Volga Stormwater Improvements

MLM Consultants

University of Iowa CEE Senior Design

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Project Map

SCOPE

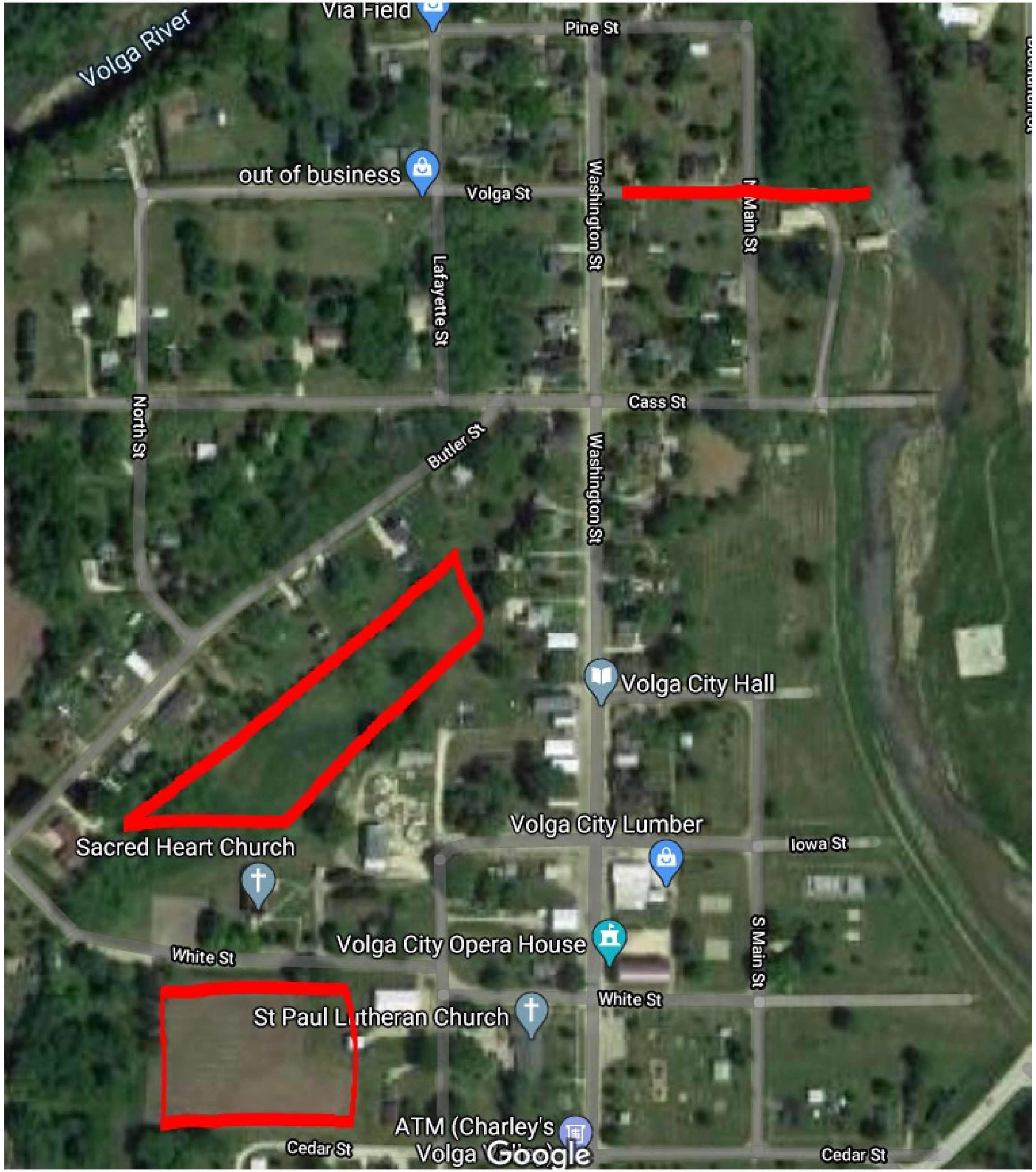
EXPLORED SOLUTIONS

DESIGN METHOD

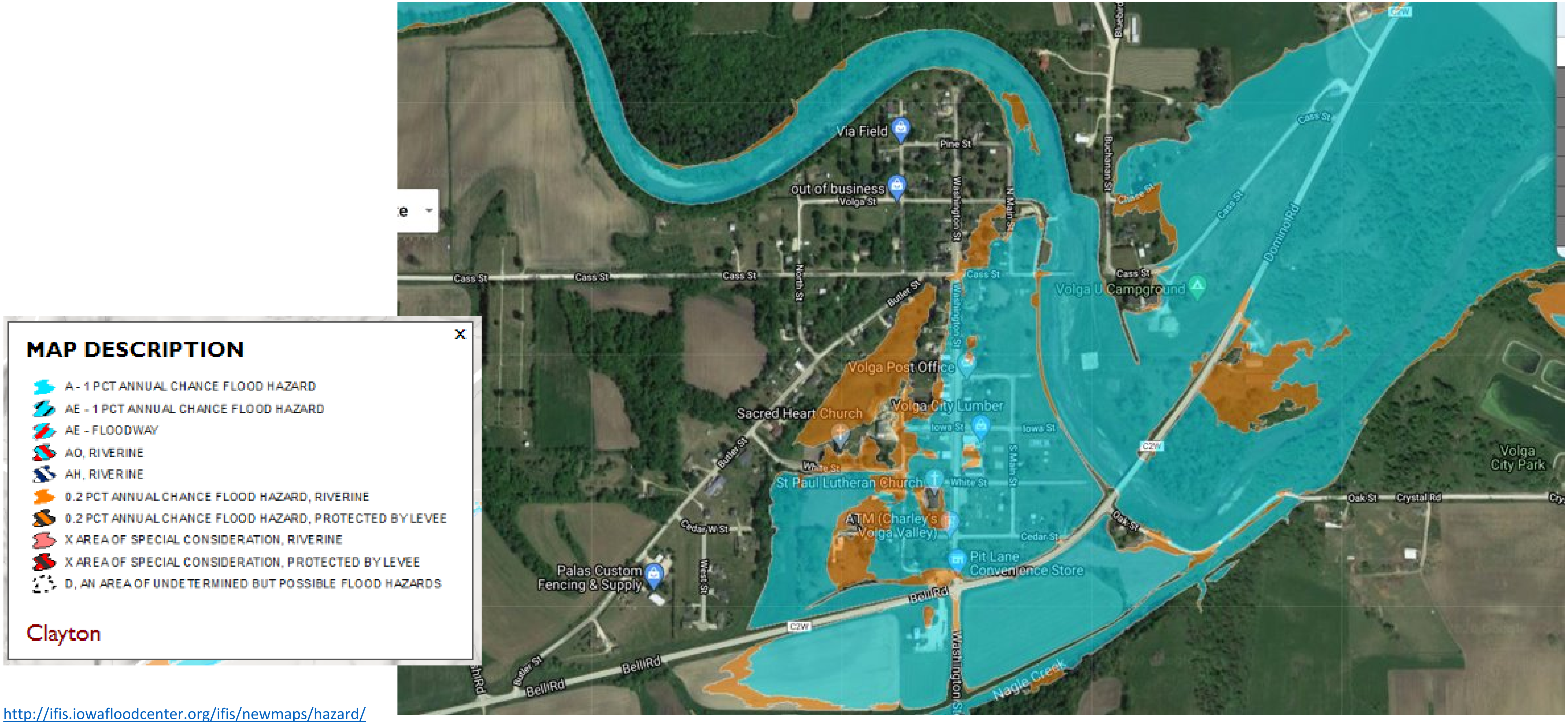
COST ESTIMATE

Scope

The city of Volga is a small town that experiences flooding during the rainy summer months. The City has a limited storm sewer system and there were many locations in the community that suffer during heavy rains. Our team worked with the City's staff and found that there were three specific sites that needed to be focused on. This includes two low-lying areas that retain water and cause flooding issues for residents, identified as the north and south regions. The other concern is a surface runoff problem on Volga Street.



