To: Mike Hoffman
From: Taylor Batz, Graci Doll, Matt Mueller, Grace Brethel, and Anthony Marazzi
RE: Storm Water Collection and Reuse at the University of Cincinnati's Main Campus
Date: April 20, 2021

Dear Mr. Hoffman,

Storm Delta Engineering Solutions is pleased to present the Storm Water Collection and Reuse at the University of Cincinnati's Main Campus Proposal.

The attached report includes:

- Literature review of historic rainfall data, storage options, and pretreatment options
- Alternative analysis for pretreatment options
- Alternative analysis for storage tank options
- Storage Simulation
- Site Plans
- Economic Analysis

Storm Delta Engineering Solutions is happy to provide design services for the completion of this design proposal and is available to answer any questions as needed. Thank you for your consideration of our proposal.

Respectfully,
Taylor Batz
Graci Doll
Matt Mueller
Grace Brethel
Anthony Marazzi

Stormwater Reuse at the University of Cincinnati Main Campus

STORM DELTA

ENGINEERING SOLUTIONS

Taylor Batz, Grace Brethel, Graci Doll, Anthony Marazzi, and Matthew Mueller

Executive Summary

Storm Delta Engineering Solutions (SDES) was given the opportunity to work with University of Cincinnati's Utility Department to help the University mitigate their stormwater runoff through stormwater reuse. Capturing stormwater and reusing it for campus benefit will allow for less water to go into the Metropolitan Sewer District's combined sewer system, and result in less sewage backups in basements and flooding in areas across campus. Additionally, reusing stormwater will help the University cut down on costs associated with water use on campus.

During the first semester an alternative analysis was performed on pre-treatment and storage options. The result of the alternative analysis was that a hydrodynamic separator would be used as pre-treatment and both the CRC and Fifth Third storage tanks could be used for stormwater collection. Two reuse options were developed. One being to route the reuse water to the utilities plant for water cooling and the other to the new Clifton Court building for toilet water flushing.

During the second semester after discussion and analysis of the options it was decided that the best option would be to use the reuse water for the utilities plant. This is due to the fact that there is already a primary treatment system in place and there was easy access to the routing tunnels for the conveyance of the reuse water. Both of these points would drive down the cost of the project. It was also decided that storm water from both the CRC and Fifth Third tanks would be routed to the utilities plant to maximize the amount of storm water being taken out of the system and reused.

After these decisions were made, routes from the tanks to the utilities plant were developed using Bluebeam Revu, these were approved by the client. Preliminary analyses were carried out to determine the peak flow rates for each storage tank system and to determine how much water could be collected based on historical data. Additionally, a simulation was carried out to show storage changes for dry, average, and wet years. Savings were then calculated by showing how much water would be supplemented to the utilities plant and how much would be taken out of the system. A pump curve was then developed on EPANET. Then different distributors were contacted to budget out the pump, piping, hydrodynamic separator, screening, and debris baskets costs. An economic analysis was performed to determine the estimated total cost of the project and the breakeven point.

The final designs that were determined for each tank are as follows. The CRC tank will have a hydrodynamic separator as the pre-treatment before the storage tank and a Xylem-Flygt pump after the outlet of the tank. The Fifth Third tank will have debris baskets on each of the three inlets and will also have a dual screen strainer prior to a Xylem-Flygt pump on the outlet of the tank. The stormwater will then go through existing primary treatment at the utility plant. The reuse of water will supplement between 3% and 8% of the utility's plant total water usage. The reuse will also result in 100% reduction of runoff entering the combined sewer overflow system for both parcels. The total amount saved from reusing the water will be $157,882 per year. The total project cost was $315,462. This results in a payback period of 2 years.

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Introduction

1.1 Scope

The services required for this project were to conduct a review of existing campus stormwater reuse systems and review options for the following: separating existing storm and sanitary sewer collection systems, assessing stormwater storage, determining stormwater treatment for possible reuse for irrigation or toilet use, and reviewing regulatory hurdles for re-using stormwater for the University of Cincinnati campus. The objectives of this project would be to reduce the amount of stormwater runoff going into MSD's collection system, find a cost-effective way to reuse the storm water runoff using existing storage (this includes pretreatment and primary treatment of water), and assess the action of green infrastructure on campus.

1.2 Background

Located in a combined sewer overflow (CSO) drainage shed, UC's main campus has some stormwater overflow issues during major storm events. These issues include campus sewers backing up, drains being overwhelmed, and water damage to University buildings, classrooms, and living areas. This has resulted in significant cost to the University. The University of Cincinnati Utilities Department believes that runoff on the main campus can be reused once it is collected into existing detention tanks. This will not only allow runoff to serve a purpose on campus, but also be efficiently mitigated so that it will not enter the CSO drainage shed. In order for the water to be reused it must be treated and conveyed to the proper destination.

1.3 Approach

Storm Delta Engineering researched different technologies and processes for pretreatment, preliminary treatment, and overall reuse projects. Two underground storage tanks that are already in place on campus were analyzed and selected (the CRC and Fifth Third tank.) A preliminary analysis was performed to determine expected stormwater collection for each tank based on historical data, and a simulation was developed to show change in storage over time. An analysis was also performed to determine the peak flow of the system. The stormwater will be collected using existing stormwater sewers going into underground tanks. An outlet control will be put in place to prevent flow to CSO during storm events (until the capacity of the tank is reached.) This was designed according to an existing plan performed by the Metropolitan Sewer District. Storm Delta then determined the route from the tanks through existing tunnels to the University of Cincinnati's Utility Plant. A pump curve was developed through EPANET to help determine what pumps were needed. Quotes for the hydrodynamic separator, debris baskets, piping, and pump were then obtained. Site plans were then developed using Bluebeam and Revvit. Finally, an economic analysis was performed to determine the breakeven point of the project.

Alternative Analysis

This section goes through an alternative analysis for the storage tanks and pre-treatment. For each analysis alternative, every option was rated based on how many options were available with the highest number being the most favorable. Criteria were then weighted based on priorities chosen by Storm Delta Engineering Solutions. These weights were multiplied by each rating and then the sum of the scores were calculated. The final score was used to rank each alternative from the highest score to lowest score.

2.1 Storage Tanks

The four criteria selected for the storage tank analysis were storage capacity, accessibility, drainage potential, and degree of treatment needed. The criteria containing the heaviest weight was drainage potential; this shows how much stormwater runoff will be mitigated and the potential for reuse. The second category was storage capacity. Storage capacity was an important decision factor because there needs to be enough storage to meet the demand requirements of the reuse processes and to store the runoff. The lowest criteria for the analysis was accessibility. Accessibility is something that should be considered but is not seen as a dealbreaker for the project. A comparative analysis for the four criteria is provided in Table 1.

Table 1: Comparative analysis for storage tank options

Comparative Analysis for Storage Tanks			
Criteria	**CRC**	**Campus Green**	**5th/3rd**
Capacity (Gallons)	822,800	12,234	248,815
Accessibility	Has three access points	Has one access point	Has two access points
Type of Inlet	Storm sewer only	Storm sewer only	Storm sewer only
Drainage Potential	10 acres	2 acres	4 acres

Using data from the comparative analysis in Table 1, an alternative analysis matrix was developed (Table 2).

Table 2: Alternative analysis for storage tank options

Storage Tank Alternative Analysis Matrix				
Criteria	**Weight**	**CRC**	**Campus Green**	**5th/3rd**
Drainage Potential	3	3 (9)	1 (3)	2 (6)
Storage Capacity	2	3 (6)	1 (2)	2 (4)
Accessibility	1	3 (3)	1 (1)	2 (1)
Unweighted Score (12)		9	3	6
Weighted Score (30)		18	6	11

Since the CRC tank and the 5th/3rd tank had the highest weight and unweighted score it was determined that these tanks would be used to hold water for reuse.

2.2 Pre-Treatment

The pre-treatment methods chosen below will only be used for high traffic and larger drainage areas. For lower drainage areas, debris baskets will be used. The four criteria chosen to evaluate the pretreatment options were cost of material and installation, maintenance costs, treatment level, and footprint. The criteria with the biggest weight was chosen to be the treatment level because the total suspended solids (TSS) needs to be reduced as much as possible. Material and installation cost of the system was weighted second because it is important the system is not too expensive. Maintenance cost was given the third weight because it is important to mitigate recurring cost. Finally, the overall footprint of the system is given the fourth weight. While space needs to be minimized; each alternative could be a possible option when regarding footprint. The estimates for each alternative in Table 3 below. Information for the Ballasted Flocculation material and installation cost were unavailable.

Table 3: Comparative analysis for pretreatment options

Comparative Analysis for Pretreatment Alternatives			
Alternative	**Ballasted Flocculation**	**Hydrodynamic Separator**	**Bioswale**
Material Cost	Unavailable	$30,000	$35,000
Installation & Shipping	Unavailable	included in above	Included in above
Total Cost	Unavailable	$30,000	$35,000
Treatment Fecal Coliforms	65%	0%	0%
Treatment TSS	85%	at least 80%	
Yearly Maintenance Hours	80	8	Once a month or after 1.5 inches of rain
Yearly Maintenance Cost	$1,600	$160	$1,200.00
Yearly Pump Cost	$1,000	$1,000	$0
Total Maintenance Cost per Year	$2,600	$1,160	$1,200
Footprint Above Ground	N/A	N/A	1000
Footprint Below Ground	Largest due to Low Flow Required	Compact	Medium (Not a lot of Area on Campus)
Total Footprint	N/A	N/A	6000 (1000 sqft, 6ft deep)

Based on the information in Table 3, an alternative analysis matrix was developed (Table 4).

Table 4: Alternative Analysis for Pretreatment Options

Pretreatment Alternative Analysis Matrix					
Criteria	**Weight**	**Combination**	**Flocculation**	**Hydrodynamic Separator**	**Bioswale**
Treatment Level	4	3 (12)	4 (16)	1 (4)	2 (8)
Material and Installation Cost	3	2 (6)	1 (3)	4 (12)	3 (9)
Maintenance Cost	2	2 (4)	1 (2)	4 (8)	3 (6)
Footprint	1	2 (2)	1 (1)	4 (4)	3 (3)
Unweighted Score (16)		12	7	13	11
Weighted Score (40)		24	22	28	26

Since the hydrodynamic separator had the highest unweighted score, it was determined that this would be used for pretreatment in the high trafficked and large drainage area for CRC. For the Fifth Third tank the pretreatment can be less stringent and there are three different inlets into the tank. Thus, debris baskets will be used to reduce cost. Which is a typical method of "pre-treatment" for areas that need less filtering.

Preliminary Analysis

3.1 Surface Runoff Analysis

The land area of the University of Cincinnati's 200 acre main campus consists of a variety of run-off generating surfaces. In order to calculate the amount of run-off generated on main campus, an analysis of these surfaces was required. The campus was divided up by surface types: brick sidewalk, concrete sidewalk, rooftops, and green space. The total area of UC's main campus was calculated as well as the drainage areas for each of the storage tanks located on campus. The polygon area tool in Bluebeam Revu was used to manufacture precise areas for each surface type on campus (Table 5). The total average runoff coefficient was determined by calculating the percentage of the total area for each respected surface type and multiplying it by the runoff coefficient. These values were then summed together in order to find the overall average coefficient used for the runoff volume (see Appendix A, Equation 1).

Table 5: Types of surfaces on campus, their areas and runoff coefficients

Surface Type	Surface Area (sqft)	Surface Area (acres)	Runoff Coefficient	Percent of Total Area
Brick Sidewalk	316960	7.27	0.775	0.0999
Concrete Sidewalk	90981	2.08	0.875	0.0286
Rooftops	1753278	40.25	0.850	0.5527
Green Space	1011179	23.21	0.175	0.3187
Total:	**3172399**	**72.83**		

Total Average Runoff Coefficient: 0.6281

In order to determine the runoff coefficient for each drainage area, the same process was followed above, except for smaller areas. This resulted in 0.628 for the CRC tank drainage area and 0.875 for the Fifth Third tank drainage area. It makes sense that CRC would be similar to the whole campus because the drainage area is much larger and contains similar surface types. The runoff coefficients will be used in determining the peak flow in Section 3.3, the recovered runoff volume for both tanks in Section 3.4, and to determine the amount of runoff going into the tanks for the storage simulation in Section 3.5.

3.2 Stormwater Collection

In order to collect stormwater for reuse the existing inlet and outlet locations of the storage tanks needed to be determined. Both of the tanks, CRC and Fifth Third, have existing connections. Both the CRC and Fifth Third tanks have a stormwater sewer inlet pipe and an outlet pipe that connects to the surrounding combined sewer overflow (CSO) system. Instead of adding more pipes to the system to collect and route stormwater to the tanks, the inlets already in place will continue to be utilized and the outlets will be controlled. The University of Cincinnati Utilities and MSD currently have a project for outlet control of the CRC tank. A gate will be installed on the 12” low flow outlet that will be controlled through a level sensor in the tank, downstream sensors, and weather forecast information. This gate will be remotely communicated to the MSD SCADA system, which will allow it to take into account the factors mentioned above. By controlling the outlets during storm events, the amount of stormwater being collected will be able to be managed and the amount being reused will be able to be tracked.

3.3 Time of Concentration and Peak Flow Rate

In order to size different preliminary treatment devices, the peak flow needs to be determined. To do this the time of concentration for the drainage area for each of the tanks was determined by creating a path through the drainage area. This path was divided into sheet flow, shallow concentrated flow, and pipe flow. The information for each of these paths was then put into HydroCAD which then calculated the time of concentration. After the time of concentration was determined, the rainfall intensity based on the time of concentration was calculated. The standards equations to calculate the rainfall intensity were found in Hamilton County Code Article 07. Once the rainfall intensity was determined for both watersheds the rational method (Q = CiA) was used to determine the peak flow rate (see Appendix A Equation2.) The coefficients (C) from Section 3.1 were used in the rational method calculation. As stated in Section 3.1, the CRC coefficient is 0.628 and the Fifth Third coefficient is 0.875.

