4-15-2022

Centralized Wastewater System

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Centralized Wastewater System Project 2022-12

Ashton Loitz, Gabe Ferguson,

Byshop Williams, Caleb Inorio

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Outline

- Acknowledgments and Background
- Problem Statement
- Design Alternatives
- Design Selection
- Preliminary Design
- Final Design Walkthrough
- Engineering Analysis
- Cost Analysis
- Design Validation
- Conclusion

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Acknowledgments

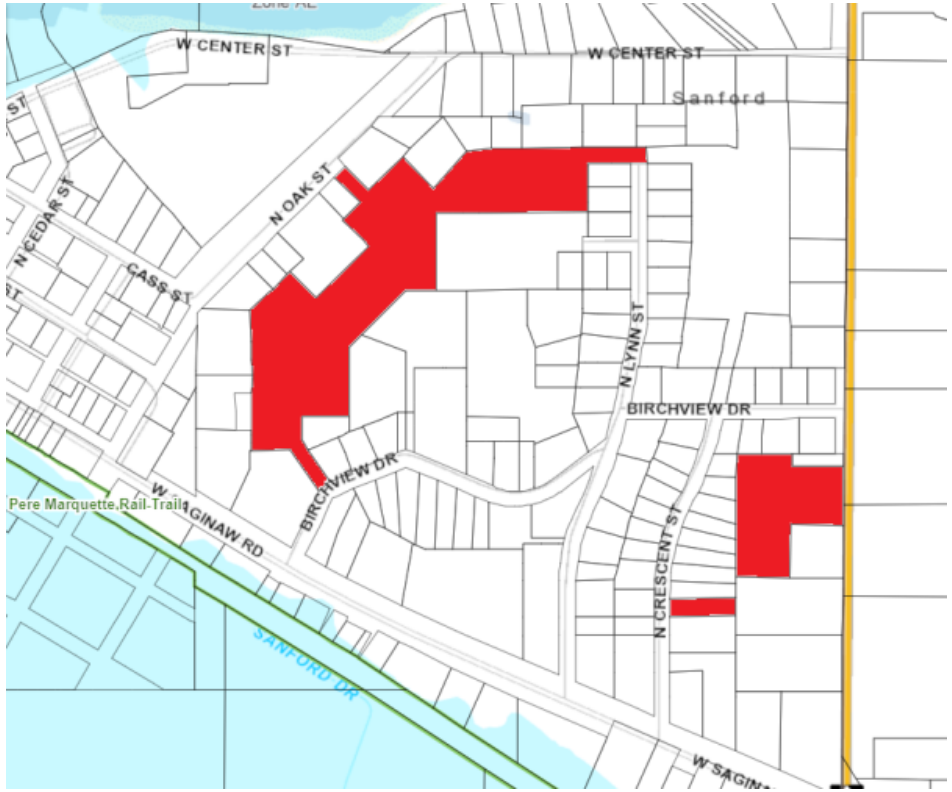
- VIPs (Very Important Professors)
  - Faculty Mentor: Prof. Ragan
  - Dr. Schroeder
- Professional Team
  - Jen Robinson
  - Amanda Laramie
  - Richard Goldszer
  - Mark Fetters
- Sponsor: CECorps
  - Stephan Barr
- Sanford Council Members
  - Dolores Porte

Background, Need for Implementation

- Sanford, MI devastated by dam failure in May 2020
- Over 30 houses and multiple businesses lost
  - Lost tax base
- No centralized wastewater system
  - Over 60% of houses built before 1969 as of 2014 Master Plan
- Need to help Sanford reinstate tax base while providing affordable housing

Problem Statement

- 3 Potential sites for housing developments
  - Wastewater is a concern for all developments
- Focused on Habitat for Humanity site
- Provide a cost effective and environmentally friendly solution to handle wastewater on site



*Data from Midland County GIS

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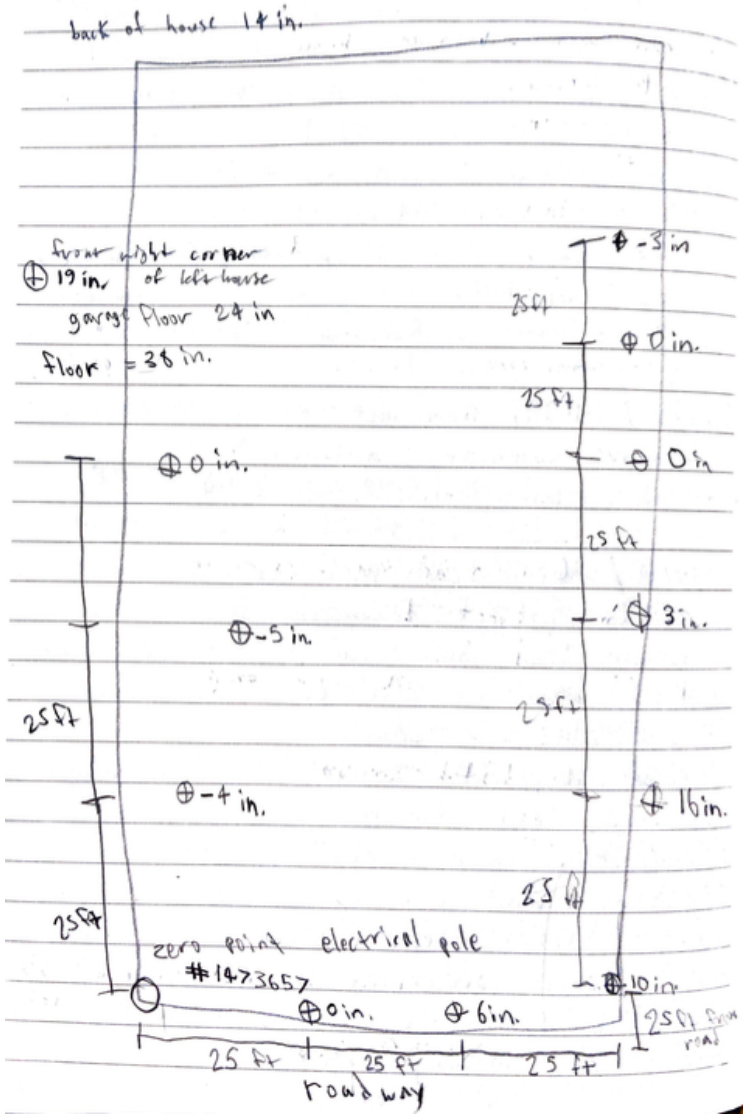
Habitat for Humanity Site

- Need to design septic tank and field for site
- 75’ x 270’
- Sits roughly 2 feet lower than neighbors
- Depth to water table of 0 inches
  - From USGS Web Soil Survey
- Clay-loam soil, poor draining



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Current Site Conditions

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Design Objectives

- Our objective is to provide the Village of Sanford with an on-site wastewater treatment solution that is:
  - Affordable yet meets all the environmental and health requirements
    - Have long lifespan
  - Must be easily serviceable and cost effective to maintain
  - Needs to be configurable to fit similar shaped lots nearby