Floodplain Map of Volga



http://ifis.iowafloodcenter.org/ifis/newmaps/hazard/

Researched Alternatives – North and South Regions

Alternatives	Pros	Cons
Pump both regions	• The area would be drained of all water	• Most expensive option as it would require a larger piping network and more tiling • Does not address the issue of potential wetland mitigation that could lead to additional expenses
Enhance both regions as wetlands	• Would be the lowest maintenance option • Should fully comply with wetland restoration	• Difficult to establish • May not fully address existing problems
*Enhance the south region and pump the north region	• Helps mitigate potential wetland situation • Addresses primary concern of flooding	• Might not fully comply with wetland restoration

*Client's Chosen Alternative

Enhanced Wetland Design

Constructed Wetland

Design Process – South Region

- EPA Guidelines and NRCS were consulted for refences
- Water Quality Volume was calculated to size basin

Q = 9.4 cfs

Volume = 80,000 cuft

Size up the basin to account for sediment buildup

Flowrate into the Wetland

$$\frac{4.5\ in}{day} * \frac{ft}{12\ in} * \frac{day}{24\ hours} * \frac{1\ hour}{3600\ s} * 2149857\ ft^2 = 9.4\ cfs$$

Sizing Wetland Basin

Assumed Precipitation, P = 4.5 in

Drainage Area = 2149857 ft^2

$R_v = 0.05 + 0.0009I$

I = 5%

$R_v = 0.05 + 0.0009(5) = 0.095$

$WQ_v = A*P*R_v$

$= (2149857\ ft^2)*(4.5\ in * ft/12\ in) * (0.095)$

$= 66{,}500\ ft^3$

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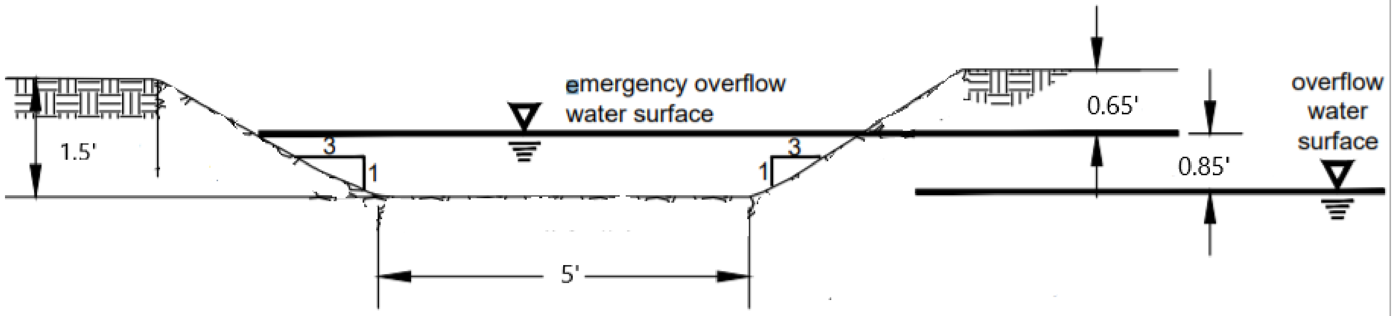
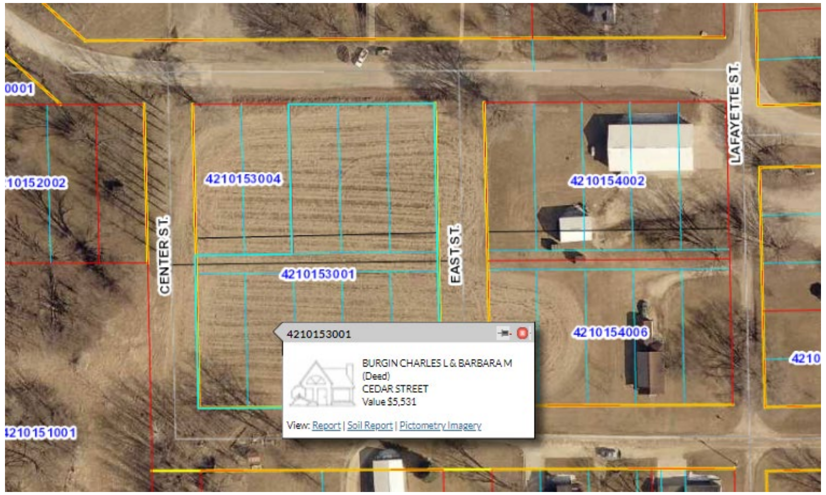
Outlet Design

- Using Hydraflow Express on Civil3D and a known flowrate of a 100-yr flood being about 16 cfs
- A bottom length of 5 ft was chosen, and the depths were calculated using 16 cfs
- Weir design to a turf spillway
  - Very flat area