Table 6: Time of Concentration Values

CRC Tank Tc = 27 min		
Return Periods (years)	**Peak Rainfall (in/hr)**	**Peak Q (cfs)**
2	2.4	14.5
5	2.8	17.2
10	3.4	20.5
25	4	24.3
50	4.6	27.9
100	5	30.1

Fifth Third Tank Tc = 10 min		
Return Periods (years)	**Peak Rainfall (in/hr)**	**Peak Q (cfs)**
2	3.9	14.1
5	4.5	16.2
10	5.2	18.5
25	5.8	20.6
50	6.8	24.2
100	7.1	25.4

3.4 Historical Rainfall Analysis

Using the historical rainfall data given by MSD last semester, a historical statistical analysis was completed to determine how much rain can be expected. A total rainfall amount in inches was summed for every month during the 16 year period. Next, a box and whisker plot was created for each month with the sixteen totals, any outliers were identified, and an average rainfall was taken. After having monthly average rainfall data, the runoff coefficients from Section 3.1 were used to determine the estimated runoff recovery of rainfall in each drainage area in inches (see Appendix A Equation 3). The monthly average volume was determined using the estimated runoff recovery and the drainage area volumes. Monthly water usage volumes were provided by the utilities plant and the monthly supplemental percentage is outlined in Table 7.

Table 7: Average Monthly Rainfall and Monthly Supplemental Percentage

Month	Avg Rainfall (in)	Est Recovery 5th/3rd (in)	Est Recovery CRC (in)	Avg Runoff 5th/3rd (CCF)	Avg Runoff CRC (CCF)	Utility Avg Usage (CCF)	Water Supplemented
January	2.856	2.499	1.793	399.09	624.29	14,088	7.26%
February	3.395	2.971	2.132	474.53	742.31	19,811	6.14%
March	4.437	3.883	2.787	620.15	970.09	21,916	7.26%
April	4.815	4.213	3.024	672.96	1052.70	24,561	7.03%
May	4.185	3.662	2.628	584.82	914.82	26,742	5.61%
June	4.764	4.169	2.992	665.83	1041.56	27,004	6.32%
July	4.349	3.805	2.731	607.79	950.75	36,379	4.28%
August	3.387	2.964	2.127	473.34	740.44	36,889	3.29%
September	3.704	3.241	2.326	517.62	809.71	35,013	3.79%
October	3.675	3.216	2.308	513.66	803.52	28,813	4.57%
November	3.393	2.969	2.131	474.24	741.84	21,137	5.75%
December	3.729	3.263	2.342	521.20	815.31	16,813	7.95%

3.5 Storage Simulation

A storage simulation was created in Microsoft Excel so that the University of Cincinnati can visualize what the storage in the tanks could look like during an average, wet, and dry year. The averages from Table 6 were compared to the rainfall data for each year to determine what years would be used for the simulation. It was decided that 2006 most closely represented an average year, 2014 most closely represented a dry year, and 2011 most closely represented a wet year. In the simulation the rainfall data was summed to become daily amounts of rain over the year. It was then converted to runoff by multiplying it by the runoff coefficient from Section 3.1 for each drainage area and then it was converted to gallons per day (GPD.) The runoff GDP is the inflow for the tank. The outflow was determined by taking the total daily plant demand for that month and subtracting it by the amount the utilities plant would need to receive from GCWW. For the different weather conditions, the amount that the utilities plant would receive from GCWW would fluctuate due to there being an increase or decrease of inflow. For the dry year simulation, the utility plant on average would get 7% of their water from the tanks and 93% of their water from GCWW. For the average year simulation, the utility plant on average would get 10% of their water from the tanks and 90% of their water from GCWW. For the wet year simulation, the utility plant on average would get 23% of their water from the tanks and 77% of their water from GCWW. These percentages were determined by stopping the simulation once the storage at any point of the year was below the max amount of combined storage, which is around 1,000,000 gallons. This can be observed in the storage graphs below, where storage equals inflow minus outflow. The graph shows storage in gallons versus time on the bottom x-axis and daily rainfall in inches versus time on the top x-axis.

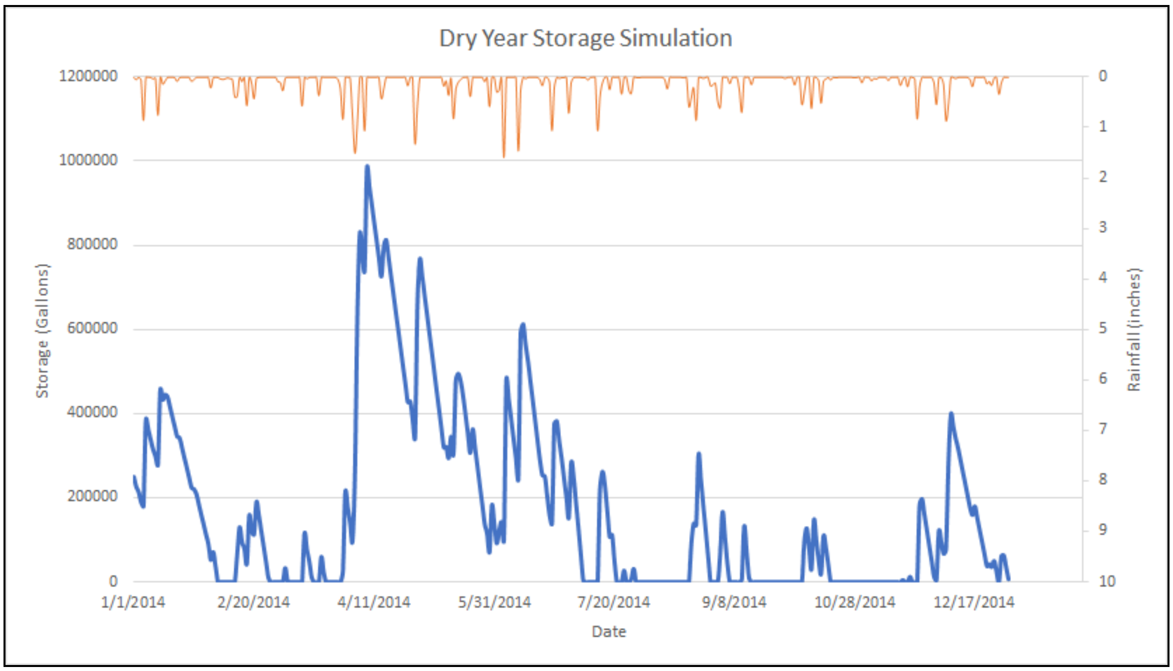


Figure 1: Dry Year Storage Simulation

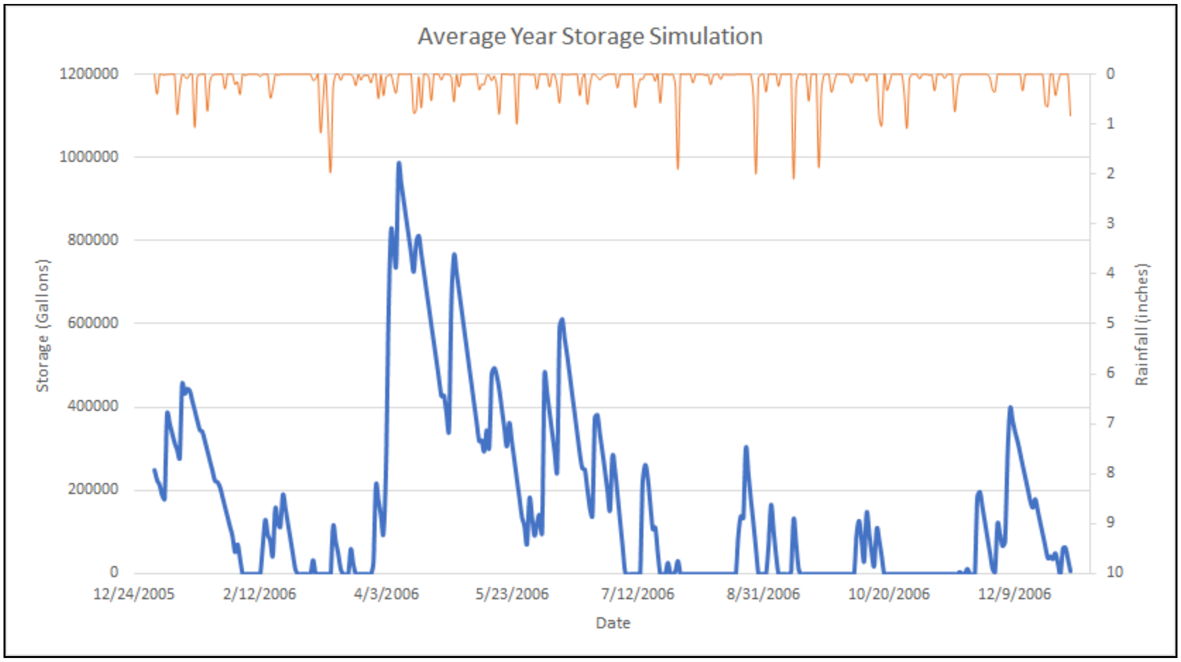


Figure 2: Average Year Storage Simulation

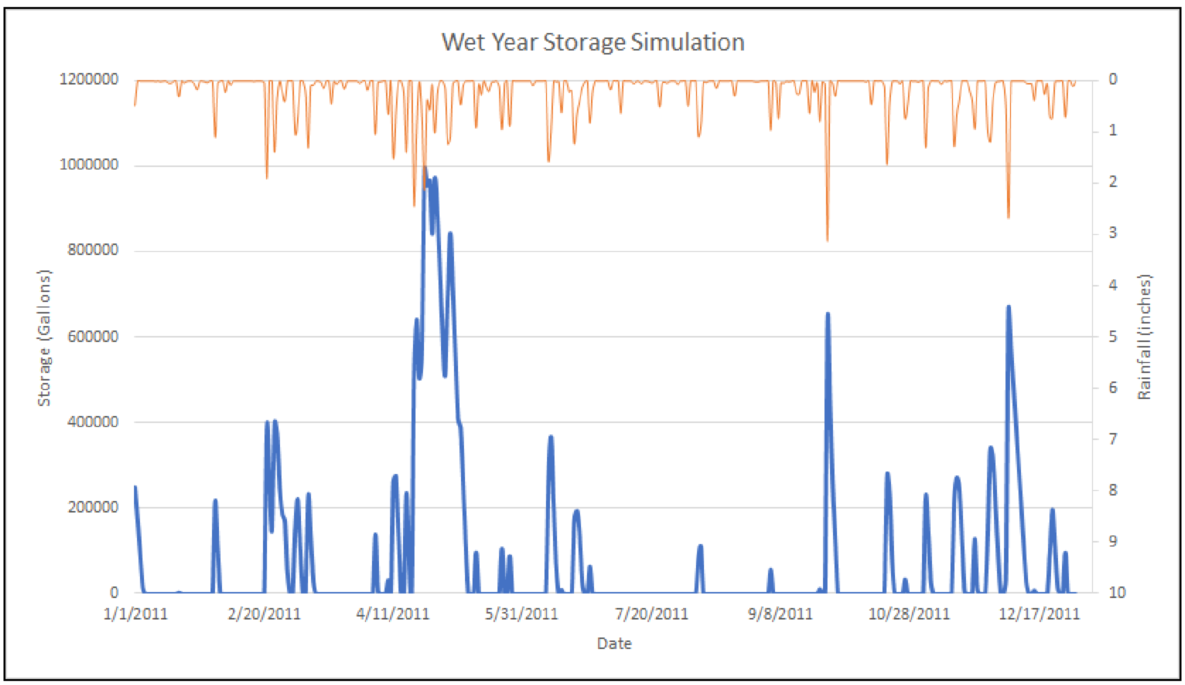


Figure 3: Wet Year Storage Simulation

An example calculation for the simulation can be found in Appendix A, Equation 4. For each simulation there are months that have larger storage peaks. During these months, there is a larger amount of storage due to an increased amount of rainfall. Since there is more water in the tanks, the utilities plant could draw more water and therefore the percent supplemented by the tanks would be larger than the base percent mentioned above. For instance, during a wet year for April 2011 the utilities plant could pull more water and thus for that month the percent supplemented would be larger 23%. The graphs also have areas where there is zero storage, this means that during those times the amount sent to the utilities plant pulled all the water out of the tank or there was a dry spell. Thus, the percent supplemented would be at the base percent or below it. By looking at the rainfall data on the top axis, it can be observed if there was a dry spell or if all the water was just taken to the utilities plant. All of these graphs never have an instance where the runoff goes above the maximum storage amount. Therefore, it is correct to assume that all runoff from these drainage areas can be collected, stored, and used.

Design

4.1 Hydrodynamic Separator Design (Appendix C - Figure C1)

The hydrodynamic separator (HDS), Cascade Separator-8, by Contech Engineering Solutions was designed to separate and trap debris, sediment, and hydrocarbons from stormwater runoff before entering the CRC detention tank. The stormwater will enter the HDS through a 20 inch inlet pipe where the water creates a swirling vortex causing floatable debris to be captured in the separation chamber and sediment to settle in an isolated sump. This design allows the Cascade Separator-8 to treat high flow rates with a small environmental footprint. The campus area where the CRC storage tank is located has a large drainage area of 9.59 acres and is a heavily trafficked part of campus. The Cascade Separator-8 will be able to handle the large volumes of runoff and trash that this area of campus will produce. These two factors have determined the Cascade Separator-8 to be installed at manhole D31, about 110 feet from the inlet of the CRC storage tank. See Appendix B, Figures B1 and B2 for placement and Appendix C, Figure C1 for sizing.

4.2 Strainer Design

4.2.1 Debris Basket (Appendix C - Figure C2)

Since the Fifth Third storage tank has a smaller drainage area than that of the CRC detention tank and the storage tank has three inlets, it was decided that a debris basket would be installed rather than a hydrodynamic separator for collection of large solid material. In order to prevent debris from entering the storage tank a B1B trash basket, by Halliday Products, will be placed at the inlets of the Fifth Third storage tank. This provides a cheaper alternative to screen out solids that may damage the pump equipment. The trash basket is placed on rails that work as a hoist to easily raise and lower the basket for cleaning purposes. See Appendix B, Figures B3 and B4 for placement and Appendix C, Figure C2 for sizing.