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Functional Requirements

- Our wastewater treatment solution should:
  - Handle 350 gpd on average
  - Separate out all solids larger then 1/16”
  - Alert resident to problems within the system
  - Effectively dose field to allow for proper draining and filtration

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Design Constraints and Codes

- Midland County Health Department requirements
  - Section 305.5 (c) Bottom of field must be 18 inches above water table
  - Section 305.3 Field size must be 2,100 square feet and tank size must be 1,000 gallons
  - Section 304 Field must be 10 feet from property lines and tanks must be 10 feet from house
- Michigan Criteria for Subsurface Sewage Disposal
  - II A. Soil needs to accept water at a rate of 45 minutes per inch or faster
    - Clay-loam over 45 minutes per inch

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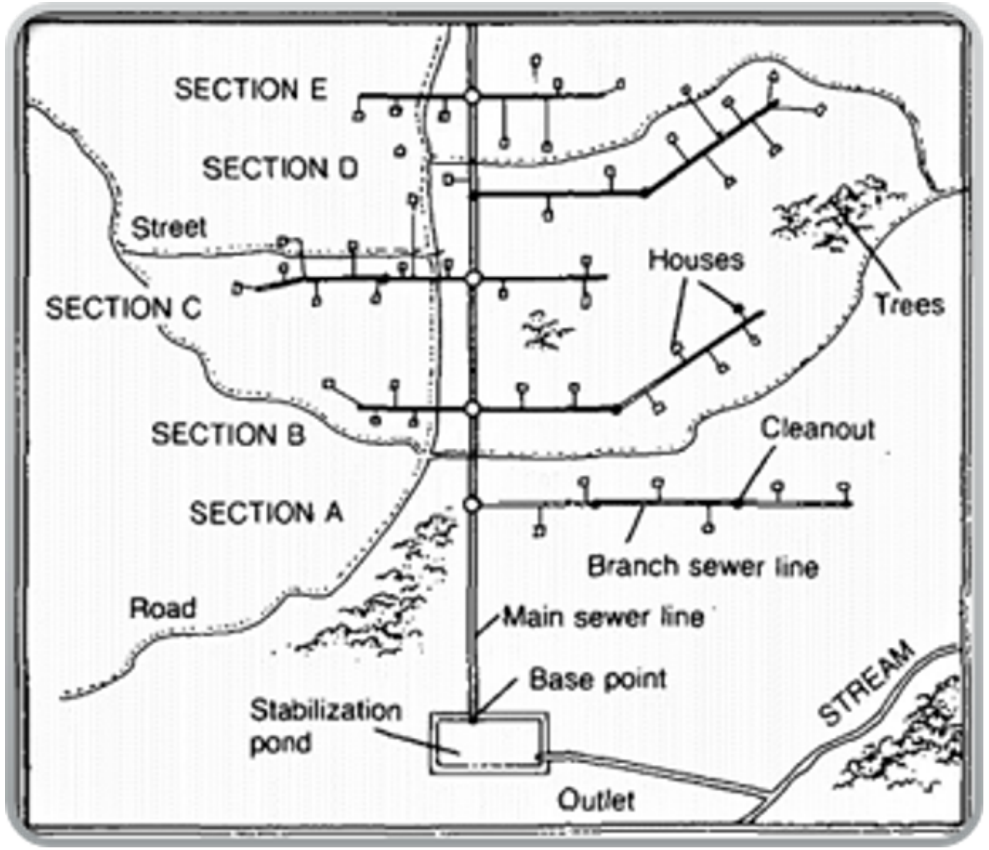
Additional Considerations and Constraints

- Health Department requests:
  - 1,250-gallon dual compartment septic tank
  - 7:1 slopes on embankments of septic field
- Other considerations
  - Buoyancy of tanks
  - Have room for a reserve field when first one fails
  - Verify site is outside floodplain

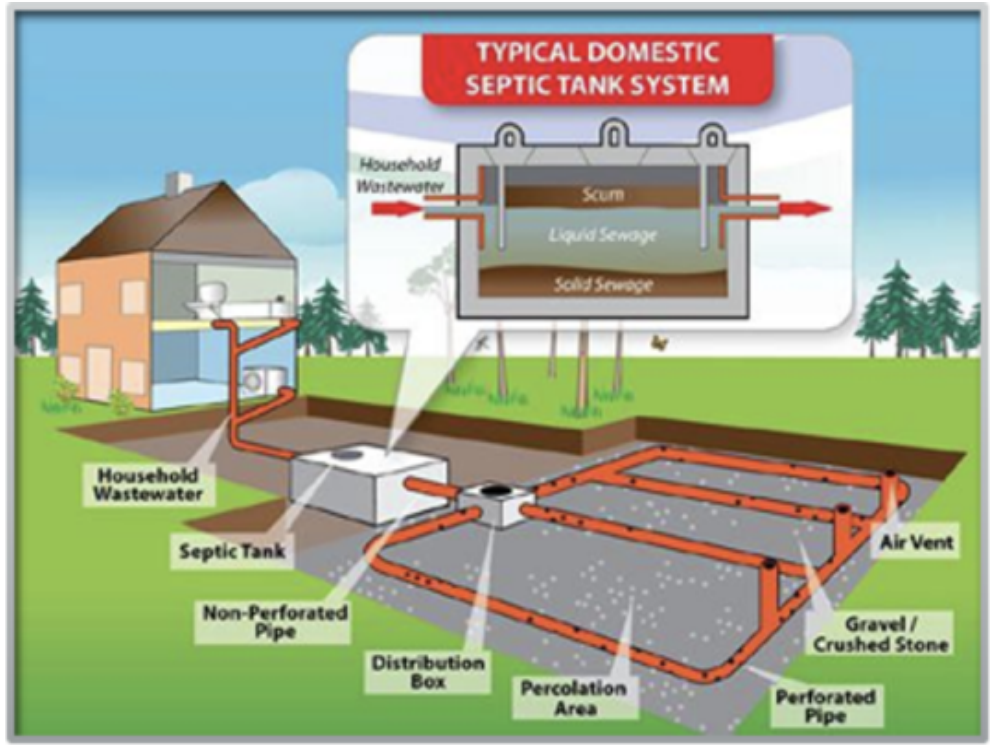
On-site vs Centralized Wastewater System

- Centralized municipal systems have a sewer main that each house can hook up to
  - Wastewater collected and treated at plant before release to public waters
- Allows a house to be built without worrying about individual wastewater concerns



On-site vs Centralized Wastewater System

- On-site system stores solids and releases liquids into ground
  - Liquids required to be filtered by soil
- Septic tank separates solids from liquids
  - Septic tank will be pumped depending on usage
- Septic field allows water to enter the ground and be filtered



Design Alternatives

- Centralized Wastewater Plant
  - Would allow new homes to be built with no regard for wastewater, but large up-front cost from village
- Pump wastewater to nearby towns treatment plant
  - Cheaper than option 1 up front but would allow nearby town to set rates and get all the revenue
- Constructed Wetland
  - Lower cost maintenance, but needs large area
- Community drain field
  - Cost spread amongst several residences. Mainly suitable for subdivisions
- Engineered mound
  - **Best for areas with high water table**, but costly and short lifespan