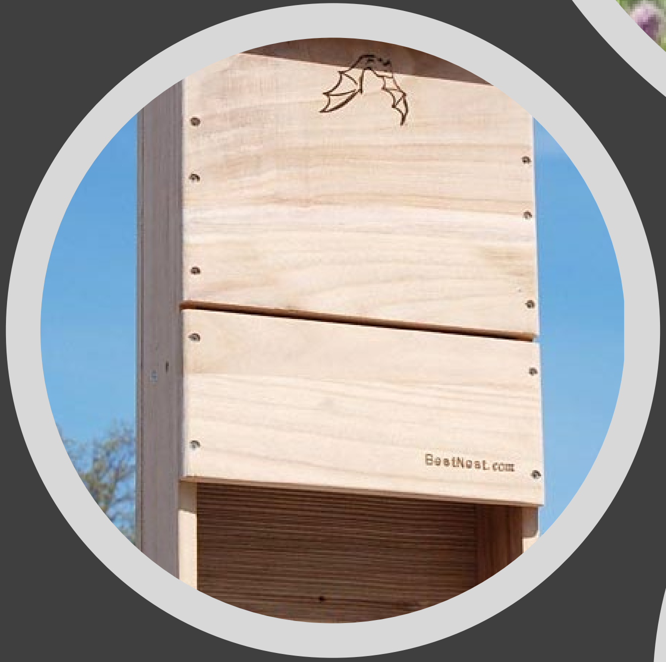


Site Selection for Wetland



Plant and Wildlife Consideration

- Bat houses were proposed to help with the existing mosquito problem experienced during the summer months
- Some native plant suggestions were: Scirpus Pungen, Cassia Hebecarpa, and Liatris Pycnostachya
  - Native plants help to ensure invasive species don't grow
- Minnows in the wetland help control mosquitos and other pests in the area.