4.2.2 Duplex Strainer (Appendix C - Figure C3)

A Keckley carbon steel 6 inch duplex strainer will be installed at the outlet of the CRC and Fifth Third storage tanks, prior to the pumping system, to prevent any small solids or sedimentation from passing through the pump, which may cause clogging or pump damage. The duplex strainer will be manufactured with positive sealing bronze diverters in order to safely handle the suction service provided by the water pump. In addition, the two separate basket housings allow for continuous flow, so the system never has to be shut down for cleaning and/or maintenance. Keckley duplex basket strainers are designed with knob type covers for tool free removal of the baskets. Also, the handle to divert the water flow is designed to be over the in-service chamber allowing for easy cleaning and removal of the off-duty chamber basket. The selected duplex strainer will also have flanged rather than threaded ends on both the inlet and outlet pipes for ease of installation. See Appendix B, Figures B1, B2, B3, and B4 for placement and Appendix C, Figure C3 for design.

4.3 Pump Design (Appendix C - Figure C4 & Figure C5)

In order to designate a pump for the system, the total head loss from the tank to the utilities plant needed to be determined. Before determining the head loss, the characteristics of the system must be decided. The flow rate of 150 gallons per minute was specified from the client.

The piping used will be carbon steel with an inside diameter of 6 inches, resulting in a velocity of 1.7 feet per second. The routes from CRC and Fifth Third were drawn (see Figure 6), the number of 45 and 90 degree turns were counted, the lengths were measured, and the elevation changes were determined. Minor losses due to turns, contraction from tank to pipe, and expansion from pipe to the utility's tank were all included in the equation to ensure better accuracy. Next, the frictional factor was determined using Von Karmen's equation as an initial guess and iterating using Colebrook's Equation. Once the frictional factor was obtained, the Darcy Weisbach Equation was used to determine the dynamic head (see Appendix A, Equation 5). The static head is the difference between the elevation of the tank and the utilities plant. The total head of the system in feet is the sum of the static and dynamic head. The total head for each route as well as the horsepower needed for each pump is outlined in Table 8.

Table 8: Total Head and Total Horsepower Needed for Each Route

Route	Head (ft)	Horsepower
CRC to Utilities	192	7.27
5th/3rd to Utilities	157	5.94

Once the total head for each tank was determined, the one point method in EPANET was used to obtain pump curves. The total head in feet and the desired flow rate of 150 gallons per minute were inputted to obtain adequate pump curves. After the pump curves were developed, a salesperson at BL Anderson Company was consulted. It was determined that Xylem-Flygt pumps with an NZ configuration would best fit this application. The pumps will be contained in a pump house directly next to the tank, with the dimensions of twenty-three feet tall, twelve feet long, and six feet wide, with walls one foot thick. This will make it accessible from ground level and provides plenty of room for the pump to be maintained.

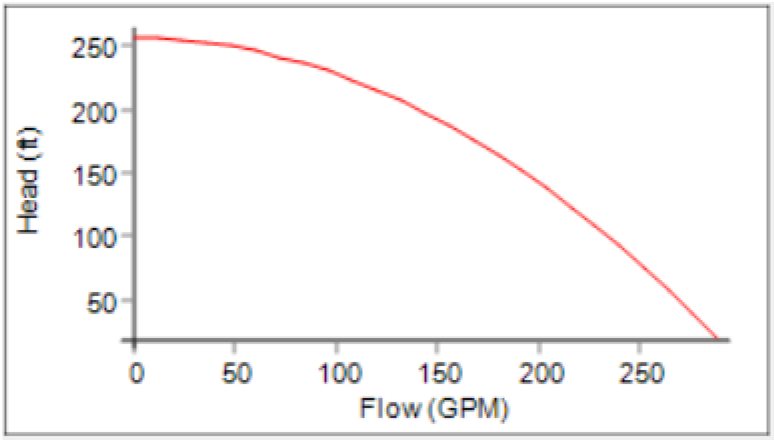


Figure 4: Pump Curve from EPANet for CRC Tank

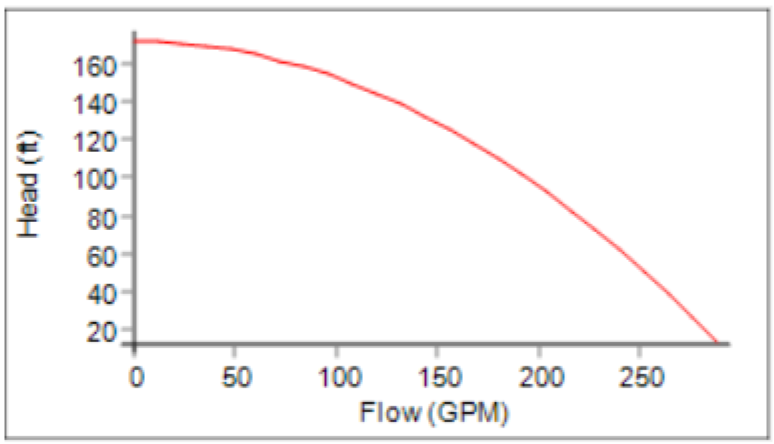


Figure 5: Pump Curve from EPANet for Fifth Third Tank

4.4 Conveyance Design

In order to convey the stormwater collected in the CRC and Fifth Third tanks to the Utility Plant 0.83 miles (4,382.4 feet) of carbon steel pipe is to be installed. This length was measured from routes proposed by Storm Delta Engineering Solutions and approved by the client; routes shown in Figure 6. These routes were based off the existing university tunnel system and are the shortest distances possible with the least amount of excavation needed. For the material of the pipe, originally SDE considered PVC piping due to it being inexpensive. However, PVC has a low melting point and the pipes could come in contact with high temperatures in the university tunnel system. To account for the heat in the tunnel system SDE decided that carbon steel would be the best material for the conveyance system due to being durable and heat resistant.

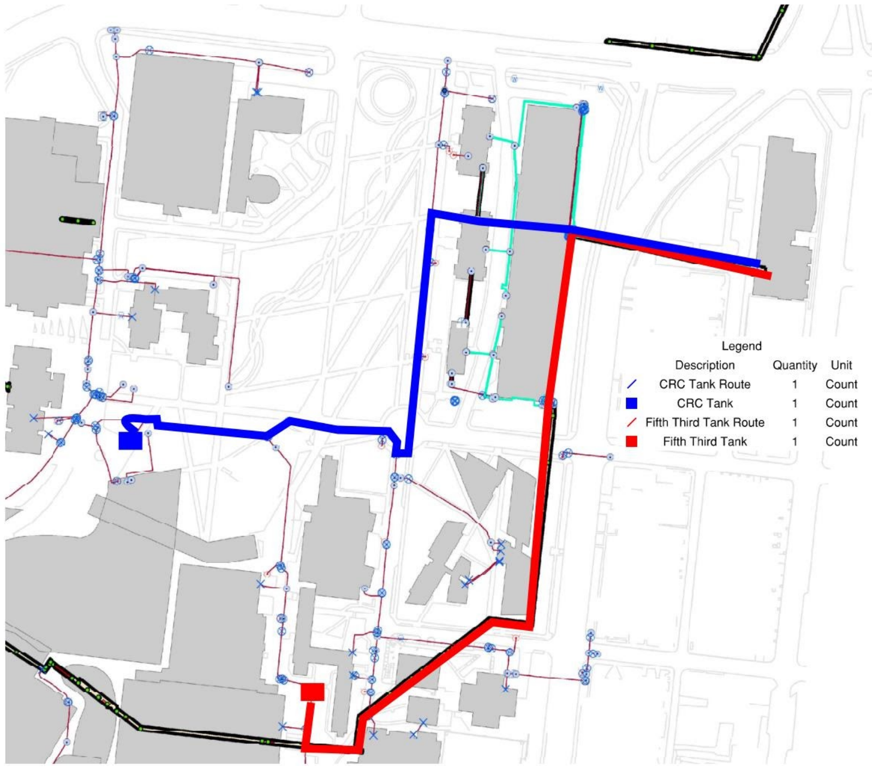


Figure 6: Conveyance Routes to Utilities Plant

For both the CRC tank and the Fifth Third tank an outlet pipe will need to be installed and connected to the university tunnel system. As previously mentioned, the outlet pipe will be 6" carbon steel and connected to a duplex strainer then a Xylem-Flygt pump. The height of this outlet pipe will be about 2' above the bottom of the tank. This height was decided so that the maximum amount of stormwater can exit the tank without bringing extra debris that has settled to the bottom of the stormwater collection tanks. See appendix B, Figures B1-B4 for corresponding site plans of conveyance layout to tanks.

Economic Review

5.1 Savings

Using the historical rainfall analysis in Section 3.2, the monthly and annual cost of water savings were calculated. The City of Cincinnati charges commercial institutions $2.25 per gallon for every gallon used after 600 CCF of water. In order to get the cost amount saved on water usage, the gallons supplemented from the stormwater was multiplied by $2.25.

Table 8: Monthly and Annual Savings on Water Usage at the Utilities Plant

Month	Utility Avg Usage (CCF)	Water Supplemented (CCF)	Cost Savings
January	14,088	1,083.56	$2,438.01
March	21,916	1,683.74	$3,788.42
April	24,561	1,827.12	$4,111.02
May	26,742	1,587.82	$3,572.60
June	27,004	1,807.78	$4,067.51
July	36,379	1,650.18	$3,712.91
August	36,889	1,285.14	$2,891.57
September	35,013	1,405.37	$3,162.08
October	28,813	1,394.63	$3,137.92
November	21,137	1,287.58	$2,897.06
December	16,813	1,415.09	$3,183.95
Total per year	289,355	16,428.01	$36,963.02

In addition, the University will save money from a reduction in stormwater charge on both areas of campus. The Fifth Third “watershed” has a current monthly stormwater cost of $3,129. It is estimated the utilities plant will capture and reuse 100% of the stormwater from this parcel, saving the University $37,554 per year. The CRC “watershed” has a current monthly stormwater cost of $6,947. The estimated capture and reuse percentage is 100%, which saves the University $83,365 per year. The total savings from water usage and stormwater cost reduction is $157,882 per year.

5.2 Project Cost

Various quotes from businesses were used to estimate the projected costs of the project (Appendix D). The total material cost estimate is $242,663, while the total project cost is estimated to be $315,462. The construction and project management costs are estimated to be 30% of the total material costs. The construction costs would include the installation of the piping, debris baskets, pumps, hydrodynamic separator, new tank outlets, and construction of pump houses. The estimate of 30% is conservative due to the fact that the University employs plumbers, engineers, and other maintenance workers who may be able to assist the project at a lower cost than a contractor. A breakdown of the project costs can be seen in Table 8.

Table 8: Overall Project Costs

Description	Quantity	Units	Cost per Unit	Total Cost
Trash Basket (5th/3rd)	3	EA	$775	$2,325
Strainer 6 inches (5th/3rd and CRC outlets)	2	EA	$23,012	$46,024
Hydrodynamic Separator (CRC)	1	EA	$30,000	$30,000
Pipe from 5th/3rd to Utilities	2112	LF	$12	$25,344
Pipe from CRC to Utilities	2112	LF	$12	$25,344
Pipe Delivery Cost	2	EA	$2,800	$5,600
Excavation/Backfill from Tank to Tunnel	2	LS	$2,400	$4,800
New Tank Outlet	2	EA	$1,150	$2,300
Pump House	2	LS	$6,000	$12,000
Pumps and Controls	2	LS	-	$88,926
Construction and PM contingency	30%	LS	-	$72,799
Total				$315,462

5.3 Payback Period

The payback period was determined by taking the total project costs divided by the yearly saving. With yearly savings of $157,882, the project will take only 2 years to pay for itself in savings. Because the payback period is so short, interest and inflation are not considered in the calculation.

Conclusion

The final designs that were determined for each tank are as follows. The CRC tank will have a hydrodynamic separator as the pre-treatment before the storage tank, dual screen strainer prior to the pump and Xylem-Flygt pump after the outlet of the tank. The Fifth Third tank will have debris baskets on each of the three inlets and will also have a dual screen strainer prior to a Xylem-Flygt pump on the outlet of the tank. The stormwater will then go through existing primary treatment at the utility plant. The reuse of water will supplement between 3% and 8% of the utility's plant total water usage. The reuse will also result in 100% reduction of runoff entering into the combined sewer overflow system for both parcels. The total amount saved from reusing the water will be $157,882 per year. The total project cost was $315,462. This results in a payback period of 2 years.

References

1. "Computing Storm Water Runoff Rates and Volumes." New Jersey StormWater Best Management Practices Manual, vol. 5, Feb. 2004, doi:https://www.njstormwater.org/bmp_manual/NJ_SWBMP_5%20print.pdf.

2. "Storm Water Technology Fact Sheet Hydrodynamic Separators." 2004, doi:https://water-research.net/Waterlibrary/Stormwater/hydrodynamic.pdf.

3. Downs, David. Personal Interview. February 22, 2021.

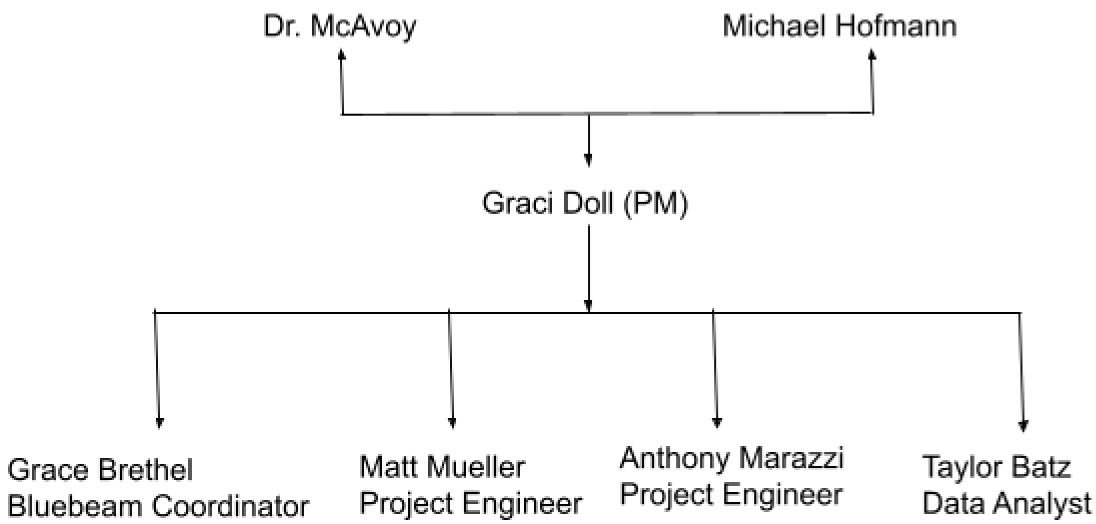
4. Ray, Patrick. Personal Interview. February 25, 2021.