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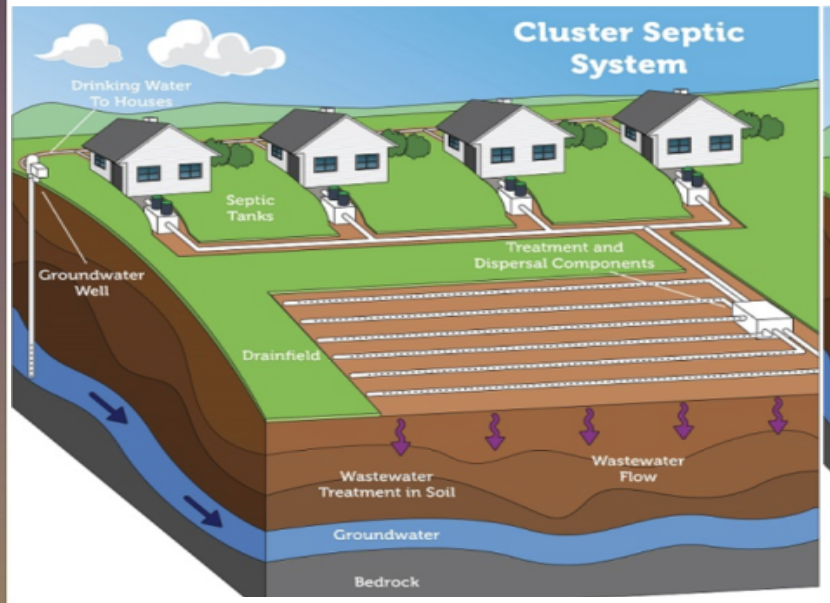
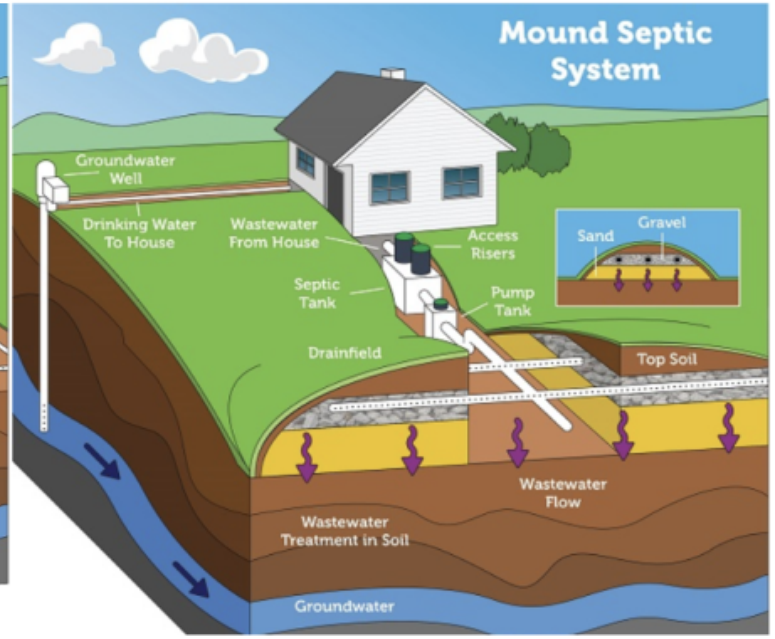
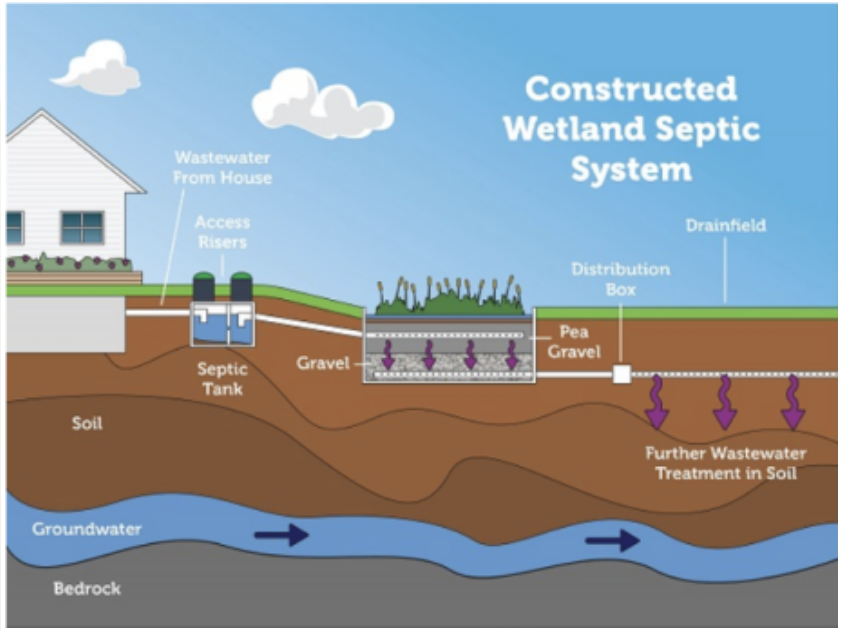
Design Alternatives

- On-site alternatives
  - All include septic tanks with variation in field designs
  - Strengths and weaknesses for each







*Pictures from epa.gov

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Design Selection

- Design Matrix
  - Each metric given a priority which gets multiplied by the score
- Engineered Mound was the alternative that won out

Design Matrix for Habitat Lot					
Designs	Functions				Total
	Cost	Environmental Impact	Treatment Capacity	Ease of Maintenance	
Priority	✓✓✓	✓✓✓	✓	✓✓	
Centralized Wastewater Plant	0	5	5	5	30
Pump to Nearby Plant	0	5	5	5	30
Engineered Mound	4	4	1	4	33
Constructed Wetland	5	2	2	4	31
Community Drain field	3	4	4	3	31

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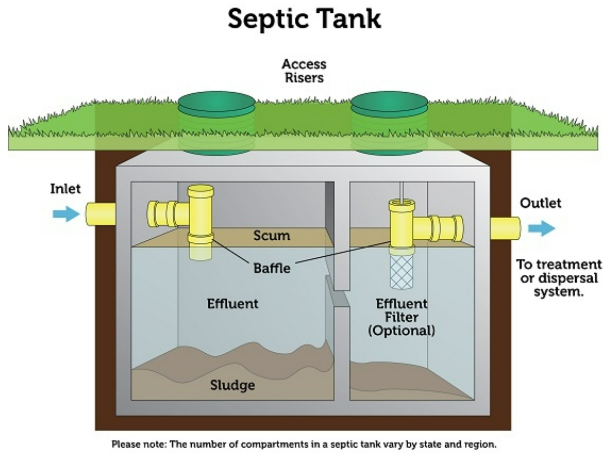
Design Team Breakdown