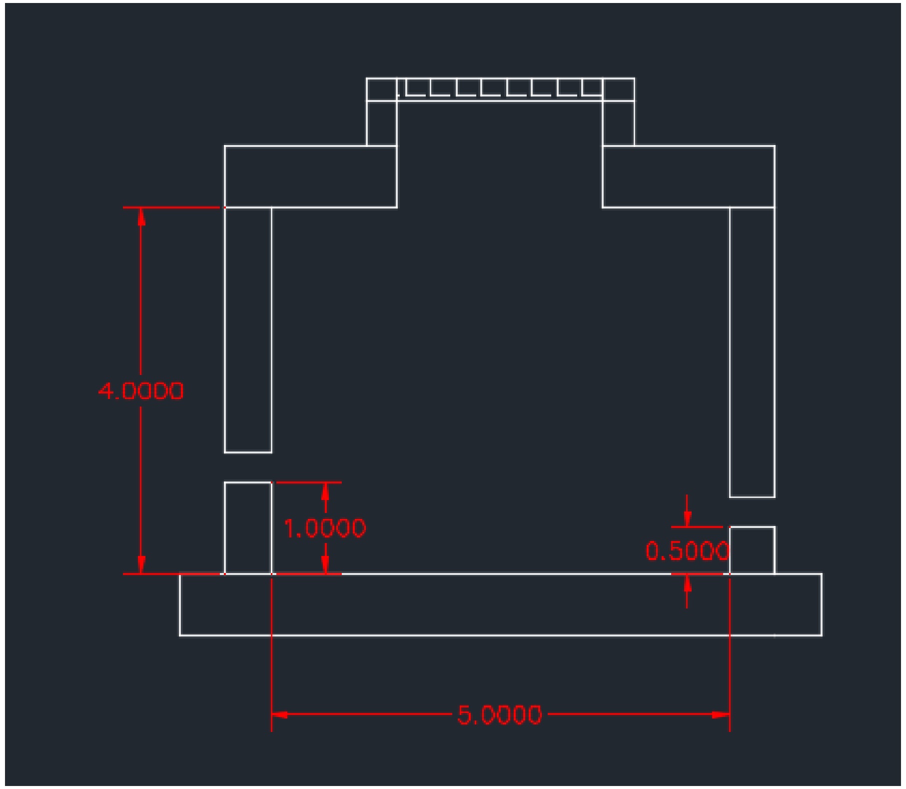


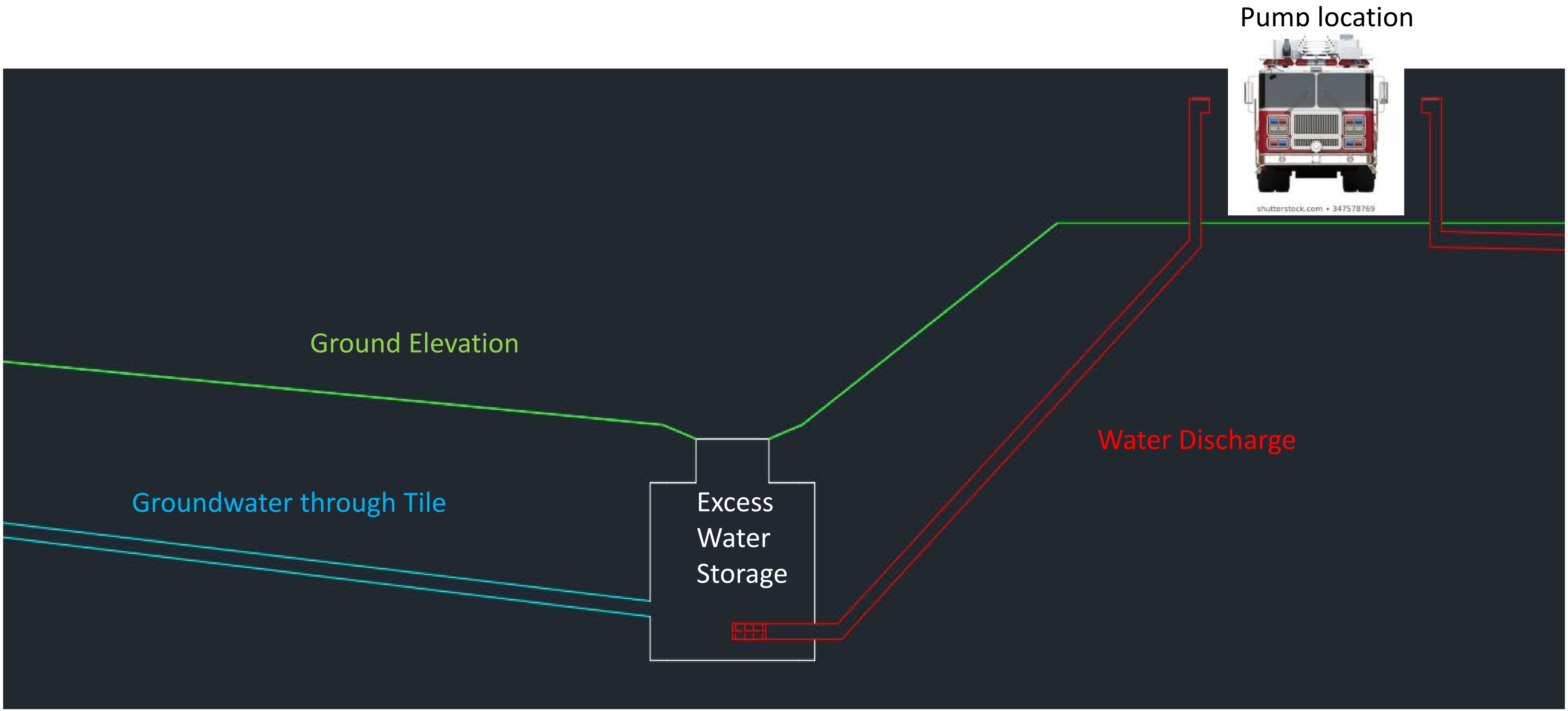
North Region Pump Design


North St
Butler St
Dean St
Volga Post Office
Iowa St
Iowa St
Sacred Heart Church
Washington St
Volga City Lumber
White St
White St
Volga City Opera House

Design Process

- Iowa DOT SUDAS guide used to design manhole
  - SW-401
- Pump Head Capacity




Pump location
shutterstock.com • 347578769
Ground Elevation
Water Discharge
Groundwater through Tile
Excess
Water
Storage