5. Buchberger, Steven. Personal Interview. March, 2021, April, 2021.

Vision Statement

Company: Storm Delta Engineering Solutions

Vision Statement: Offering stormwater management solutions rooted in professional, ethical and sustainable practices.



Personal Statements

Taylor Batz (Data Analyst)

Taylor is a fifth year environmental engineering student at the University of Cincinnati. She has co-op experience with the Ohio Department of Transportation, Terracon Consulting, and Scwhan's Food Company. Taylor spent her first co-op working in the construction management and project engineering field, followed by two co-ops working in environmental consulting consisting mostly of Phase I and II and OEPA compliance fieldwork and reports. Finally, she finished her final co-op working as a Quality Engineer remotely for Schwan's.

Grace Brethel (Bluebeam Coordinator)

Grace is a fifth year Environmental Engineering Student at the University of Cincinnati. She completed three co-op rotations with AECOM as a Wastewater co-op working on stormwater system design, one rotation with Turner working on a jobsite as an assistant engineer, and one rotation as a BIM Operator with Mid-City Electric working on clash detection and design of electrical systems. Through these co-ops she has gained significant experience using ArcGIS, Revit, AutoCAD Civil 3D, PC SWMM, and Bluebeam. Her area of interest includes sustainable stormwater management practices and implementation of Green Infrastructure in urban areas.

Graci Doll (PM)

Graci is a fifth year environmental engineering student at the University of Cincinnati. She has previous co-op experience at Fishbeck, Greater Cincinnati Metropolitan Sewer District, and Strand Associates. Graci's first three co-ops were at Fishbeck in the Water and Wastewater Department. Two of those co-ops she was contracted to MSD in the Remote Monitoring Department. Her final co-op was at Strand Associates in the Municipalities department. In all the co-ops she worked on different water and wastewater design and analysis projects. Her most recent co-op however, focused on stormwater management design and analysis. Through these experiences she has gained skills in AutoCad 3D, XP SWMM, HydroCAD, and ArcGIS.

Anthony Marazzi (Project Engineer)

Anthony is currently in his fifth year of environmental engineering at the University of Cincinnati. He has completed his five co-op rotations at Valeo Climate Control and the Ohio Department of Transportation. The first three rotations were with Valeo Climate Control where he worked in the quality lab assisting with quality control and the creation of part tolerances using Calypso CMM software. The second rotation with the Ohio Department of Transportation was spent within the environmental planning department. Anthony assisted with the GIS mapping for new construction projects and worked as a NEPA process coordinator.

Matt Mueller (Project Engineer)

Matt is currently in his fifth year of environmental engineering at the University of Cincinnati, where he has completed five co-op rotations at New Line Structures, KBD Technic, and Helix Electric. The first rotation was with NLS in which he assisted the project engineers and managers with daily site inspections in order to ensure development of the project site. Matt worked two semesters with KBD Technic, an engineering and consulting firm specializing in air system testing, where he assisted with site visits and completing client reports. In his most recent co-op, he aided Helix Electric project managers with submittals, RFIs, MOPs, and takeoffs for his respected projects.

Taylor Batz

School Address
2720 Glendora Ave, Apt. 3
Cincinnati Ohio, 45219

(740)-215-5793

batzta@mail.uc.edu

Permanent Address
918 James Rd.
Lancaster Ohio, 43130

EDUCATION

University of Cincinnati, Cincinnati, Ohio — Expected 2021
- Environmental Engineering — GPA 3.56/4.0
- Cincinnatus Scholar

University of Cincinnati, Cincinnati, Ohio — Expected 2021
- ACCEND, Master of Business Administration — GPA 3.89/4.0
- Attending MBA classes simultaneously to undergraduate classes

Lancaster High School, Lancaster, Ohio — May 2016
- Graduate of Marketing and Business Education Program, 2015-2016 — GPA 3.8/4.0

EXPERIENCE

Global Supply Chain Engineering Intern – Schwan's Company, Minneapolis, Minnesota — June 2020- August 2020
- Created an experimental design process for a manufacturing plant
- Wrote Food Defense and Food Safety plans needed for SFQ Audit for multiple manufacturing plants
- Worked with plant managers to organize audit documentation into centralized database

Engineering Technician Intern – Terracon Consultants Inc., Cincinnati, Ohio — August 2018-March 2020
- Complete different types of inspections and environmental field testing
- Made recommendations to clients based on laboratory data analyzed in excel
- Wrote Phase I Environmental Site Assessment reports
- Led office in a company-wide safety training initiative
- Worked part time (20 hours per week) during school semester to help finish projects

College Intern – Ohio Department of Transportation, Hamilton County, Ohio — January 2018- August 2018
- Collaborated with supervisor and crew to quickly come up with solutions for problems encountered on the job
- Managed work crew on day-to-day operations
- Organized and filed all necessary documentation for completion of job
- Worked part time (15 hours per week) during school semester to help finish projects

ACTIVITIES

Bearcat Buddies — January 2020-present
- Tutored elementary Cincinnati Public School students weekly in multiple subjects

Women in Leadership — January 2018-present
- Attend monthly meetings and networking events for women pursing their master's degree

Kappa Delta Sorority — January 2018-September 2019
- Contributed on various committees and attended volunteer-oriented events

Society of Environmental Engineers — January 2017-September 2018
- President and coordinator of the project planning committee

SKILLS

- Microsoft Office
- MATLAB
- ArcGIS
- Asbestos Hazard Evaluation Specialist in the state of Ohio
- Asbestos Inspector in the state of Indiana

Grace Brethel

brethegm@mail.uc.edu / (614) 623-0848

EDUCATION

University of Cincinnati, Cincinnati, Ohio — Class of 2021
Bachelor of Science in Environmental Engineering

Upper Arlington High School, Upper Arlington, Ohio — Class of 2016

EXPERIENCE

BIM Operator Intern, **Mid-City Electric**, Columbus, OH — May 2020-August 2020

- Developed documents to track project completion across multiple departments
- Generated drawing sheets in Revit for large data centers, high-rise hotel, and library building
- Utilized Revit Dynamo to streamline workflow
- Created families in AutoCAD to be utilized in Revit for use by multiple BIM Operators

Engineering Assistant, **Turner Construction**, Cincinnati, OH — January 2020-May 2020

- Prepared and monitored asset management document for the owner
- Facilitated communication between subcontractors and the owner for requests for information
- Reviewed and tracked subcontractor submittals for compliance with specifications for project close-out
- Actively participated in field coordination meetings and assisted in preparation of meeting minutes

Water/Wastewater Intern, **AECOM**, Columbus, OH — May 2019-August 2019
Water/Wastewater Intern, **AECOM**, Cincinnati, OH — August 2018-December 2018
Water/Wastewater Intern, **AECOM**, Columbus, OH — January 2018-April 2018

- Modeled water mains, storm sewer lines, and structures, in PCSWMM, AutoCAD, and ArcGIS
- Mapped existing waterlines for replacement associated with the Water and Sewage Department of Detroit
- Created and edited maps for incorporation into product submittals to display project plan
- Generated maps of Green Infrastructure using ArcGIS to facilitate data collection
- Created and modified Access Databases to track status of required work to meet clients' needs

SKILLS

MATLAB, Microsoft Office (Word, Excel, PowerPoint, Access), ArcGIS, AutoCAD Civil3D, PCSWMM, Revit, Navisworks, Trimble Sysque, Revit Dynamo, Certified SCUBA diver

ACTIVITIES AND INVOLVEMENT

College/Community:

Tapped Member, **Rho Lambda Honorary** — October 2019-Present

- Collaborate with a diverse group of leaders on campus

Roar Guide, **University of Cincinnati** — November 2017-Present

- Lead weekly campus tours for 10-30 prospective students and family members
- Effectively communicate facts and statistics for a two-hour tour
- Recruit current students to join ROAR

Vice President Standards, **Kappa Kappa Gamma Sorority** — November 2016-May 2020

- Managed the standing and academic achievements of a chapter of 150 women
- Led a seven-member committee to prepare morale boosting and educational events with a $2000 budget
- Conducted individual meetings with members who are not maintaining chapter standards
- Assisted chapter members in creating a recovery plan to achieve chapter standards

Alumni Council Member, **Central Ohio Leadership Academy** — July 2015-Present

- Facilitate small group meetings
- Present on alumni panels throughout the year

AWARDS

Gloria S Goering Giving Forward Award-Scholarship — October 2018

(513)-638-2479
dollgm@mail.uc.edu

Graci Doll

5585 Lucenna Dr.
Cincinnati, OH 45238

Skills

AutoCAD 2019 with Civil 3D • Matlab • Microsoft Office • ArcGIS • XPSWMM • Technical Writing • Communication

Education

University of Cincinnati | *Cincinnati, Ohio* — Spring 2019 – Spring 2021
Carl H. Lindner College of Business — 4.0 / 4.0
Master of Business Administration

- ACCEND Program

University of Cincinnati | *Cincinnati, Ohio* — Fall 2016 – Spring 2021
College of Engineering and Applied Science — 3.7/ 4.0
Bachelor of Science, Environmental Engineering

- Recipient of Dean's List for the years of 2017, 2018, and 2019

Experience

Strand Associates, Inc. | *Cincinnati, Ohio*

Municipal Engineering Co-op — Summer 2020

- Developed modeling skills to assist with three different stormwater and water projects by using XPSWMM, HydroCAD, and WaterGEM
- Assisted with a community capability assessment for an upcoming municipal project
- Performed an alternative cost analysis for disinfection systems for a wastewater treatment plant project.
- Strengthened project management skills by assisting with project research, budgeting, and organization tasks

University of Cincinnati

Research Position — Fall 2019 - Present

- Researching an innovative and cost-effective solution for removal of Perfluorooctanoic acid (PFOA) and Perfluorooctanesulfonic acid (PFOS) families from water
- Run experiments in a lab to determine ways to functionalize sawdust that will remove PFOA and PFOS from water

Fishbeck | *Cincinnati, Ohio*

Engineering Co-op – Contracted to Greater Cincinnati MSD — Fall 2018 and Summer 2019

- Developed problem solving skills to troubleshoot issues for over 100 telemetry and flow monitor devices
- Analyzed flow monitor data using Ayyeka to configure remote monitoring devices for over 200 project sites
- Drafted drawings and existing utility design for three municipal projects using AutoCAD Civil 3D
- Assisted in field work such as surveying and water sampling
- Applied research skills to find information on permitting for multiple municipal project
- Wrote 30 procedures on different tasks done at MSD by utilizing technical writing and communication skills

Engineering Co-op — Spring 2018

- Assisted in drafting drawings for watermain, sewer, and pump station project plans for four different municipal projects using AutoCAD Civil 3D
- Created 24 utility letters to inform municipal utilities of project areas
- Enhanced organizational skills by working in Excel sheets to calculate flow data and create graphics for presentation for various projects
- Collaborated with three coworkers to collect flow monitor data through flow monitor installs

Anthony Marazzi

Phone: 216-280-7642

marazzal@mail.uc.edu

EDUCATION

University of Cincinnati Class Of 2021

Major: Environmental Engineering Current GPA: 2.9

EXPERIENCE

Quality Engineer Co-op, Valeo Climate Control (Cincinnati, OH)

May 2018 – August 2019

- Full-Time
- Wrote new processes for testing methods
- Presented results to quality team including international visitors
- Maintained historical data to determine part tolerances
- Examined deficiencies on parts sent into the Validation Lab

Environmental Engineer, Ohio Department of Transportation (Cincinnati, OH)

January 2020 – August 2020

- Full-Time
- Coordinated NEPA process for upcoming projects
- Created mapping using ArcGIS for project proposals
- Consulted with the public to satisfy NEPA public involvement requirement

Crew Leader, Bellaire Puritas Development Corporation (Cleveland, OH)

May 2014 - August 2017

- Full-Time
- Managed a team of seven to provide housing services to seniors
- Managed customer needs with appropriate resources
- Revitalized neighborhoods through work

Stagehand Union Hand, Local 27 (Cleveland, OH)

Jan 2016 - May 2017

- Used teamwork and problem solving to set up and remove stages in a time stressed environment

TRAINING

- Microsoft Office
- MatLab
- AutoCAD
- CALYPSO Measurement Software

Matthew P. Mueller

muellemp@mail.uc.edu / 216-630-0845

EDUCATION

University of Cincinnati, College of Engineering & Applied Science, Cincinnati, Ohio — Class of 2021

- Bachelor of Science: Environmental Engineering — GPA 3.1/4.0

EXPERIENCE

Intern — January 2020 – August 2020

Helix Electric, San Diego, California

- Attended weekly site meetings at the California State University of Los Angeles project to participate in a site walk-through
- Assisted Project Managers with submittals, RFIs, MOPs, and takeoffs for the CSULA and PMRF projects

Intern — August 2018 – December 2018; May 2019 – August 2019

KBD Technic, Cincinnati, Ohio

- Participated in meetings with project team to plan and prioritize weekly goals
- Assisted Project Engineers with airflow measurements during site visits and participated in meetings with clients
- Completed client reports, which included calculations, measurements, and drawings from site visits

Intern — February 2018 – May 2018

New Line Structures, New York, New York

- Assisted Project Engineers at the NLS's Hallett's Point project site
- Attended daily inspections of the project site to ensure development of the project site
- Participated in meetings with contractors to communicate the progress of Hallett's Point
- Managed the organizational program that communicated daily updates to all individuals/teams involved in the Hallett's Point project

Scholar Program — June 2016 – December 2017

Cintas, Solon, Ohio

- Interacted with the business department to develop customer service skills
- Maintained the factory bay area; organized incoming shipments and assisted various departments

ACTIVITIES

Member, Engineering & Applied Science Tribunal — September 2016 – Present

- Provide input and feedback regarding policies and curriculum to the College of Engineering and Applied Science
- Assist in the development of professional, social, and leadership contacts for students