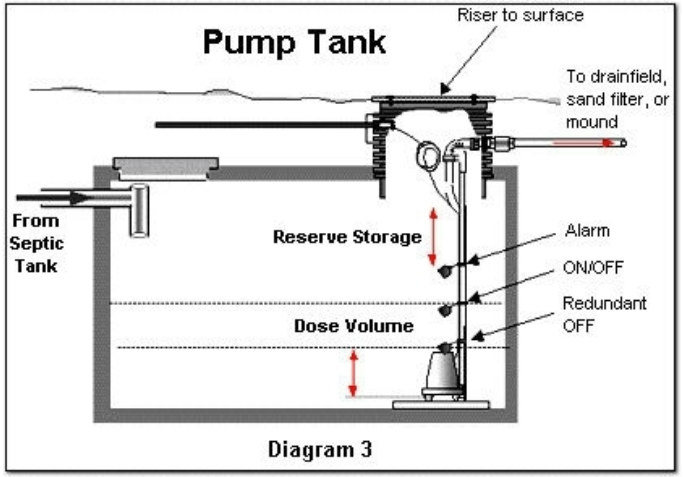
Selected design allowed team responsibilities to be assigned

- Ashton Loitz: Communicate with suppliers and calculate pump information
- Gabe Ferguson: Design and Drafting (AutoCad)
- Byshop Williams: Design and Drafting (AutoCad)
- Caleb Inorio: Research background information and health regulations

Description of Design

- Septic Tank
  - First phase
  - Separates out solids and contains them
- Pump Tank
  - Second phase
  - All gravity flow to this point
  - Pumps effluent up to the field
- Engineered Septic Mound
  - Third phase
  - Disperses effluent into mound for filtration

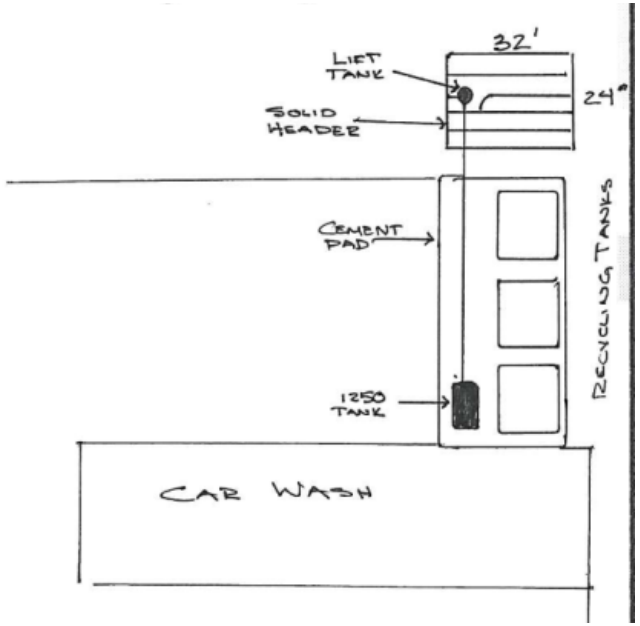


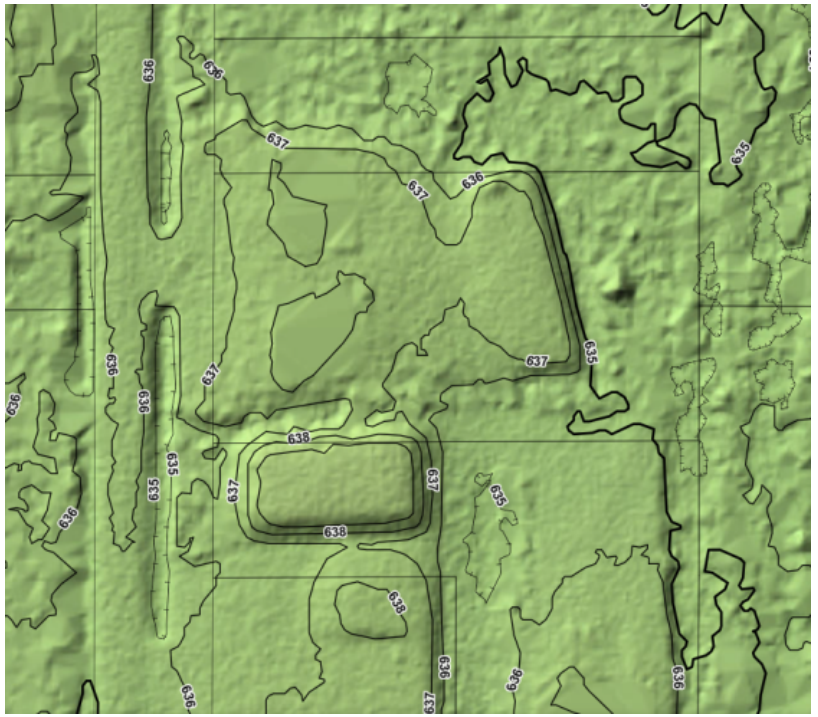


*Pictures from thesepticpro.com and epa.gov

Nearby Systems

- 2 sites to the south have mound systems
- Both built over 18 years ago
- Both raised 2+ feet at least above current grade

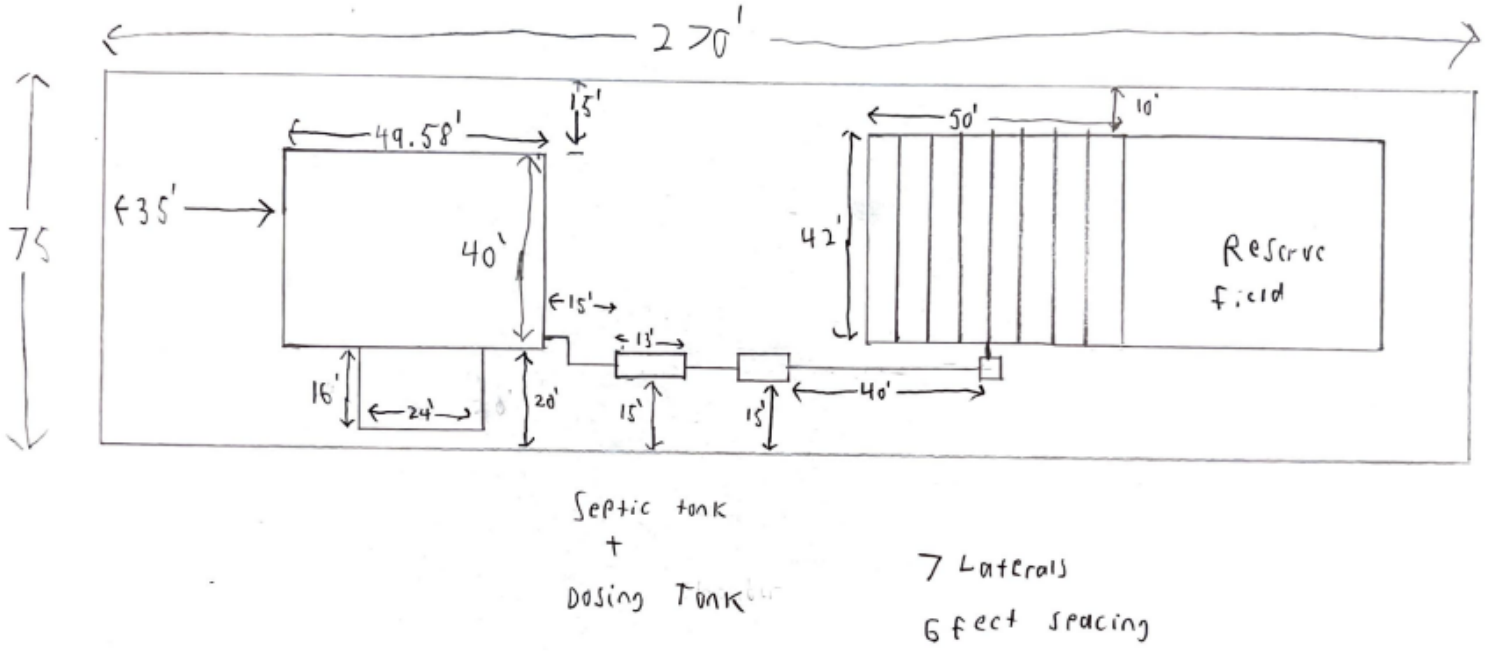




*Data from Midland County Health Department and Midland County GIS

Preliminary Design

- Put tanks on side for shorter laterals
- Easier access to reserve field when needed
- Tried to keep field close to a square