Example Configuration

-3.9%
-3.3%
-6.1%
-4.2%
-3.9%
790.00
788.00
789.00

Potential Concerns

North Region

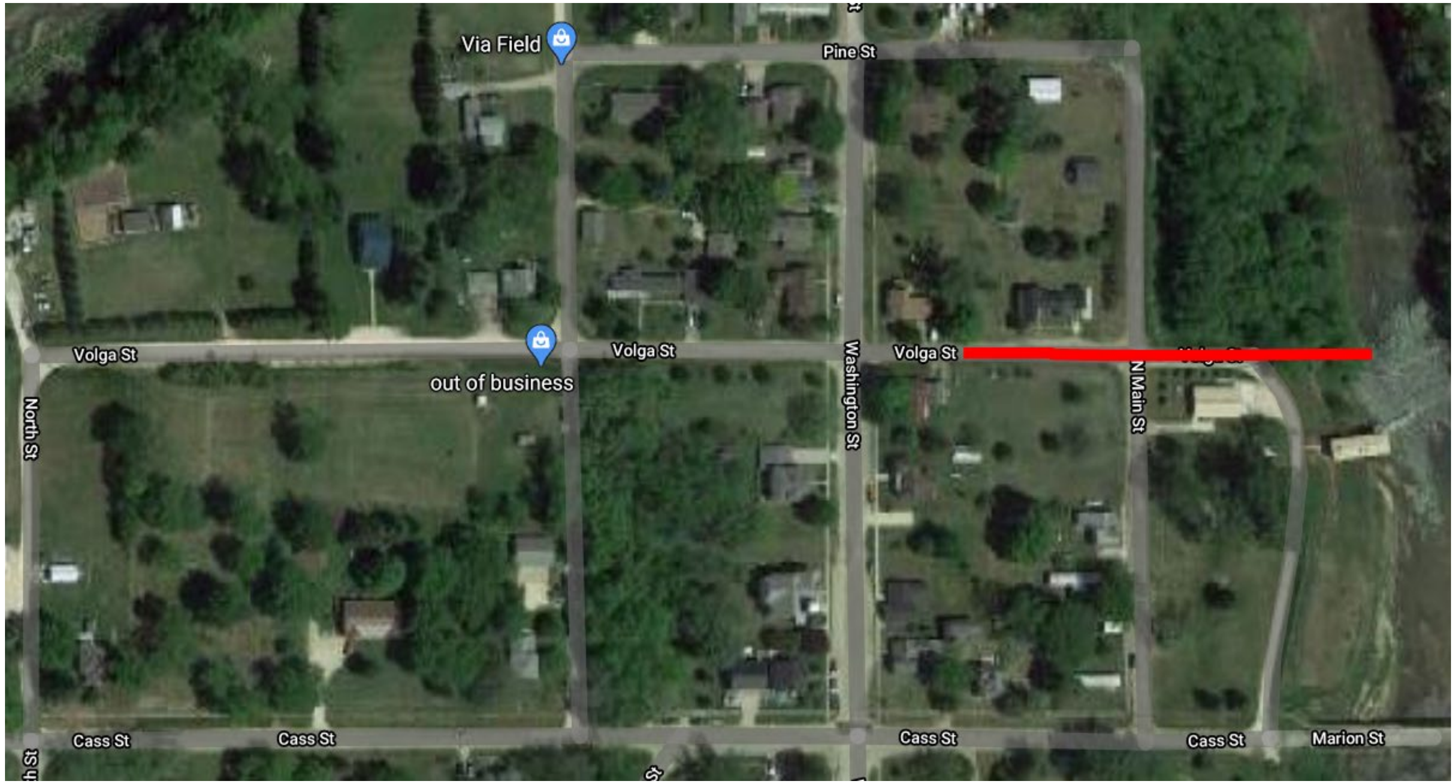
South Region

- Land acquisition for pipe network
- Wetland assessment needs to be conducted for the area
  - If the enhancement of the south region is not enough, other mitigation methods must be implemented

Storm Sewer Design

Client's Concerns

- Volga Street (West) washing out during heavy rain events
- Low points create unwanted pooling on street
- Two 24" floodgates currently serving the city are above capacity



Researched Alternatives – Volga Street

Alternative	Pros	Cons
Upstream Retention	• If we find a good location, this would be an easy way to control runoff before it gets to Volga Street	• The land is very steep upstream,– not enough diversion to solve the problem
*Underground Storm Sewer System	• Proposed property already owned by the city • Collaborate with another Volga senior design team	• This must be designed carefully and consider future expansion of the sewer system. • Does not solve all client's problems with this street
Improving Existing Culverts	• Cheaper alternative • Is able to be implemented on rural-style roads	• This is the system Volga already has in place and it does not seem to be effective • Would have to increase size of current floodgates to build capacity upstream