Member, EWeek Committee — January 2017 – February 2017

- Participated in the organization of Engineers' Week's interactive events for the College of Engineering and Applied Science

SKILLS

Technical

- Microsoft Office Suite, Bluebeam Software, BIM360, ASITE, AutoCad

Seeking a full-time position after graduation in May 2021

Appendices

Appendix A: Calculations

Equation 1: Total Average Runoff Coefficient

Total Average Runoff Coefficient = (Brick RC * % of Brick Total Area) + (Concrete RC * % of Concrete Total Area) + (Rooftop RC * % of Rooftop Total Area) + (Green Space RC * % of Green Space Total Area)

Example calculation to solve for the total average runoff coefficient (Use Table 1 - Section 3.1: *Surface Runoff Analysis* for runoff coefficients and area type percentages)

Total Average Runoff Coefficient =

(0.775*0.0999)+(0.875*0.02868)+(0.850*0.5527)+(0.175*0.3187)

Total Average Runoff Coefficient = 0.6281

Equation 2: Rational Method (Peak Runoff)

Q = A*I*C

Q = Runoff Volume (ft^3/sec)

A = Total Basin Surface Area (acres)

I = Peak Rainfall (in/hr)

C = Total Average Runoff Coefficient (unitless)

Example calculation to determine the runoff volume for the 100-year storm and Tc = 27:

A = 9.59 acres, I = 5 in/hr , C = 0.6281

Plug values into Equation 2 above to solve for Q (ft^3/sec)

Q = (9.59 acres)*(5 in/hr)*(0.6281)

Q = 30.1 ft^3/sec

Equation 3: Runoff Recovery Calculation

$$Q = (A*AP*C)/100$$

Q = Runoff Volume (centennial cubic feet)

A = Total Basin Surface Area (ft^3)

AP = Average Precipitation (ft)

C = Total Average Runoff Coefficient (unitless)

Example calculation to determine recovery volume for January to the Fifth Third tank:

$Q = [(191{,}664\ ft^2)*(0.238\ ft)*(0.875)]/100$

Q = 399.09 CCF

Equation 4: Simulation Example Calculation

Rainfall = 0.483 inches

CRC Tank: C=0.628

Fifth Third Tank: C=0.875

Total Runoff CRC = (.628*0.483 in)/ 12in)*(8.59 acres*43,560 ft^2/acre)*7.48 gallons/ft^3 = 78,983 gallons

Total Runoff Fifth Third = (.875*0.483 in)/12 in)*(4.4 acres*43,560ft/acre)*7.48 gallons/ft^3= 50,491 gallons

Total Inflow = 78,983 gallons + 50,491 gallons =129,747 gallons

Total Plant Demand = 340,000 gallons

Plant Demand From GCWW = .90 * 340,000 gallons = 261,800 gallons

Outflow of Tank = 340,000 gallons -261,800 gallons = 76,200 gallons

Net Supply = 129,747 gallons - 76,200 gallons = 51,274 gallons

**For the simulation a running sum of the net supply was taken for each day, with negative values being set to zero.

Equation 5: Total Head Equation

$$H = f(L/D)*(v^2/2g)+(z_2-z_1)+c*n*(v^2/2g)$$

H= total head loss (ft)

f= friction factor coefficient (unitless)

L = length of pipe (ft)

D = diameter of pipe (ft)

v = velocity (ft/sec)

g = gravitational force (ft/sec^2)

z_i = elevation at point i (ft)

c = various coefficients for pipe turns, expansion, and contraction

n = number of occurrences (unitless)

Example Calculation for total head loss of CRC tank:

$$H = 0.0304*(2112ft/0.5ft)*[(1.703ft/sec)^2/2(32.2ft/sec^2)] +(880ft-780ft)+(0.75*7*[(1.703ft/sec)^2/2(32.2ft/sec^2)]) + (0.35*5*[(1.703ft/sec)^2/2(32.2ft/sec^2)])+(0.5*1*[(1.703ft/sec)^2/2(32.2ft/sec^2)])+(1*1*[(1.703ft/sec)^2/2(32.2ft/sec^2)])$$