Final Design

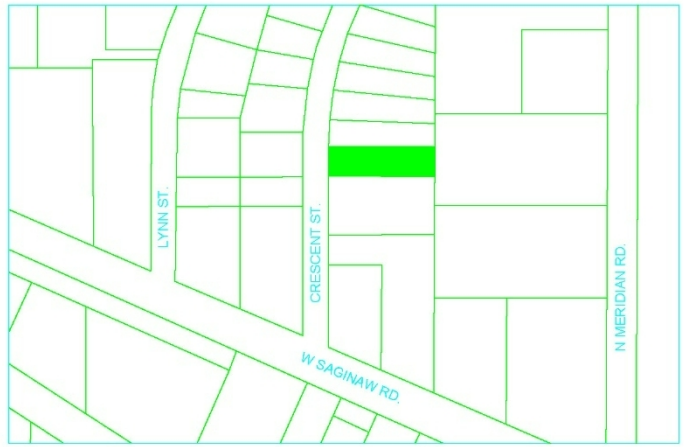
ENGINEERED SEPTIC DRAIN FIELD

HABITAT FOR HUMANITY
2036 Crescent Street Sanford, MI 48657

INDEX OF DRAWINGS:

SYMBOL AND LINE LEGEND:

- PROPERTY LINE
- DRAIN FIELD PERIMETER
- PERFORATED PIPING
- GRAVEL
- EARTH
- SAND
- NORTH ARROW (N)



LOCATION MAP
Scale: NOT TO SCALE (NTS)

NO	DESCRIPTION	BY	DATE

SHEET TITLE: COVER SHEET

PROJECT DESCRIPTION:
Parcel ID: 061-160-013-150-00
Property Address: 2036 Crescent Street Sanford, MI 48657
0.465 Acres

DRAWN BY: GABRIEL FERGUSON
APPROVED BY:

DATE: 04/11/2022

SCALE:

SHEET: C-0

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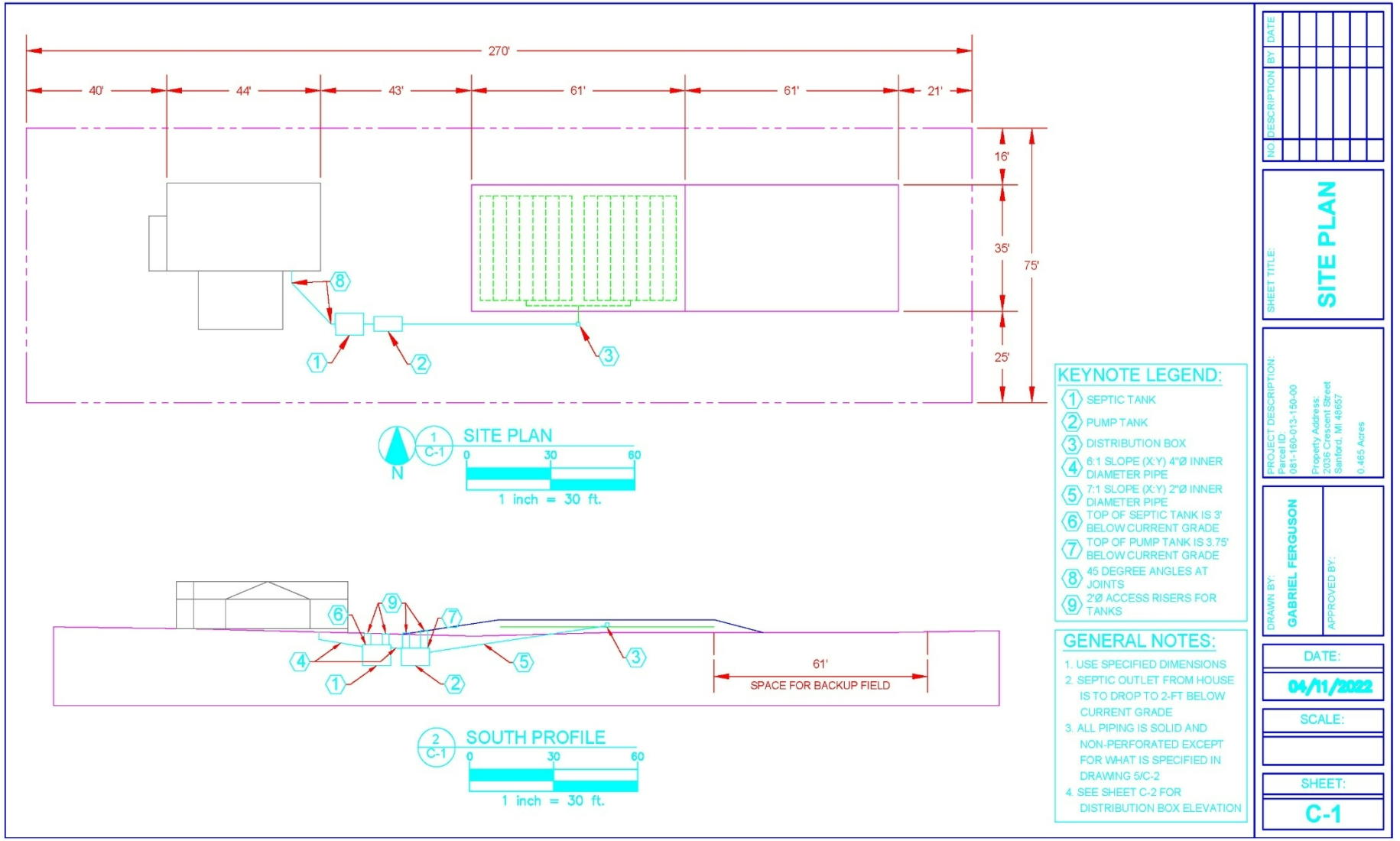
Final Design