* Client's Chosen Alternative

Engineering Calculations

Rational Method - Runoff

- Calculated in Civil 3D's HydroExpress
  - A drainage area (A) of 3 acres was used
  - Runoff coefficient (C) of 0.39 was used for low-density housing

    (Table 1, Iowa DOT Section 4A-5)

  - A rainfall intensity (*i*) used was for a 10-year, 1-hour event and was found to be 2.17 in/hr (Table 2, Iowa DOT Section 4A-5)

Mannings – Pipe Sizing

- Used the Concrete Pipe Design Manual as guidance
- Assumed Coefficient n = 0.012
- Slope of system S = 0.02 feet/ft

Chapter 4—Drainage | Section 4A-5—Using the Rational Method to Determine Peak Flow

The Rational Equation

The Rational Method uses the Rational equation given below:

$$Q = CIA \quad \text{(Equation 4A-5\_1)}$$

where:

Q = Peak flow, ft^3/s.

C = Runoff coefficient (dimensionless).

I = Rainfall intensity, in/hr.

A = Drainage area, acres.

Important Design Characteristics:

Q = **12 cfs**

Pipe Diameter = **18"**

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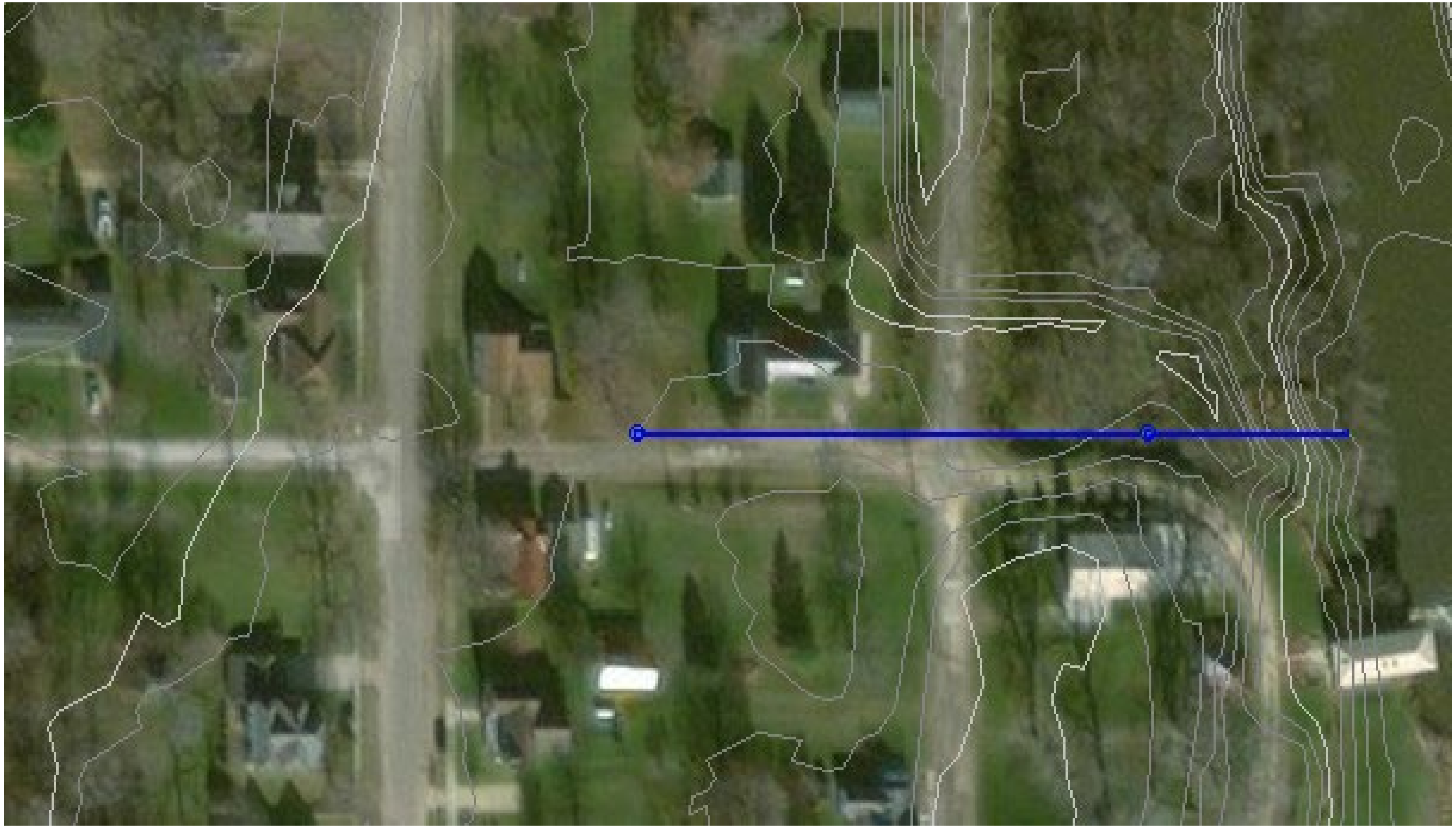
Proposed Product