H = 192 ft

Appendix B: Site Plans

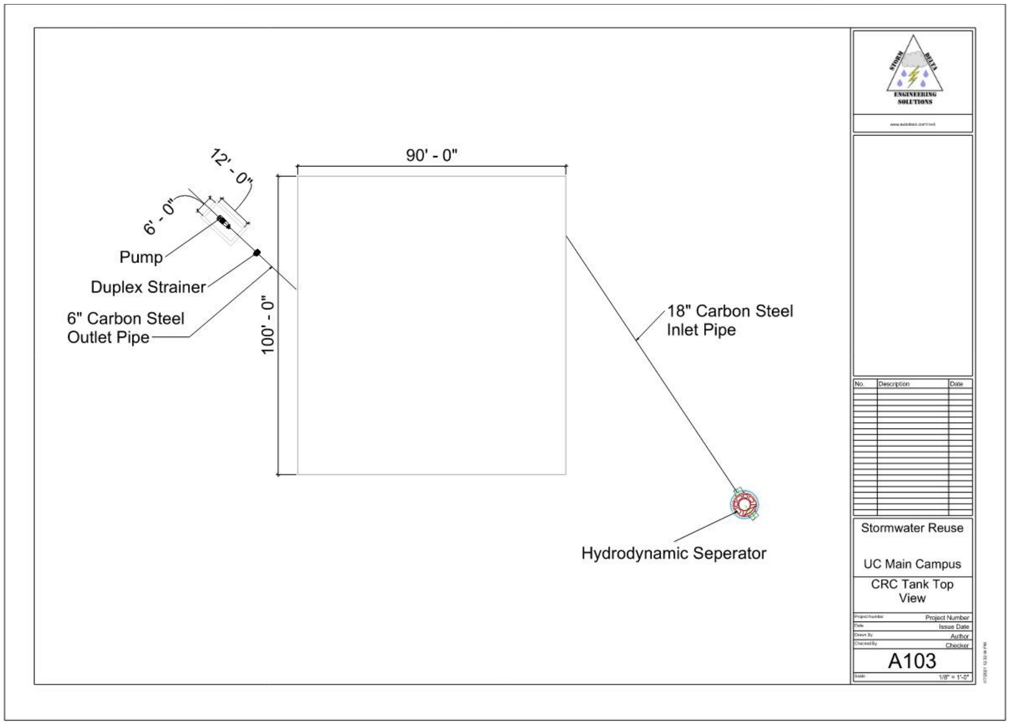


Figure B1: CRC Tank Top View

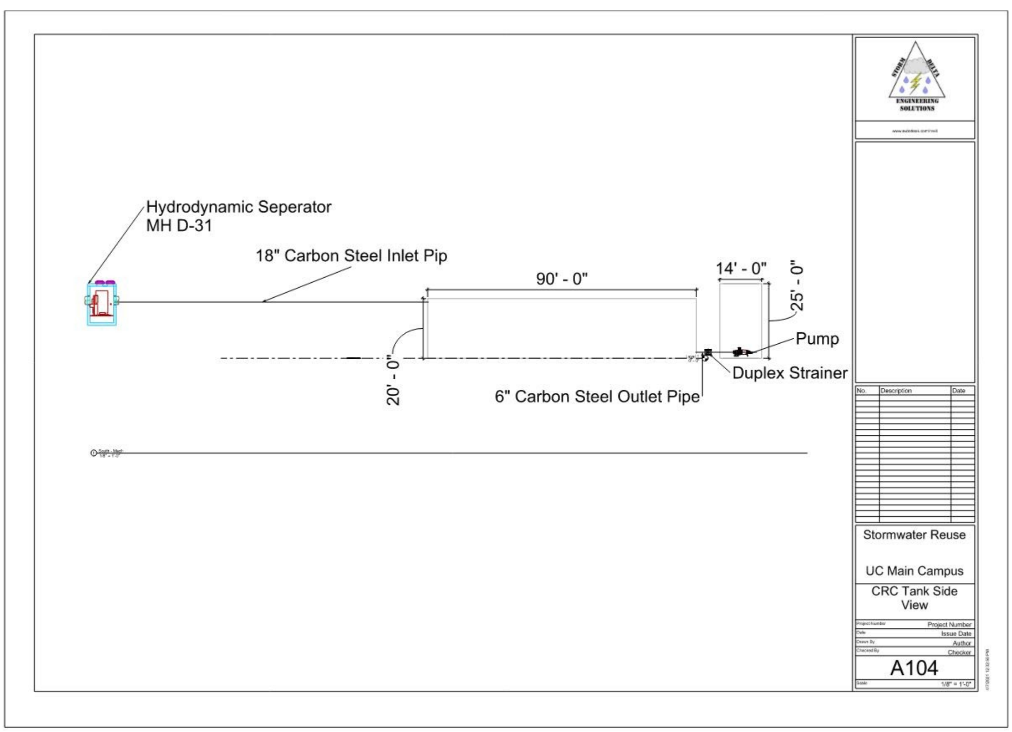


Figure B2: CRC Tank Side View

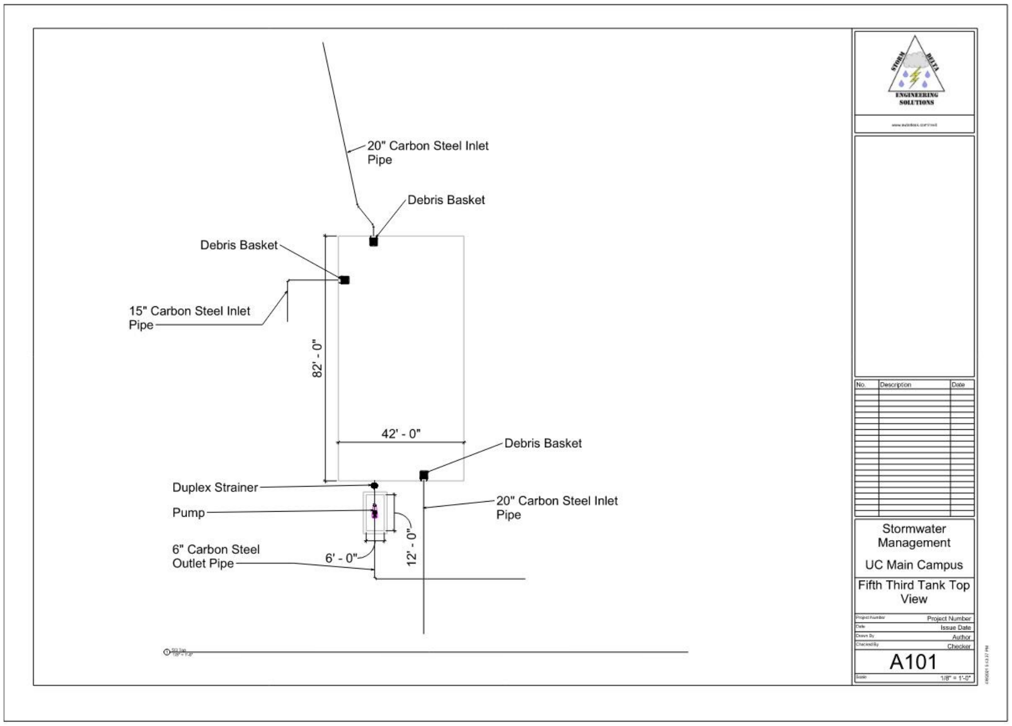


Figure B3: Fifth Third Tank Top View

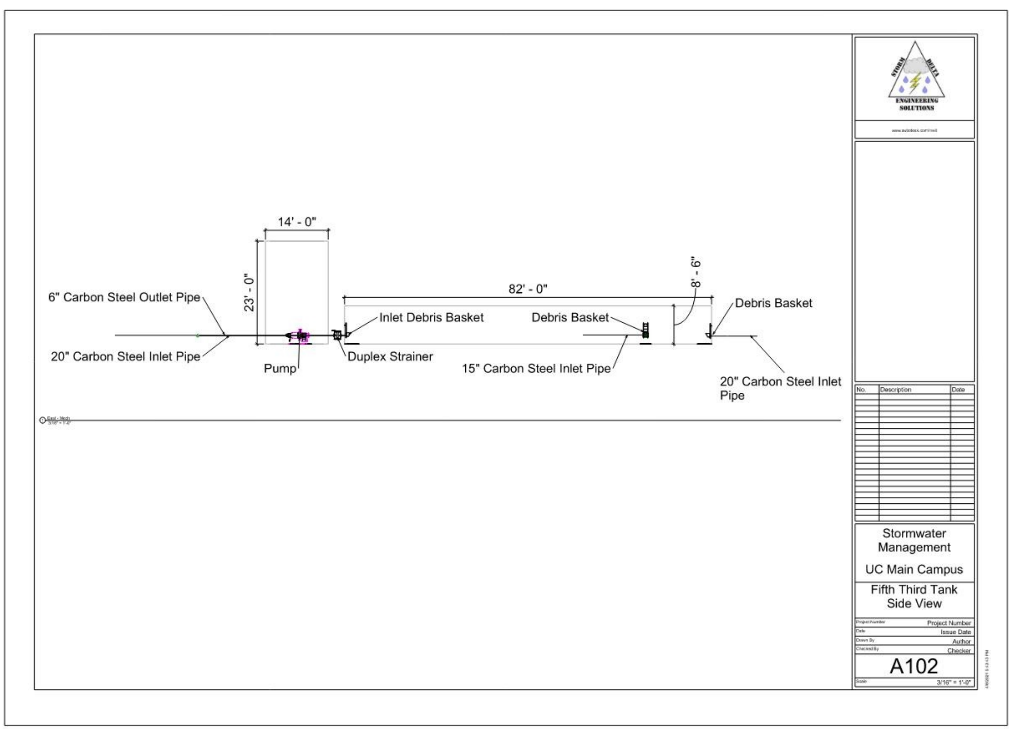


Figure B4: Fifth Third Tank Side View

Appendix C: Product Data

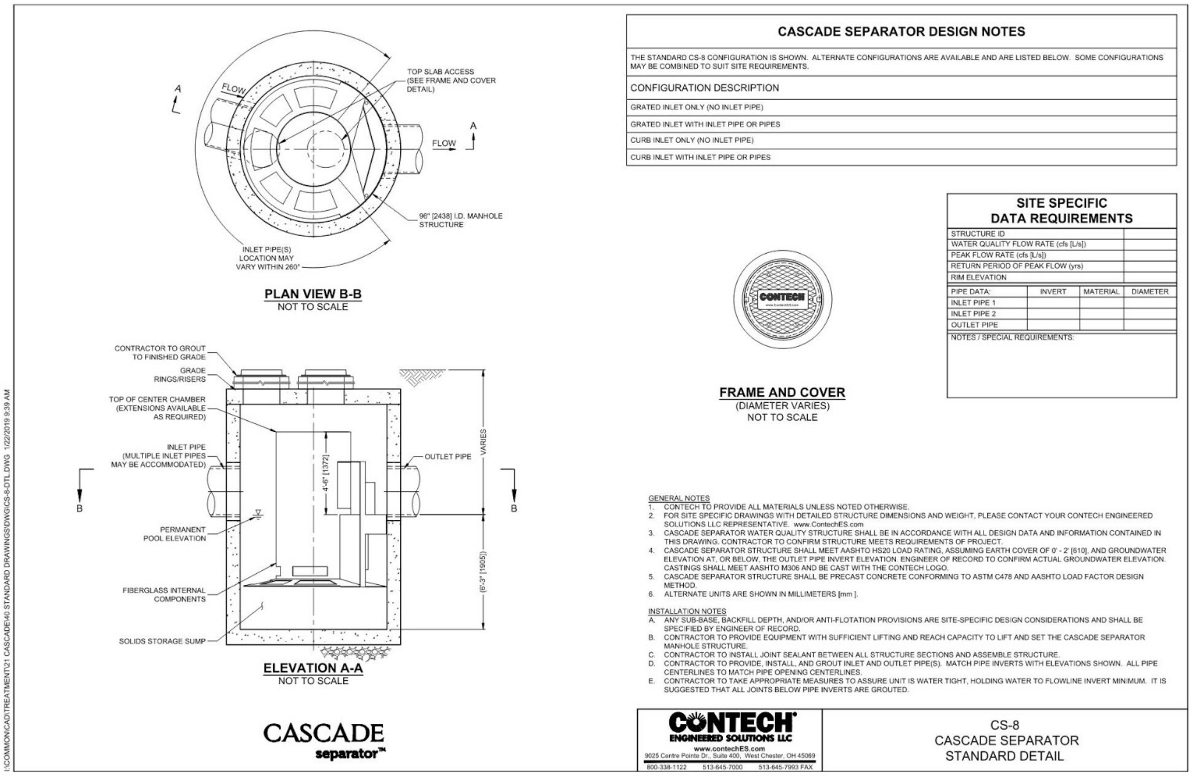


Figure C1: Hydrodynamic Separator Product Data

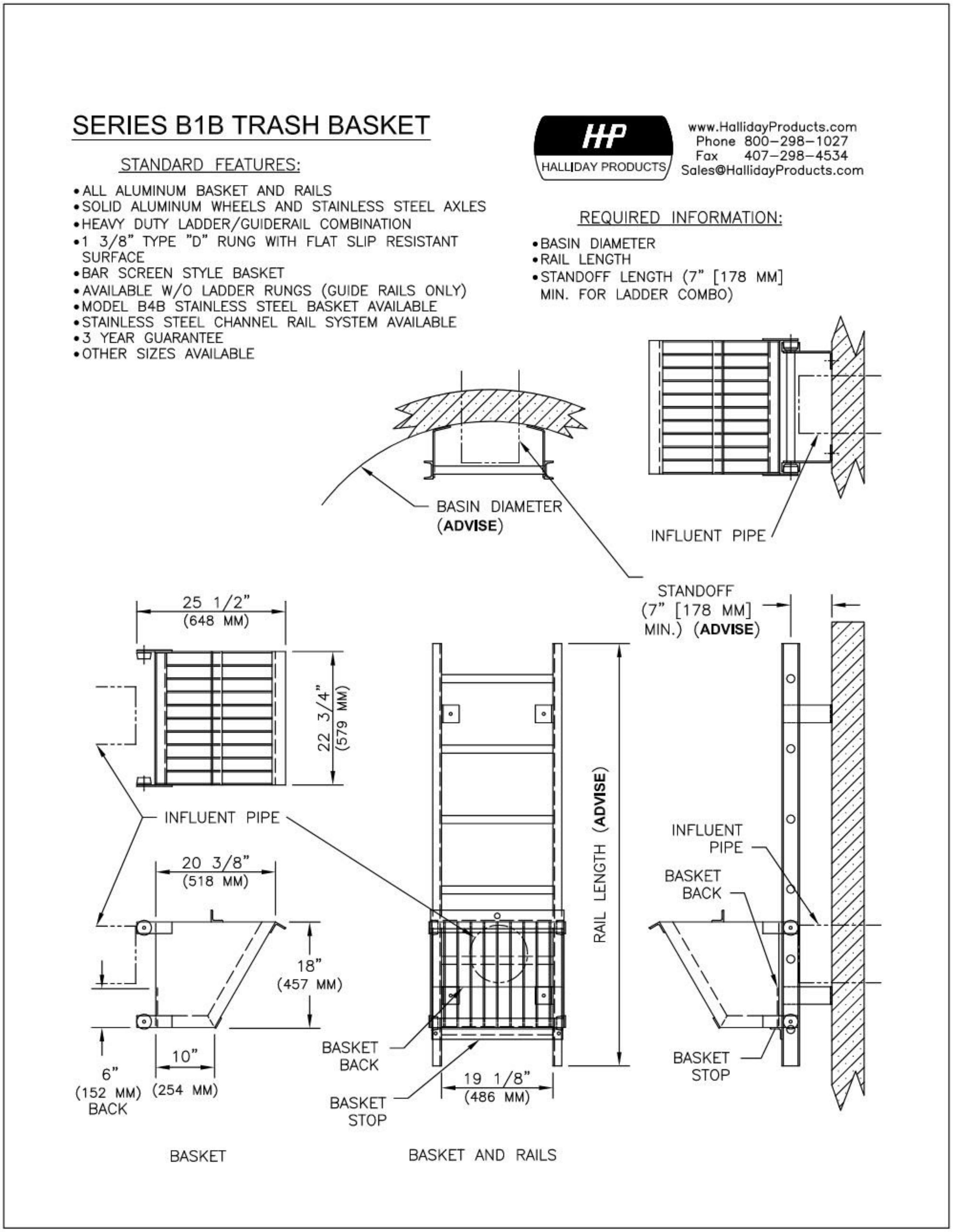
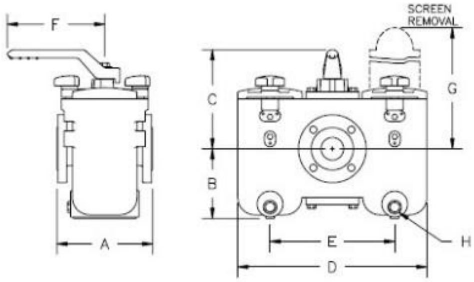


Figure C2: Debris Basket Product Data



Product Details for 62RFD-CS-SDPXF

Category: Style SDPXF Flanged

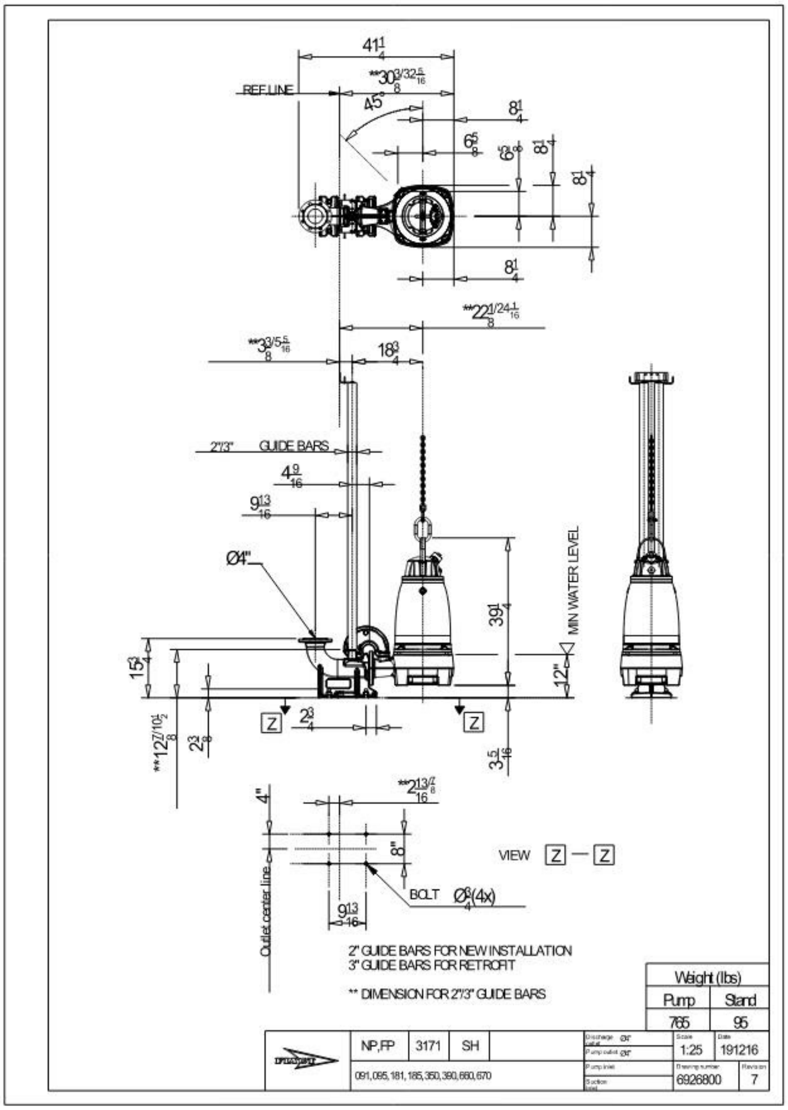
Print this page

Attributes	Values
Size (in)	6
Pressure Class (lb)	150
A (in)	18 5/8
B (in)	10 9/16
C (in)	13.000000
D (in)	23 1/2
E (in)	16
F (in)	15
G (in)	22 5/8
H (in)	1/2
Weight (lbs)	673.0
Screen Perforation (steam) (in)	1/8
Open Area (steam)	0.43
Screen Perforation (liquid) (in)	1/8
Open Area (liquid)	0.43
Flange Dia. (in)	11
Bolt Circle Dia. (in)	9 1/2
Flange Thk. (in)	1
Raised Face Dia. (in)	8 1/2
No. Bolts	8
Bolt Dia. (in)	3/4
Bolt Length (in)	3 1/4
Stud Length (in)	4

Figure C3: Duplex Strainer Product Data

NP 3171 SH 3~ 277

Dimensional drawing

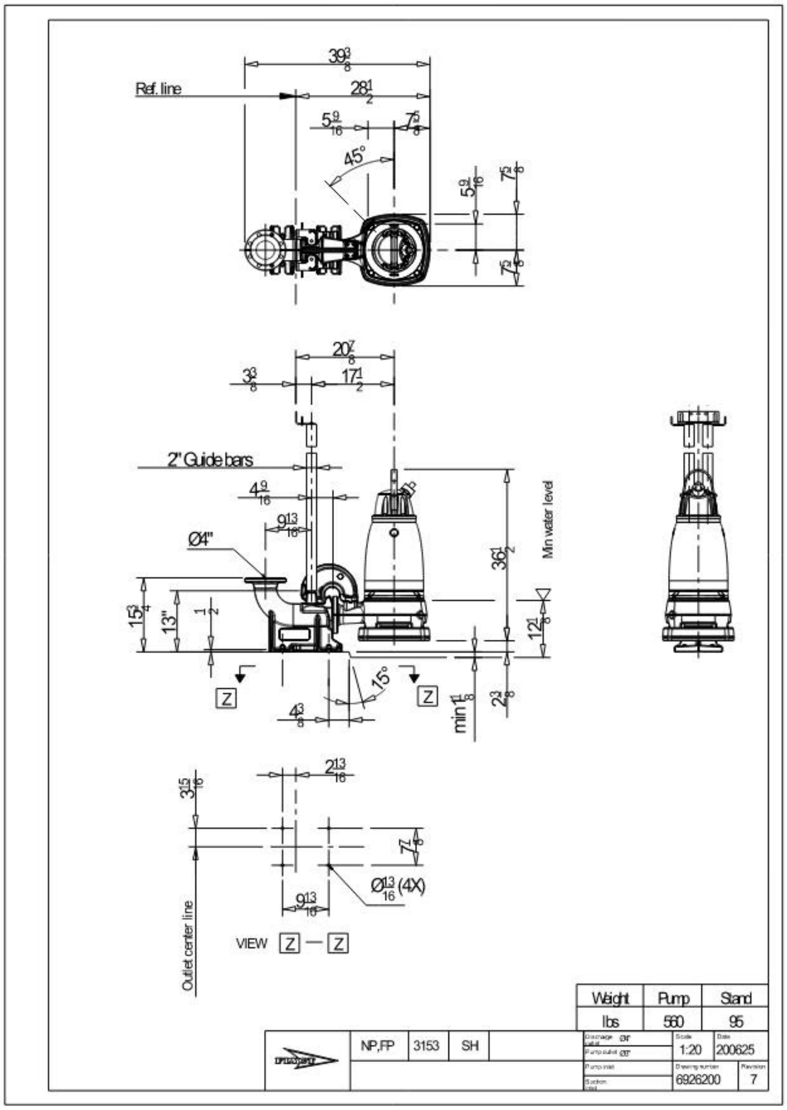


Project	UC Storm water Well 1	Created by	Dave Wilson
Block	0	Created on	3/16/2021 Last update 3/16/2021

Figure C4: CRC Tank Pump Product Data

NP 3153 SH 3~ 276

Dimensional drawing



Project	UC Storm Water Well 2	Created by	Dave Wilson
Block	0	Created on	3/16/2021 Last update 3/16/2021

Figure C5: Fifth Third Tank Pump Product Data

Appendix D: Product Quotes

4/6/2021 Mail - Mueller, Matt (muellemp) - Outlook

RE: [EXTERNAL] Re: UC Capstone Project - Hydrodynamic Separator

Dana Hinaman <Dana.Hinaman@ContechLLC.com>

Wed 2/24/2021 3:49 PM

To: Mueller, Matt (muellemp) <muellemp@mail.uc.edu>
Cc: Doll, Graci (dollgm) <dollgm@mail.uc.edu>; Brethel, Grace (brethegm) <brethegm@mail.uc.edu>; Batz, Taylor (batzta) <batzta@mail.uc.edu>; Marazzi, Anthony (marazzal) <marazzal@mail.uc.edu>

2 attachments (439 KB)

CS-8-DTL.pdf; OH - Water Quality Flow Calculator.pdf;

Matt,

Thanks for the information! I ran a quick WQf calculation to determine the 'first flush' that would be coming from your drainage area. This is how I generally size the HDS. That being said, it looks like you need a CS-8 to treat the WQf. Assuming we do the internal bypass, the CS-8 can easily bypass your 100yr storm-event. And if memory serves me correct, this would be outletting to your detention/storage. If you want to fully treat your water quality, you'd need to take the WQv you calculated into account for your total detention storage. But I think I remember you saying all this was for reuse anyway, so it may not be necessary since the water would be treated again during the reclamation process.