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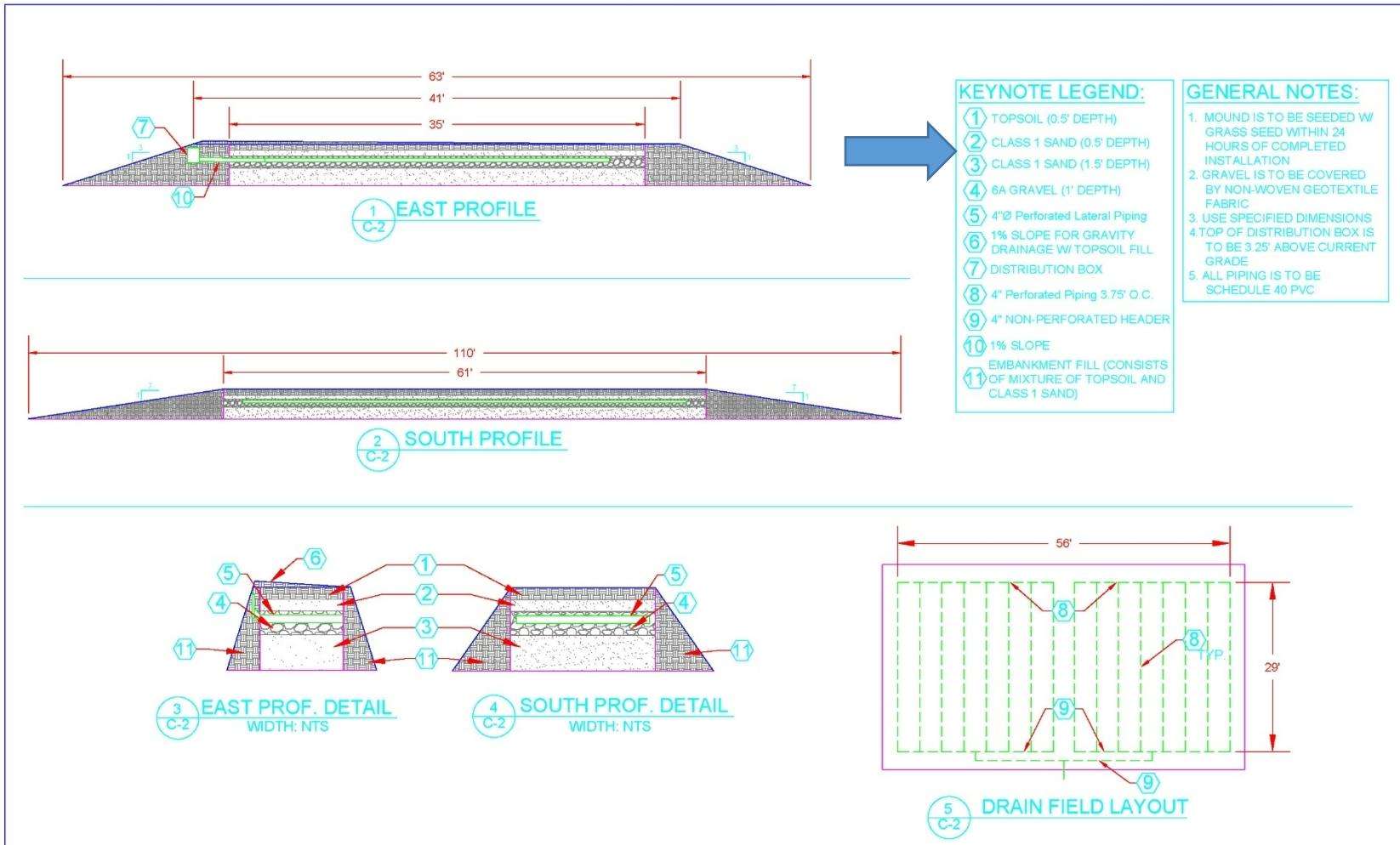
Final Design



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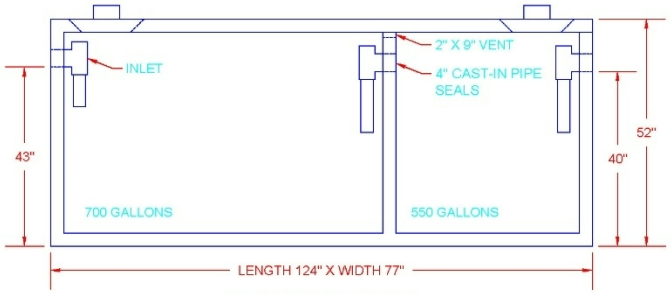
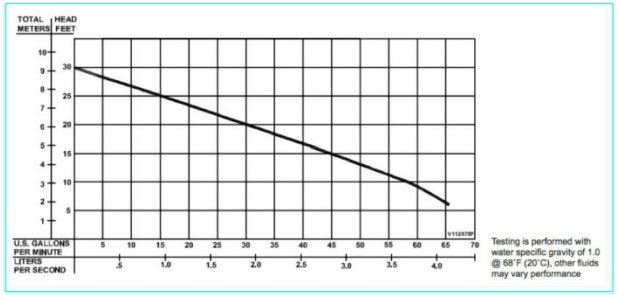
Final Design



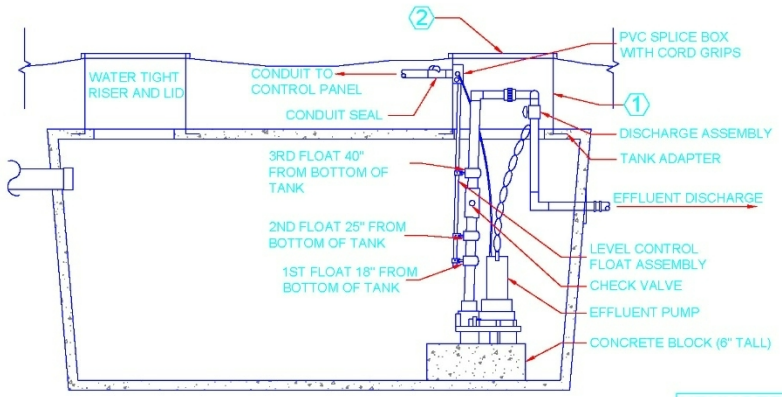
1 C-3 SEPTIC TANK



2 C-3 PUMP CURVE

Item	Unit	Quantity
Mobilization	LS	
Excavation (Include Hauling)	CYD	55
Backfill	CYD	39
Class 1 Sand*	TN	213.5
6A Stone*	TN	102
Top Soil*	TN	78
Embankment Fill (Fill Sand)*	TN	559
Non woven Geotextile*	SF	2135
1,250 Gal Septic Tank	EA	1
600 Gallon Pump Tank	EA	1
EF-4 Effluent Filter*	EA	1
24" Access Risers	EA	4
4 Hole Distribution Box	EA	1
4" Sch 40 Perforated PVC*	LF	517
4" Sch 40 PVC*	LF	122
2" Sch 40 PVC*	LF	60
4" Sch 40 PVC Tee*	EA	25
4" Sch 40 PVC 90*	EA	11
Check Valve	EA	1
1/2 HP Effluent pump*	EA	1
Power Post with Alarm and Timer	EA	1
Site Restoration (Seed & Blanket, Dumpster, Refuse Removal, etc)	LS	
*Or approved equivalent		

3 C-3 MATERIALS



4 C-3 PUMP TANK

GENERAL NOTES:

1. PUMP SYSTEM WILL REQUIRE A DEDICATED 20A 120V 1ϕ CIRCUIT
2. PUMP OPERATES AT ¾ HORSEPOWER AT 3450 RPM

KEYNOTE LEGEND:

1. PVC RISER WITH GROMMET(S) (BONDED TO TANK ADAPTER WITH RECOMMENDED ADHESIVE 24"
2. 24" Ø(MIN) FIBERGLASS GASKET LID WITH STAINLESS STEEL BOLTS

NO | DESCRIPTION | BY | DATE

SHEET TITLE: DETAILS & MATERIALS

PROJECT DESCRIPTION:
Parcel ID: 081-160-013-150-00
Property Address: 2036 Crescent Street Sanford, MI 48657
0.465 Acres

DRAWN BY: GABRIEL FERGUSON
APPROVED BY:

DATE: 04/11/2022

SCALE:

SHEET: C-3

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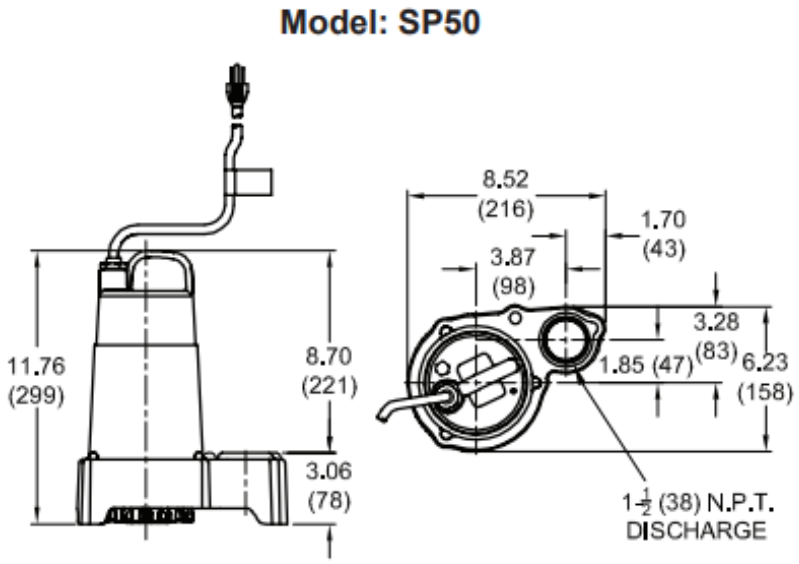
Pump Design

Standard pump available for use and example of installation



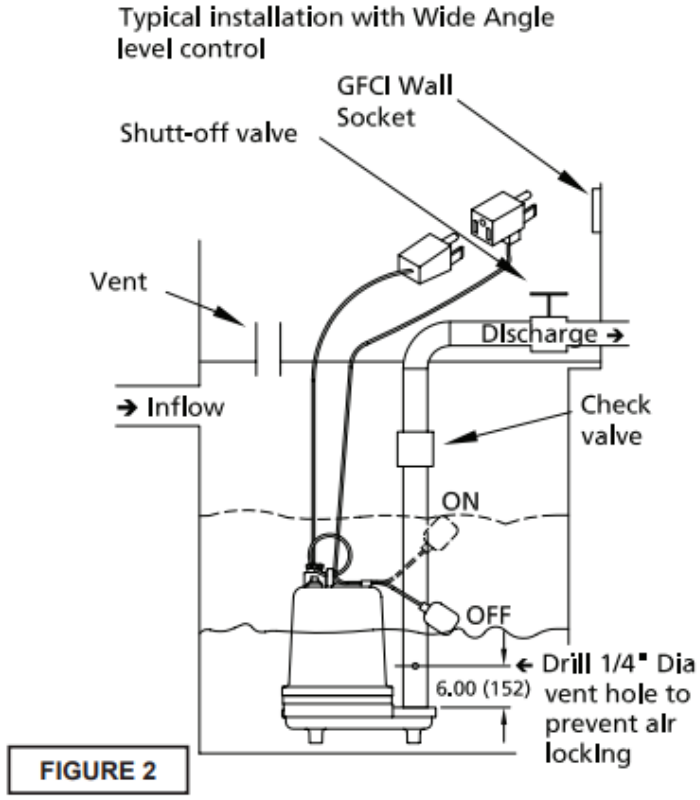


FIGURE 2

*From cranepumps.com

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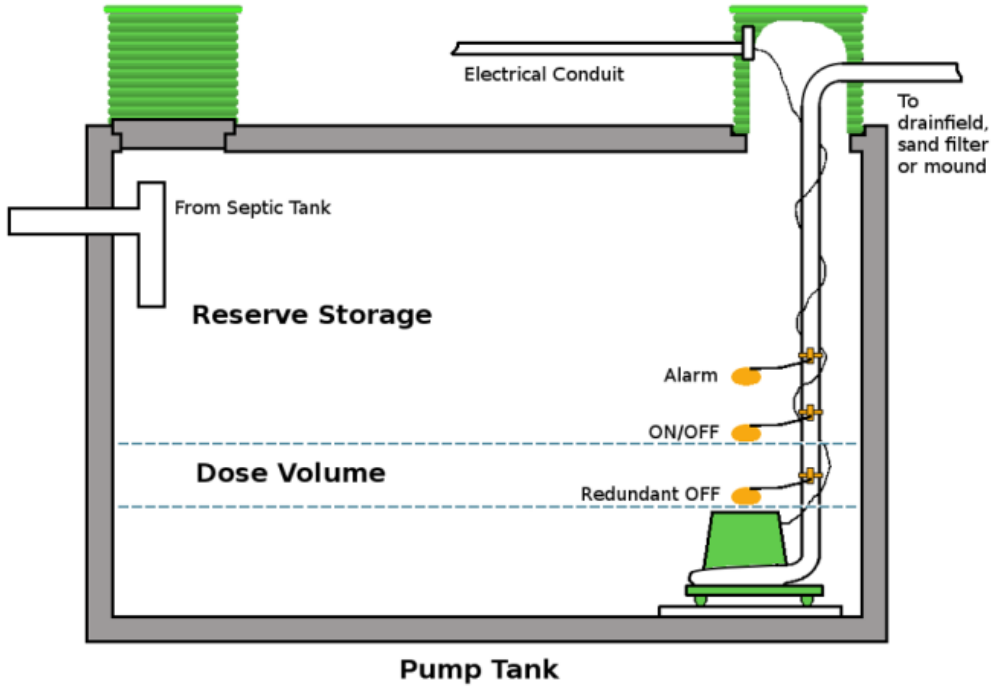
Engineering Analysis

- Design Flow
  - Assume 100 gpd and .17 lbs BOD per person
  - Single family house averages 3.5 people
    - 350 gpd
  - Assume max daily flow of 1,000 gallons per day
- 204 mg/L BOD concentration
  - Drain field size is appropriate per Michigan Criteria for On-Site Wastewater Treatment chapter 5