Neenah Foundry
R-4341-A

~415 ft concrete system
2 structures
2% slope to river

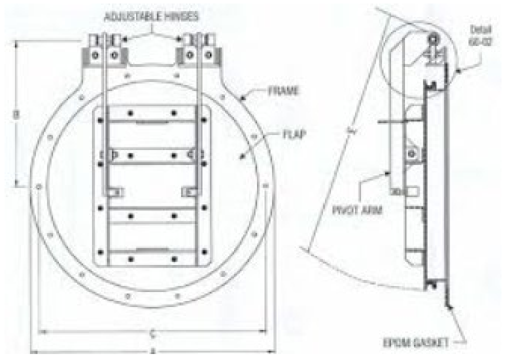
Outlet

Designed to be 18" above normal river height

Sized to serve future system expansion

Backflow Preventer

- Less maintenance
- Works with gravity
- Less chances of surcharges during heavy events



Cost Estimate

- Guide used was searching Iowa DOT bids for average prices for each bid item
- Cost for each design element
  - Enhancing Wetland
  - Implementing pump system
  - Storm sewer
- Unit cost includes material, labor, overhead, and profit
- Total cost across 3 phases is expected to be around $114,200

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Phasing

Phase	Proposed Plan	Total Expected Cost
A	South Wetland	$36,600
B	North Pumping Station	$30,600
C	Volga Street Redirection	$47,000

- We recommend breaking up the project into phasing to spread out spending and ease the financial strain on the city.

Total cost for the entire project comes out to be around **$114,200**

Recap Project Map

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Questions?

Cost Analysis - Enhancing Wetland

Task	Unit Cost	Quantity	Price
Excavation/Grading	$5.00 / CY	2930 CY	$11,950
Outlet-turf spillway	$12.50 / SF	500 SF	$6,250
Plants	Vary		$2,700
Seeding/Erosion Control	$1,800 / acre	2 acres	$3,600
Construction Total			$24,500
Easements and Property Acquisition	$5,500 / LOT		$3,500
15% Contingencies			$3,675
20% Engineering and Admin			$4,900
Total Cost Phase A			**$36,600**

Cost Analysis - Pumping North Region

Task	Unit Cost	Quantity	Price
Manhole	$5200 / EACH	1	$5,200
Manhole Cover	$100 / EACH	1	$100
4" Perforated Tile	$10.50 / LF	600 LF	$6,300
Hole Plug (Vertical Wells)	$15 / EACH	10	$150
4" Ductile Iron Pipe	$27.50 / LF	100 LF	$2,750
4" PVC Pipe	$14.15 / LF	350 LF	$5,000
Seeding/Erosion Control	$1,800 / acre	2.11 acres	$3,800
Construction Total			$23,300
Land Acquisition	$2,511 / LOT	0.10	$250
10% Contingencies			$2,330
20% Engineering and Admin			$4,660
Total Cost Phase B			**$30,540**

Cost Analysis - Volga Street

Task	Unit Cost	Quantity	Price
Manhole Structure	$5,200 / Each	2	$10,400
Manhole Cover	$100 / Each	2	$200
12" Concrete Pipes	$60 / FT	415	$24,900
Backflow Gate	$600/LS	1	$600
Construction Total			$36,100
10% Contingencies			$3,610
20% Engineering and Admin			$7,220
Total Cost Phase C			**$46,930**