THOMAS & HUTTON

TOWN OF SULLIVAN'S ISLAND

HMGP 4241-0049 - TECHNICAL DELIVERABLES

PHASE 2 STORMWATER IMPROVEMENT

ATTN:
Mitigation Specialist, HMGP
South Carolina Emergency Management Division

J – 27091

AUGUST 2022

TABLE OF CONTENTS

SECTION **PAGE**

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DELIVERABLE 1:

Engineering Design and Analysis, Surveying, Permitting, and Other Studies that May be Needed to Properly and Thoroughly Scope for Phase II Construction

This deliverable presents the base input information used for the Phase II portion of the project.

Due to extreme low elevations, lack of an outfall and hardly any collection system, it is proposed to collect stormwater by using conventional drainage inlets and pipes. Then allow stormwater stations to pump the rainfall runoff water to the nearest receiving body because the drainage basins are in a depression without any outlet. The following shows the calculations for these improvements.

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ATTACHMENT 1

Hydrologic and Hydraulic Report

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HYDROLOGIC AND HYDRAULIC REPORT

Sullivan's Island Multi-Basin Stormwater Drainage Improvement
Phase 1
FEMA DR-4241-SC at
Sullivan's Island, SC

Prepared for:
Town of Sullivan's Island

J – 27091.0000

November 2021

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TABLE OF CONTENTS

FIGURES

APPENDICES

EXHIBITS

1.0 INTRODUCTION

Sullivan's Island is a 2,200-acre barrier island between the Atlantic Ocean and the intracoastal waterway in eastern Charleston County, South Carolina. The island was incorporated as a town in the early 1800's and is located approximately four miles southeast of Charleston, South Carolina. The Island was once an active military establishment with remnants throughout the Island. Today, the Island inhabits approximately 2,000 residents.

Because of its position on the coast, low elevations, and lack of drainage infrastructure, Sullivan's Island endures frequent flooding and wind damage from coastal and inland storms. In October 2015, a catastrophic storm event caused major damage statewide, surpassing 24-hour historic rainfall records. This storm was called the "thousand-year" event. During such storm events, flooding problems on Sullivan's Island are highlighted. Low-laying areas which are depressed and have no outfall are affected the most. The past several years, certain areas in Sullivan's Island have encountered recurring flood damage from rainstorm events and are more problematic when rain happens at the same time of exceptionally high tides. Flooding problems are compounded by the fact that many parts of the Island have no drainage system.

Thomas & Hutton (T&H) has prepared this report to provide the necessary engineering calculations to demonstrate that the proposed drainage improvements will meet regulatory requirements and minimum standards of an associated FEMA HGMP grant. The Town of Sullivan's Island proposes to construct drainage improvements in two priority sub-basins:

- Station 18 Street/Atlantic Avenue Watershed Basin (Sta. 18)
- Station 18.5 Street/Flag Street (Sta. 18.5)

The drainage improvements are intended to provide drainage and alleviate flooding including reoccurring structural flooding with the basins. The improvements will include installing new pipes, inlets, swales, stormwater pump stations, and structures while re-establishing existing open channels and swales where possible.

The design report primarily focuses on the supporting design considerations for the drainage improvements.

2.0 PURPOSE

The purpose of this study is to:

- Examine two watershed sub- basins, Station 18 Street/Atlantic Avenue Basin (Sta. 18 Basin) and the Station 18.5 Street/Flag Street Basin (Sta. 18.5 Basin), both which experience continuous flooding resulting in repetitive property damage.
- Determine potential aids to improve the existing stormwater drainage system to minimize flood associated losses.

- Document compliance with regulatory requirements of the Town of Sullivan's Island, Charleston County, South Carolina Department of Health and Environmental Control, and FEMA grant requirements.

2.1 Station 18 Street/Atlantic Avenue Watershed Basin (Sta. 18)

This watershed basin consists of two sub-basins and totals approximately 9.9 acres that includes portions of I 'On Avenue, Atlantic Avenue, and south portions of Station 18 Street. Much of the basin has residential coverage. The basin's soils are Made *Land* (map unit symbol – Ma), and *Coastal beaches and dune land* (map unit symbol – Co). The hydrologic group rating for *Made Land* is B and the Coastal beaches and dune land is D. Existing drainage is non-existent and there is no outfall for runoff.