Engineering Analysis

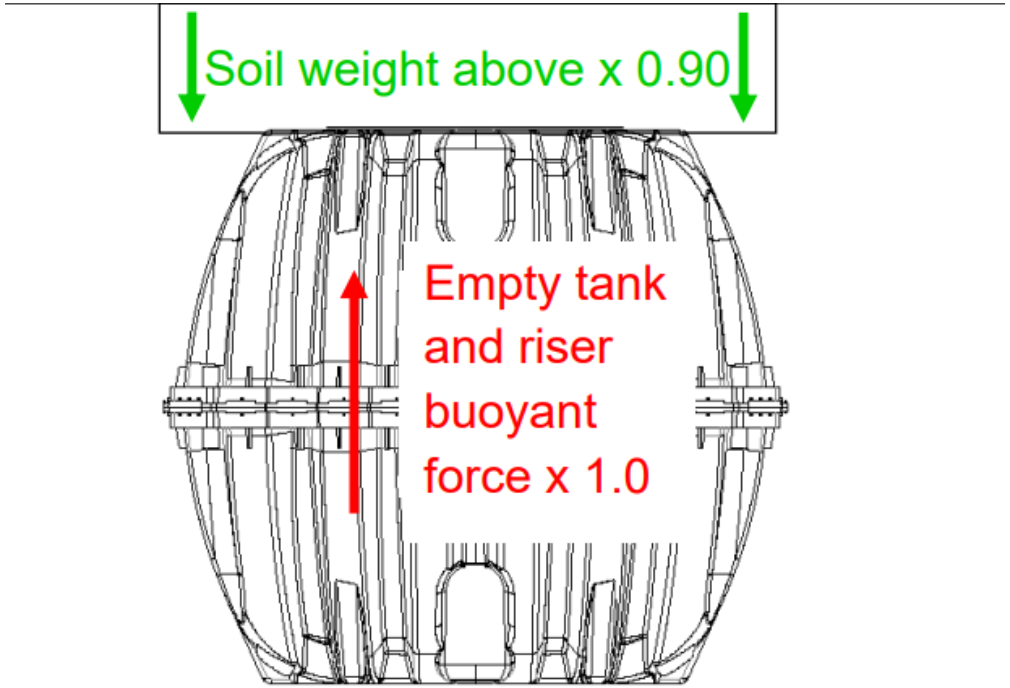
- Pump tank float levels
  - 3 floats required to operate pump with timer
- 1st float
  - 18 inches from bottom of tank
  - Only pumps with timer on
- 2nd float
  - 25 inches from bottom of tank
  - Overrides the timer
  - ~90-gallon difference
- 3rd Float
  - 40 inches from bottom of the tank
  - Sounds alarms
  - Safety factor of ~100 gallons before tank backs up



*Picture from expresssepticservice.com

Engineering Analysis

- Buoyancy of tanks
- Septic tank
  - Soil cover and weight of septic tank
    - 21,000 lbs
  - Buoyant force of 17,000 lbs
- Pump tank
  - Soil cover and weight of pump tank
    - 12,750 lbs
  - Buoyant force of 9,500 lbs



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Cost Analysis

- Material pricing sourced from local suppliers
- Labor from RSMeans Online
  - Estimates from 2011
- Material Subtotal
  - $17,100
- Labor Subtotal
  - $13,100
- Total with contingency and O&P
  - $45,600

MILAN SUPPLY COMPANY

Fisher SAND AND GRAVEL

High Grade Materials

midland sand company, llc.

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Cost Analysis

Item	Unit	Quantity	Material Unit Cost	Material Subtotal	Install Unit Cost	Install Subtotal	2022 Cost
Mobilization	LS		$185.00				$185.00
Excavation (Include Hauling)	CYD	55	$0.00	$0.00	$5.61	$308.69	$308.69
Backfill	CYD	39	$0.00	$0.00	$1.94	$75.56	$75.56
Class 1 Sand	TN	213.5	$0.00	$0.00	$1.00	$213.50	$213.50
6A Stone	TN	102	$24.00	$2,448.00	$44.63	$4,551.75	$6,999.75
Top Soil	TN	78	$15.00	$1,170.00	$1.69	$131.63	$1,301.63
Embankment Fill (Fill Sand)	TN	559	$5.75	$3,214.25	$1.69	$943.31	$4,157.56
Non woven Geotextile	SF	4270	$0.16	$683.20	$0.06	$266.88	$950.08
1,250 Gal Septic Tank	EA	1	$875.00	$875.00	$1,436.25	$1,436.25	$2,311.25
600 Gallon Pump Tank	EA	1	$575.00	$575.00	$1,213.75	$1,213.75	$1,788.75
EF-4 Effluent Filter	EA	1	$34.00	$34.00	$128.75	$128.75	$162.75
24" Diameter Access Risers 12"	EA	12	$75.00	$900.00	$11.69	$140.25	$1,040.25
4 Hole Distribution Box	EA	1	$65.00	$65.00	$43.13	$43.13	$108.13
4" Sch 40 Perforated PVC	LF	517	$6.75	$3,489.75	$4.21	$2,176.57	$5,666.32
4" Sch 40 PVC	LF	122	$6.75	$823.50	$4.21	$513.62	$1,337.12
2" Sch 40 PVC	LF	60	$2.58	$154.80	$1.74	$104.40	$259.20
4" Sch 40 PVC Tee	EA	25	$16.99	$424.75	$1.35	$33.75	$458.50
4" Sch 40 PVC 90	EA	11	$13.77	$151.47	$1.35	$14.85	$166.32
1/2 HP Effluent pump	EA	1	$292.00	$292.00	$537.50	$537.50	$829.50
Power Post with Alarm	EA	1	$298.00	$298.00	$193.75	$193.75	$491.75
Site Restoration (Seed & Blanket, Dump	LS	1	$1,500.00	$1,500.00	$0.00	$0.00	$1,500.00
Subtotal =		-	-	**$17,100**	-	**$13,100**	**$30,400**
Contingency (% of Subtotal)	20%	-	-	$3,420	-	$2,620	$6,080
Contractor O&P (% of Subtotal)	30%	-	-	$5,130	-	$3,930	$9,120
Total Alternative 1 Cost =		-	-	**$25,650**	-	**$19,650**	**$45,600**

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Testing and Validation

Requirement	Inspection	Test	Analysis	Pass/Fail
42 inches above current grade	x			PASS
18 inches above water table	x			PASS
7:1 slopes on embankments	x			FAIL
2100 sf size field	x			PASS
1250-gallon dual tank	x			PASS
10 ft isolations	x			PASS
Perc Rate of 45 min/inch or less		x		PASS
Tank resists buoyancy			x	PASS
Handles 350 gallons per day			x	PASS
Alert Residents to failure	x			PASS
Timed dosing of field	x			PASS
Outside of floodplain	x			PASS

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Testing and Validation

- Effectively separate all solids larger than 1/16”
- Design objectives
  - Affordable?
  - Easy to maintain?
  - Lifespan?
  - Fit similar shaped lots?

*Picture from tuf -tite.com

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Impacts of our design

- Sets a precedent of new developments in the town
  - More affordable housing
- Helps reestablish the tax base
- Encourages businesses to return
- Future senior design projects

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Conclusion

- Recommendations
  - We recommend Habitat move forward with the design
  - Submit the drawings with the permit application to the health department
  - Find as much volunteer work as possible to reduce labor costs
- Lessons we learned
  - The importance of codes and regulations
    - Severely limited this design
  - How to communicate effectively with suppliers
  - How to work as part of a larger team

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Q&A

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