Average price for a CS-8 is about $30,000.

Please let me know if you have any additional questions or comments.

Thanks!

Dana Hinaman
Stormwater Consultant – OH, KY

Contech Engineered Solutions, LLC
1103 Schrock Road | Suite 105 | Columbus, OH 43229
Mobile: (513) 314-4781
Dana.Hinaman@ContechLLC.com
linkedin.com/in/danahinaman

From: Mueller, Matt (muellemp) <muellemp@mail.uc.edu>
Sent: Wednesday, February 24, 2021 2:29 PM
To: Dana Hinaman <Dana.Hinaman@ContechLLC.com>
Cc: Doll, Graci (dollgm) <dollgm@mail.uc.edu>; Brethel, Grace (brethegm) <brethegm@mail.uc.edu>; Batz, Taylor (batzta) <batzta@mail.uc.edu>; Marazzi, Anthony (marazzal) <marazzal@mail.uc.edu>
Subject: [EXTERNAL] Re: UC Capstone Project - Hydrodynamic Separator

CAUTION: This email originated from outside of the organization. Exercise caution when opening attachments or clicking links, especially from *UNKNOWN* senders.

Hi Dana,

https://outlook.office.com/mail/search/id/AAQkADUyYjI3MTE3LWI0YmItNDllNi1iZjdlLWEzYWZlZmQwMGJiZQAQALTy2eBgSzdPjPbua%2BxY7oE%3D 1/3

Figure D1: Hydrodynamic Separator Quote

Halliday Products, Inc.
6401 Edgewater Dr
Orlando, FL 32810
P: 407-298-4470 F: 407-298-4534
Sales@HallidayProducts.com

Price Quotation Number
Q20655
Date: 04/06/2021
PRICING VALID FOR 90 DAYS

Page 1/1

Printed by: Jarrod 04/08/21 10:32

Customer: **000120**
UNIVERSITY OF CINCINNATI

,

US
Quoted : **ANTHONY MARAZZI**
Phone: **(216) 280-7642**
Email: MARAZZAL@MAIL.UC.EDU

Payment Terms:
NET 30 W/APPROVAL

Note: A 3.5% Service Fee is Applied to all Credit Card Payments

Ship Method:
FEDEX GROUND

HP Salesperson:
JARROD FLEMING

Production Time:
2 TO 3 WEEKS ARO

Freight Estimated To:
UNIVERSITY OF CINCINNATI

NEW HAVEN, IN 44111

Job Tag / Reference:

Qty	Item Number	Description	Unit Price	Net Price
1	B1B TRASH BSKT	FAABB22M18A20G06AA The above aluminum barscreen basket to have 1/4" x 2" flat bars w/2" clearance between bars. Basket to be 22 3/4" wide x 18" high x 20 3/8" deep. Basket sides and back will be solid 1/4" plate.	645.00	645.00

Any and all prior or subsequent negotations, documents and agreements between the parties hereto are superseded by the terms set forth in this Price Quotation.

	Subtotal	645.00
(FL - ONLY)	EXEMPT	0.00
	Estimated Freight	130.00
	TOTAL	**$775.00**

Please see www.HallidayProducts.com for O & M Manuals and Limited Product Warranties

Figure D2: Debris Basket Quote

FERGUSON

FERGUSON/WOLSELEY IND #541
3001 E. KEMPER RD
SHARONVILLE, OH 45241-1569

Phone: 513-771-6000
Fax: 513-771-4971

Deliver To:
From: **Thomas Schneider**
Comments:

10:45:53 APR 01 2021

FERGUSON ENTERPRISES LLC #1480
Price Quotation
Phone: 513-771-6000
Fax: 513-771-4971

Bid No: B931895
Bid Date: 04/01/21
Quoted By: TJS

Cust Phone:
Terms: CASH ON DEMAND

Customer: UC MAINT.
1
UNIVERSITY OF CINCINNATI, OH

Ship To: UC MAINT.
1
UNIVERSITY OF CINCINNATI, OH

Cust PO#: TBD

Job Name: UC PROJECT

Item	Description	Quantity	Net Price	UM	Total
SP-6150SDPXFSTRAIN	6 150# RF DUPLEX KECKLEY STRAINER 6 CLASS 150 RF STYLE SDPXF CARBON STEEL DUPLEX STRAINER POSITIVE SEALING BRONZE DIVETER FOR SUCTION SERVICE W/1/8 PERF 304 SS BASKET W/VITON O-RING W/KNOB COVER 62RF-CS125P34-VOQB-SDPXFPSD 12-14 WEEK DELIVERY ARO & DRAWING APPROVAL FOB:SKOKIE	1	23012.000	EA	23012.00

Net Total:	$23012.00
Tax:	$0.00
Freight:	$0.00
Total:	$23012.00

Quoted prices are based upon receipt of the total quantity for immediate shipment (48 hours). SHIPMENTS BEYOND 48 HOURS SHALL BE AT THE PRICE IN EFFECT AT TIME OF SHIPMENT UNLESS NOTED OTHERWISE. QUOTES FOR PRODUCTS SHIPPED FOR RESALE ARE NOT FIRM UNLESS NOTED OTHERWISE.

CONTACT YOUR SALES REPRESENTATIVE IMMEDIATELY FOR ASSISTANCE WITH DBE/MBE/WBE/SMALL BUSINESS REQUIREMENTS.

Seller not responsible for delays, lack of product or increase of pricing due to causes beyond our control, and/or based upon Local, State and Federal laws governing type of products that can be sold or put into commerce. This Quote is offered contingent upon the Buyer's acceptance of Seller's terms and conditions, which are incorporated by reference and found either following this document, or on the web at https://www.ferguson.com/content/website-info/terms-of-sale
Govt Buyers: All items are open market unless noted otherwise.

LEAD LAW WARNING: It is illegal to install products that are not "lead free" in accordance with US Federal or other applicable law in potable water systems anticipated for human consumption. Products with *NP in the description are NOT lead free and can only be installed in non-potable applications. Buyer is solely responsible for product selection.

HOW ARE WE DOING? WE WANT YOUR FEEDBACK!
Scan the QR code or use the link below to
complete a survey about your bids:
https://survey.medallia.com/?bidsorder&fc=541&on=41530

Figure D3: Duplex Strainer Quote

Pump / Part	List Price	Quantity	Total
NZ 3171 SH3 277	$30,529	2	$61,058
FM	$0	2	$0
**Standard Accessories	$2,836	2	$5,672
Intermediate Guide Bar		0	$0
NZ Pump Stand	$3,604	2	$7,208
Kellum Grips	$30	2	$60
Cable holder	$153	2	$306
Mini-Cas	$504	2	$1,008
Socket, 11 pin	$48	2	$96
Start up	$1,800	2	$3,600
Freight	$805	2	$1,610
TOTAL			$80,618

Testing			
Hydraulic			
Hydrostatic			
Testing Total			

Project Total			$80,618

Standard Accessories
Discharge connection
Hardware Kit
Disconnect hardware
Upper Guide Bar
Safety Hook
Chain - 3/6" 316 SS 20 ft

Figure D4: Pump Quote

Job/Configuration Name: UC - Stormwater Pumps Well #1
Model Number below based on your selections in configurator:

ACC-D-463-ST-ID-N45-FDN-2A-00-5AH-6C-6K-6N-00-10G-10K-26E-508-PX

- Duplex Pump Control Panel
- 3 Phase Power @ 460 VAC. Panel Includes Control Transformer with Primary Fuses and Control/Alarm Circuit Breaker
- NEMA 4X 304 Stainless Steel Enclosure, Pad-Lockable
- 22mm Lights and Switches Mounted on Aluminum Inner Door
- NEMA Rated Starting Device(s)
- 15 – 45 FLA NEMA Starter Size 2
- Float Control, Using DPC-4F (simplex or duplex) or TPC-4F (triplex). Floats not included, must be ordered separately.
- Pump Down (Emptying) Application
- Full Alarm Package on a Separate Incoming Power Feed, Including Amber Flashing Beacon, Audible Alarm, and Test/Silence Switches, Auxiliary Contact
- Seal Failure/Thermal Cutout Module for CLS or FLS Leakage Sensors. Auto/Manual Thermal Cutout Switch
- Pump Run Auxiliary Contact(s)
- Pump Fail Auxiliary Contact(s)
- Power Fail Auxiliary Contact(s)
- Elapsed Time Meter(s)
- 3 Phase Lightning Arrestor
- Anti-Condensation Heater w/Adjustable Thermostat
- 3 Phase Voltage Monitor
- UL/CUL 508A
- KWIKSWITCH 4-Port KIT, 100FT Manifold cable (4) 25Ft Float N.O., SS Mt Bracket & 6-Pos hook Bracket

Net Price: $ 6,508.00
(Price valid for 30 days. US Dollars)

Figure D5: CRC Tank Pump Controller Quote

PRIMEX

ACCEL PANEL PROGRAM

Job/Configuration Name: UC Storm Water Well 2 Control Panel
Model Number below based on your selections in configurator:

ACC-D-463-ST-ID-N27-FDN-2A-00-5AH-6C-6K-6N-00-10G-10K-26E-508-PX

- Duplex Pump Control Panel
- 3 Phase Power @ 460 VAC. Panel Includes Control Transformer with Primary Fuses and Control/Alarm Circuit Breaker
- NEMA 4X 304 Stainless Steel Enclosure, Pad-Lockable
- 22mm Lights and Switches Mounted on Aluminum Inner Door
- NEMA Rated Starting Device(s)
- 9 – 27 FLA NEMA Starter Size 1
- Float Control, Using DPC-4F (simplex or duplex) or TPC-4F (triplex). Floats not included, must be ordered separately.
- Pump Down (Emptying) Application
- Full Alarm Package on a Separate Incoming Power Feed, Including Amber Flashing Beacon, Audible Alarm, and Test/Silence Switches, Auxiliary Contact
- Seal Failure/Thermal Cutout Module for CLS or FLS Leakage Sensors. Auto/Manual Thermal Cutout Switch
- Pump Run Auxiliary Contact(s)
- Pump Fail Auxiliary Contact(s)
- Power Fail Auxiliary Contact(s)
- Elapsed Time Meter(s)
- 3 Phase Lightning Arrestor
- Anti-Condensation Heater w/Adjustable Thermostat
- 3 Phase Voltage Monitor
- UL/CUL 508A
- KWIKSWITCH 4-Port KIT, 100FT Manifold cable
  (4) 25Ft Float N.O., SS Mt Bracket & 6-Pos hook
  Bracket

Net Price: $ 6,508.00
(Price valid for 30 days. US Dollars)

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Figure D6: Fifth Third Tank Pump Controller Quote

Federal Steel Supply, LLC
747 Goddard Avenue • PO Box 840
Chesterfield, MO 63006-0840
(636) 537-2393 • (800) 325-1584 • Fax (636) 537-8795
www.fedsteel.com

Federal Steel Quote #	R61866 Page: 1
Salesman #	Michelle Meyers
Warehouse	2
Prosp/Cust #	149284
Quote Date	03/17/21

Attention: TAYLOR BATZ

Your Inquiry #: 6" PIPE

Freight Info: PPD

Company:
UNIVERSITY OF CINCINNATI
2600 CLIFTON AVE
CINCINNATI, OH 45221

513 556-6000

Customer PO #:

Accepted By:

Quotation

Ln#	Description & Piece Length	Qty		Price	UM	Pounds	Item Total
	HI TAYLOR, SEE BELOW, HOPE THIS WILL HELP YOU WITH YOUR BUDGET PLANNING. LET ME KNOW ANY QUESTIONS OR ANYTHING ELSE I CAN HELP WITH. THANKS! MICHELLE 636-812-9009 MMEYERS@FEDSTEEL.COM --------------------						
1	6.625" X .280 A53-B ERW 6" STD WELDED PIPE. IMPORT MATERIAL STOCK, SUBJECT TO SALE. -----------------------------------	4,224	FT	12.0000	FT	80129	50,688.00
2		1	EA				
3	FREIGHT DELIVERY ESTIMATE 2 FULL TRUCKLOADS OF MATERIAL. PRICING IS SUBJECT TO RATE AND AVAILABILITY AT TIME OF BOOKING. ---	2	EA	2,800.0000	EA		5,600.00

This quotation and sales resulting from it, are made subject to FSSLLC Standard Terms and Conditions of Sale. Acceptance of our offer of goods, constitutes express acceptance of the associated terms & conditions. Prices in U.S. $
Terms: Net 30 days, subject to final approval.
All items are offered subject to prior sale.
All prices subject to final confirmation.

Weight Total		
80,129	Taxable Total:	
	Sales Tax:	
	Total Amount:	56,288.00

Figure D7: Pipe Quote

Environmental Engineering Senior Capstone Project
University of Cincinnati

Stormwater Reuse at the University of Cincinnati Main Campus

Sponsor: University of Cincinnati Utilities
August 2020

Introduction

Founded in 1819, the University of Cincinnati is a public research university that serves a diverse community of 46,388 students across 14 colleges – the highest enrollment in our history thanks to nearly a decade of steadily rising enrollment and unrivaled momentum, and has been named "Among the top tier of the Best National Universities," according to U.S. News & World Report.