There is an operating existing stormwater pump station which serves a single private parcel, owned by Dominion Energy (formerly the South Carolina Electric and Gas Company - SCE&G). This existing pump station cannot serve the entire basin. It is proposed that the existing Dominion Energy pump station continue to serve its sub-basin. This existing pump station has a single existing 10-inch force main that outfalls to the north end of the island into the marshes of the intracoastal waterway. The existing force main cannot handle any additional flow.

Due to low elevations and extensive conflicts to reach a suitable outfall, a new stormwater pump station is the most feasible option to serve the project area.

2.2 Station 18.5/Flag Street Watershed Basin (Sta. 18.5)

This watershed basin is approximately 16.5 acres that includes portions of I 'On Avenue, Thee Street, Flag Street, and Station 19 Street. The basin is residential properties. The basin's soils are Made *Land* (map unit symbol – Ma), and *Coastal beaches and dune land* (map unit symbol – Co). Existing swales serve this basin, but there is no outlet for stormwater runoff. During any storm event, the lack of a drainage system allows the runoff to pond in the low laying areas which are in most cases, in the streets, adjacent rights-of-way, and spread to adjacent properties. This area's existing drainage system does not provide positive drainage outlets. Areas within the basin flood even during minor storm events with the ponding that affects emergency service response.

3.0 HYDROLOGY

The drainage basins are entirely developed, so it is not anticipated that stormwater runoff will increase in the future.

Two hydrologic conditions are considered in the design of the proposed improvements to adhere to regulatory and FEMA grant requirements. The following hydrologic parameters were used:

1. The Rational method is used to size the peak flow to the pump stations.
2. The rainfall intensity for each storm event was obtained from the *NOAA Atlas 14 Sullivan's Island Station ID 38-8405*. NOAA Atlas 14 Point Precipitation Frequency Estimates for Sullivan's Island, SC, see Appendix D.
   a. 2-year, 24-hour duration - 4.33 inches
   b. 10-year, 24-hour duration - 6.62 inches
   c. 25-year, 24-hour duration - 8.06 inches
   d. 50-year, 24-hour duration - 9.24 inches
   e. 100-year, 24-hour duration - 10.5 inches
   f. 100-year, 5-day duration - 13.1 inches

   A FEMA HGMP grant secured by the Town of Sullivan's Island requires the infrastructure to provide a level of protection to the 100-year, 5-day precipitation event which is 13.1 inches from NOAA records.
   The base design storm is for a 10-year, 24-hour event.
3. The time of concentration for each basin was calculated according to the procedures set forth in *Urban Hydrology for Small Watersheds (TR-55)* (USDA-NRCS, 1986). A minimum time of concentration of 5 minutes was used, per accepted hydrology practices.
4. Per the FEMA grant requirements, the project will provide a level of protection to the 100-year, 5-day precipitation event which is like what Sullivan's Island experienced during an October 2015 storm event.

4.0 BASE DATA/ASSUMPTIONS

The following base data was compiled, and assumptions were made to complete the study:

- Existing utilities for water and sewer were obtained from GIS plans - Town of Sullivan's Island.
- Property claims damage records for flood locations – Town of Sullivan's Island.
- Existing drainage system and flooding photos show problem locations – Town of Sullivan's Island.
- Existing Dominion Energy (formerly SCE&G) pump station design documents – Town of Sullivan's Island and Dominion Energy.
- Hydrologic soil data and group rating – Natural Resources Conservation Service Web Soil Survey from National Cooperative Soil Survey.
- Existing stormwater drainage system inventory/GIS data – Rostan Solution LLC/Charleston County Public Works.
- Additional data was collected from Thomas & Hutton GIS reference library - topography was LiDAR-derived, aerial photography, parcels, and soils.

- Allowable ponding during the design storm event at peak tide elevation is 0.5-feet for the 100-year, 5-day event.
- Design storm for culvert under roadway. Jasper Boulevard shall be designed using the 50-year storm event per SCDOT standard requirements.

5.0 NPDES CONSIDERATIONS

The proposed drainage improvements will outfall to the marshes behind the Island and the intracoastal waterway.

This project is not related to land development or the increase in any impervious surfaces. Thus, no post-construction, permanent water quality control is required.

The proposed land disturbance consists of existing drainage channels that will be disturbed as part of the drainage system installation and localized grading between structures and in existing road rights-of-way for the installation of the storm drain system. Once the drainage system has been installed and grading activities completed, all disturbed areas will be returned to the pre-construction condition. This will ensure that the post-construction runoff from the site will remain unchanged and will not have a significant impact on the downstream water quality.

