydraulogic/Watershed Information of Whisky Creek
Figure B3: More Hydrologic Data, including Curve Numbers and Times of Concentration
Appendix C: Budget Estimate

Physical Model: $60

Miscellaneous/Contingency: $40

Total Estimated Budget: $100
Appendix D: Gantt Chart