The university has nearly 200 years of history as a research pioneer, with a culture strongly emphasizing collaboration in order to achieve innovative results that can be applied to solving complex problems and furthering scientific advancement.

The UC campus setting continues to garner worldwide acclaim, with The New York Times highlighting UC's dramatic campus renovation of the past quarter century "the most ambitious campus design program in the country." In addition, Forbes, Delta Sky and Travel + Leisure magazines have all highlighted UC as one of the world's most beautiful campuses. It's also a sustainable one where all new construction and major renovations are completed to LEED Silver standards or higher whenever possible.

The focus of this RFP is on water usage and, in particular, supporting the goal of reducing water usage, as well as reducing combined sewer overflows (CSOs) to the Mill Creek. In particular, the UC Utilities has embarked on a program to reduce its water/sewage usage volume by 20% annually. First year reductions reached over one million gallons of decreased consumption through the collection and reclamation of plant process water streams. Currently UC's west campus water usage is in excess of 33 million gallons annually at a cost of $460,000 per year. In addition, another 54 million gallons of water drains from the 137 acre main campus geographic area via combined sewers on an annual basis.

Utilities personnel have had several discussions with Cincinnati Metropolitan Sewer District (MSD) over the last twelve months regarding the need to construct additional large sized drains not only to remove stormwater from the UC campus, but as well from the broader UC community area to insure the stormwater, at significant cost and energy consumption. MSD's goal is to reduce CSO discharges into the Mill Creek, and to reduce sewer backups of private properties.

Site Description

UC's main campus is located in a combined sewer overflow (CSO) drainage shed. When major storm events occur, campus sewers back up, drains are overwhelmed, and ultimately water gets to places that have far too often resulted in significant damage to University buildings, classrooms, and living areas. This has resulted in significant cost to the University.

Stormwater currently leaves the west campus at multiple locations. The attached drawing details the complex stormwater drainage system on main campus. The UC west campus has the ability to collect a significant amount of stormwater through “detention” tanks that are strategically located under buildings throughout the vast network of buildings on campus. Please see the attached spreadsheet. These storage tanks could then be utilizes for storage and reuse of stormwater on campus.

Project Goal

The goal of this project is to get as much stormwater from the 137 acre campus out of the greater Cincinnati area’s sewage collection and treatment systems. The overall intent is to reuse the reclaimed stormwater in a multitude of different beneficial use purposes, including irrigation for the broad “green” campus area, toilet flushing, and potentially utility process makeup. We do not intend to reuse the reclaimed stormwater for sinks, drinking water, or related activities. Collecting and reusing campus stormwater will not only reduce costs for the university, but also reduce CSOs into the Mill Creek.

Description of Services Required

The student team will conduct a thorough review of the existing campus stormwater re-use systems, review options for separating the existing storm and sanitary sewer collection systems, review options for stormwater pre-treatment, review options for storm water storage, review options for stormwater treatment, and review potential regulatory hurdles for re-using stormwater in Cincinnati. Upon completion of the initial report and approval after the Fall Semester, the student team will develop conceptual drawings and perform an economic analysis of their recommended system.

CEAS and University staff will coordinate closely with the student team throughout this project and they will provide access to resources necessary to ensure project success.

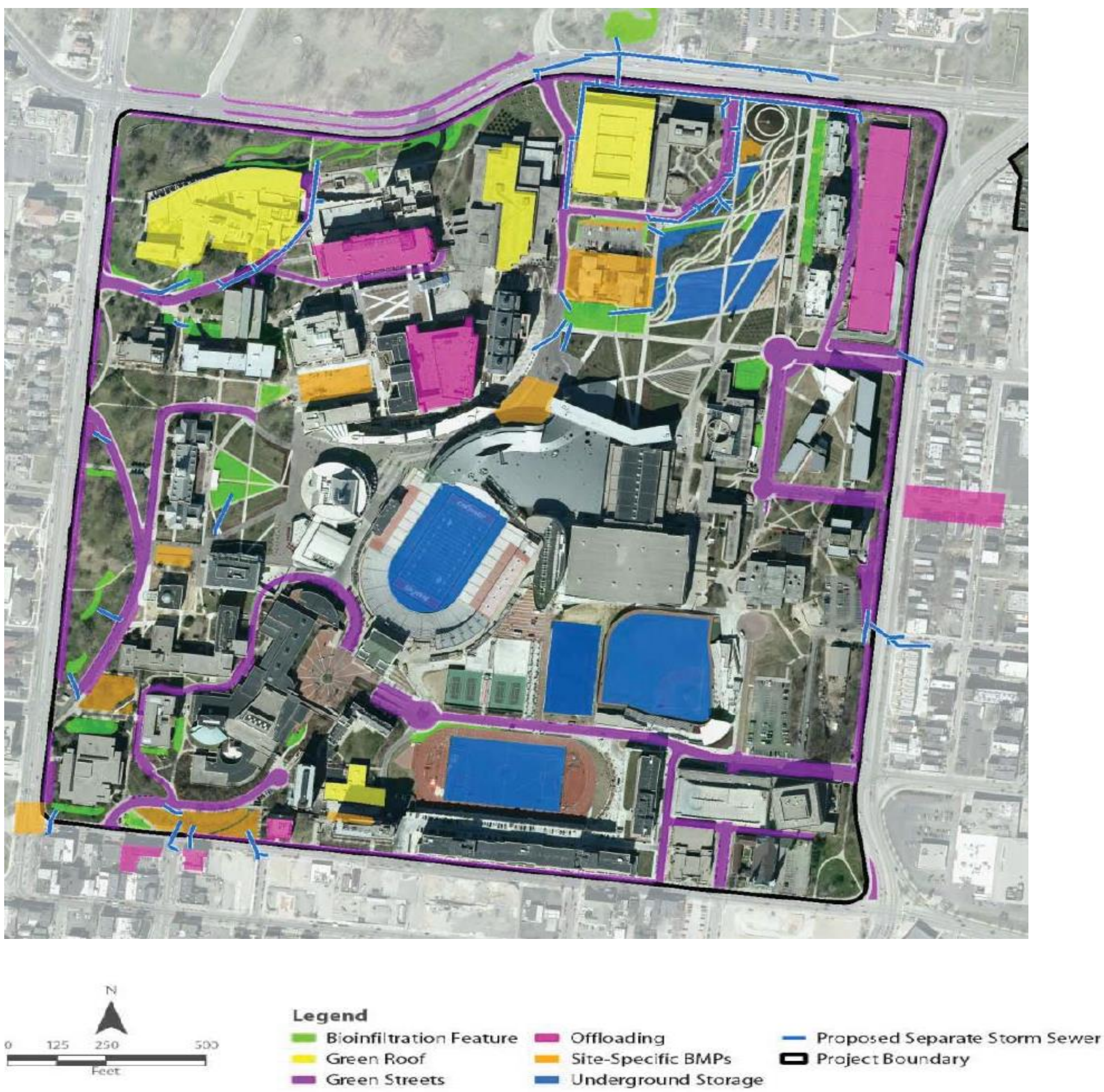
Deliverables

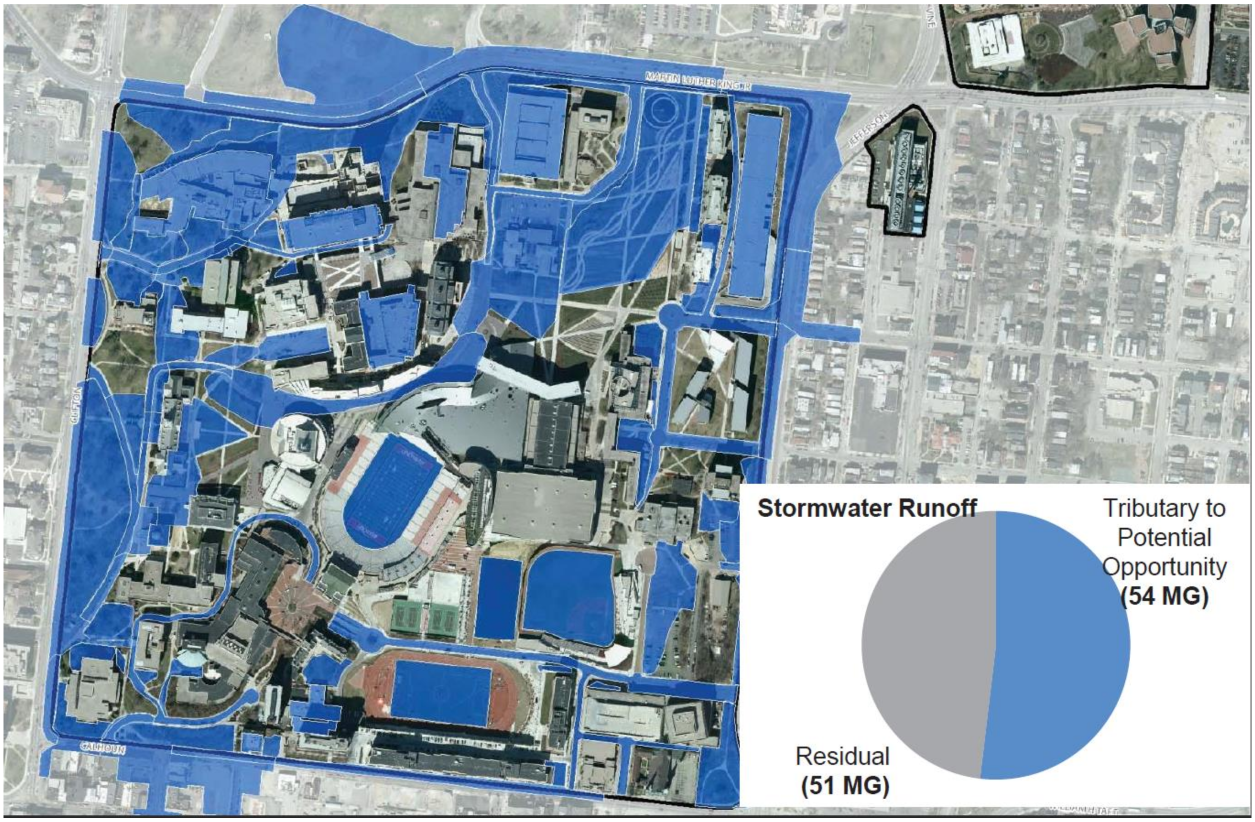
During the Fall Semester, the student team should complete the following tasks:

- Conduct a campus site visit to understand the collection area and network of stormwater removal;
- Conduct a technological review of existing data;
- Conduct literature searches and review for similar projects;
- Conduct literature searches for grey and green infrastructure solutions;
- Conduct a review of the existing stormwater collection system;
- Develop a sanitary and stormwater separation approach for existing buildings;
- Review options for treatment and storage;
- Review options for pre-treatment;
- Review potential regulatory hurdles for re-using stormwater in Cincinnati;
- Meet with CEAS and University staff as needed;
- Prepare a project proposal report on key findings and recommended options; and
- Provide a presentation on the proposed options to CEAS and University staff.

During the Spring Semester, the consultant team should complete the following tasks:

- Develop conceptual design drawings of the recommended reuse options;
- Conduct a thorough economic analysis of the recommended reuse options, including energy costs and savings derived from reduced Cincinnati Water Works and MSD charges;
- Identify the infrastructure changes required to support deployment of the reuse options;
- Prepare a final report that includes all tasks from the Fall Semester and Spring Semester; and
- Provide an oral presentation of key findings at the end of the semester.





West Campus Storm Water Detention Tank Inventory										
Building	**Campus Location**	**Roof SF**	**Retained sq.ft**	**Storm Retention**	**Tank Material**	**Tank Dimensions**	**Tank Size CF**	**Ratio of SF/CF**	**Tank Size (Gallons)**	**Tank location**
Joseph Steger Student Life Center	W	21,891	21,891	Yes	concrete	100' x 100' x 11'	110,000	2	822,800	MainStreet tank north of CRC
Lindner Athletic Center	W	39,100	39,100	Yes	steel		59,000	2	441,320	under Shakely lawn
Shoemaker CTR	W	90,370	90,370	Yes	concrete	44' x 84' x 9'	33,264	3	248,815	north west corner of the plaza
Calhoun Street Garage	W	127,700	127,700	Yes	concrete		22,480	6	168,150	under garage ramp
CCM Emery and PCP	W	151,556	151,556	Yes	concrete	(2) - 76' x 12' dia	17,191	9	128,587	north of the building under the road
Carl H. Lindner Hall (New COB)	W	57,210	57,210	Yes	metal	188' x 10' dia	14,766	4	110,450	under roadway north of building
DAAP Aronoff Center	W	49,670	49,670	Yes	concrete	240' x 8' dia	12,064	4	90,237	north of Crosley
Shakely Athletics Center and Bubble	W	82,430	82,430	Yes	plastic	600' of 36" and 480' of 48" pipe	10,000	8	74,800	S, E, N around full field and E side of half field.
Engineering Research Center	W	25,786	25,786	Yes	concrete		8,815	3	65,933	under entry
Central Power Plant	W	42,827	42,827	Yes	concrete	135' x 6' dia + 4760	8,577	5	64,156	two tanks (1) - west under parking + (1) - north of the building
Edwards CTR	W	49,690	49,690	Yes	steel	(2) - 80' x 7'-6" dia	5,309	9	39,713	north side in the garage
Marian Spencer Hall	W	16,745	16,745	Yes	Plastic	30"x18"x36" Modules	3,553	5	26,576	Between Scioto and Spencer Hall
University Pavilion	W	17,198	17,198	Yes	concrete	45' x 8' dia	2,262	8	16,919	south of the building in the lawn
French Hall-West	W	34,086	34,086	Yes	steel	56' x 7' dia	2,155	16	16,120	west side under walk
Baldwin Hall	W	27,266	27,266	Yes	concrete	70' x 6' dia	1,979	14	14,804	Southeast corner under walk
Campus Green Garage	W	78,976	78,976	Yes	brick	170' x 3'-6" dia	1,636	48	12,234	under garage center north - used the old sewer