In addition, construction BMPs have been selected for the project and their performances evaluated such that the construction site's stormwater discharges will not cause, have the reasonable potential to cause, or contribute to an excursion above any state water quality standard.

6.0 SUMMARY AND CONCLUSIONS

This analysis modeled the peak design storm to the pump stations, sized collection pipes, and modelled a manifold force main for the two new stations. Note, we recommend that the system continue to be cleaned and inspected at regular intervals. The Town should clean existing swales and ditches, as necessary. The watershed basins were delineated into sub-basins to determine the peak runoff and the needed capacity for each collection culvert. The proposed culverts and pump station wet well will serve detention storage. Pipe capacity calculations were performed using the Darcy-Weisbach Method drainage computation. Since the project areas are lacking a stormwater pond or basin, the hydraulic grade line elevation was set at the maximum water elevation in the pump station wet well.

6.1 Station 18 Street/Atlantic Avenue Watershed Basin (Sta. 18 Basin)

Much of this basin has permeable soils and has some ability to absorb the stormwater runoff during small storm events. However, the existing conditions within this basin is unable to transport runoff to an outfall without flooding. Stormwater collects in an extremely low-lying area near the beach between Station 18 and Station 18.5 as the slope falls toward the ocean. This topography retains the runoff at the lowest area of the watershed basin without an outfall, which is near the intersection of Atlantic Avenue and Station 18 Street. As mentioned earlier, the existing stormwater pump stations on the (Dominion Energy property (or SCE&G PS), will continue to operate under a standalone basis since it only serves one parcel.

6.2 Station 18.5/Flag Street Watershed Basin (Sta. 18.5)

This basin has areas prone to frequent flooding even during small events due to the lack of an outfall. The area does not have any infrastructure to convey runoff to an outfall, so runoff collects and ponds for days during any rainfall event.

This basin needs new drainage lines, inlets, and a stormwater pump station to convey runoff to the receiving body outfall.

7.0 RECOMMENDATIONS

7.1 Existing Stormwater Drainage System

We recommend the addition of new storm lines and an upgrade in capacity for the undersizesd lines. Recommended improvements are shown in the attached exhibits. We suggest two (2) stormwater pump stations be installed to move runoff out of the pockets. An outfall structure will ibe provided which is set above extreme tide levels to minimize any backflow, and to prevent sunny day flooding due to tidal influence. The backflow prevention preserves the storage volume in the system and prevents saltwater from entering and deteriorating the system.

7.2 New Station 18 Pump Station

We recommend a new stormwater Pump Station at Station 18 be installed to handle the 10-year, 24-hour storm event for the basin and to function independently from the Dominion Energy (formerly SCE&G) pump station.

The new Station 18 stormwater pump station should be designed with redundancy in case of a pump failure, and will include provisions for standby power (generator) to run the station in the event of power loss.

7.3 New Station 18.5 Pump Station

Due to impossibilities of obtaining easements and the alternative need to route large diameter storm pipes up hill (excessive depth and expensive construction/restoration costs) a second stormwater pump station will serve the Sta. 18.5 area.

7.4 Force Main

A common force main to serve both new pump stations 18 and 18.5 will be used to reduce cost. After evaluation of the proposed pump stations in a computer model, we recommend that The Town of Sullivan's Island construct two (2) triplex pump stations (3 pumps per station). We also propose that the force mains be sized as follows:

- From Pump Station 18: 18-inch PVC Force Main
- From Pump Station 18.5: 20-inch PVC Force Main
- Force main conveying combined flows: 30-inch PVC Force Main

The proposed conditions will limit ponding in the pump station basins during extreme rainfall events beyond the base design storm by utilizing two of the three pumps at once and will be able to manage moderate rainfall events through the

cycling of pumps, with one pump in operation at a time. By using the force main sizes listed above (18-inch, 20-inch and 30-inch) excessive velocities in the force mains shall be avoided. During a 10-year, 24-hour rainfall event, the resulting velocities are as follows:

- Force main from PS 18: 7.44 fps (PVC) and 6.57 fps (DIP)
- Force main from PS 18.5: 7.32 fps (PVC) and 6.20 fps (DIP)
- Force main conveying combined flow: 6.11 fps (PVC) and 5.12 fps (DIP)

During a 100-year, 5-day rainfall event, when all three pumps are in operation at each of the pump stations. The resulting velocities in the model are as follows (see Technical Memorandum, Appendix D):

- Force main from PS 18: 10.9 fps
- Force main from PS 18.5: 11.2 fps
- Force main conveying combined flow: 9.2 fps

The utilization of these force main sizes allows for the use of smaller horsepower pumps in the pump stations (35 hp for pump station 18 and 25 hp for pump station 18.5), while maintaining velocities around 10 fps in the force mains under 100-year storm conditions. It also allows velocities in the force mains during the 10-year design storm to be less than 8 fps.

The Stormwater Design Considerations for the pump stations and force mains are included in Appendix B. A technical memorandum discussing PS 18 and 18.5 is included in Appendix D.

8.0 REFERENCES

The following references were used for this study:

Hydraulic Engineering Circular No. 14 (HEC-14) *Hydraulic Design of Energy Dissipators for Culverts and Channels*, (FHWA-HIF-06-086), July 2002, Third Edition.

South Carolina Department of Transportation Access & Roadside Management Standards (ARMS Manual), 2008 Edition, Revision Date: Sept. 26, 2012.

South Carolina Department of Transportation Requirements for Hydraulic Design Studies, May 26, 2009.

United States Department of Agriculture – Natural Resources Conservation Service (NRCS), Urban Hydrology for Small Watersheds, Technical Release 55, June 1986.

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HYDROLOGIC AND HYDRAULIC REPORT

Sullivan's Island Multi-Basin Stormwater Drainage Improvement
Phase 1

FEMA DR-4241-SC at

Sullivan's Island, SC

FIGURES

J – 27091.0000

December 2021

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TOWN OF SULLIVAN'S ISLAND

MULTI-BASIN STORMWATER DRAINAGE IMPROVEMENTS
DRAINAGE IMPROVEMENTS

CLIENT:

TOWN OF SULLIVAN'S ISLAND, SC

LOCATION: CHARLESTON COUNTY
DATE: 03/2018; Rev 12/2021 DRAWN BY: CGB SHEET: LOCATION
JOB NUMBER: J-W:MARK REVIEWED BY: MFY SCALE: 1" = 2000'

THOMAS & HUTTON

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Mt. Pleasant, SC 29464 • 843.849.0200

www.thomasandhutton.com

Soil Map—Charleston County Area, South Carolina
(South Sullivan's Island Multi-Basin Stormwater Drainage Improvement)

Map Scale: 1:4,460 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 50 100 200 300

Feet: 0 200 400 800 1200

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 17N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Charleston County Area, South Carolina
Survey Area Data: Version 14, Oct 11, 2017

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Feb 9, 2017—Mar 19, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
Co	Coastal beaches and dune land	21.2	41.8%
Ma	Made land	29.6	58.2%
Totals for Area of Interest		**50.8**	**100.0%**

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HYDROLOGIC AND HYDRAULIC REPORT

Sullivan's Island Multi-Basin Stormwater Drainage Improvement Phase 1

FEMA DR-4241-SC at

Sullivan's Island, SC

APPENDIX A

SOUTH BASIN - EXISTING CONDITIONS RATIONAL METHOD CALCUATIONS

J – 27091.0000

December 2021

STORMWATER DESIGN CONSIDERATIONS

PROJECT: MULTI-BASIN DRAINAGE IMPROVEMENT

PREPARED FOR: TOWN OF SULLIVAN'S ISLAND

Job: J-27091

Date: 6/1/21

By: MFY/CGB

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Rational Method used to calculate flow rate for drainage basin/area: **Q = CiA**

Station 18 Basin

C =	0.28	SFR	
Tc =	30	min.	
i =	4.33	in/hr	SCDOT Rainfall Intensity values
A =	9.9	ac.	
Q =	**12.0**	**cfs**	

Station 18.5 Basin

C =	0.28	SFR	
Tc =	30	min.	
i =	4.33	in/hr	SCDOT Rainfall Intensity values
A =	12	ac.	
Q =	**14.5**	**cfs**	

Total combined Q :	**26.6**	**cfs**

Rainfall Intensity Values
Utilized by South Carolina Department of Transportation

Rainfall intensity values utilized by the South Carolina Department of Transportation are computed by the following formula:

$$i = \frac{a}{(b+Tc)^c}$$

where: i = rainfall intensity in inches per hour,
Tc = time of concentration in minutes,
and a, b, and c are coefficients.

The coefficients for the 2-, 5-, 10-, 25-, 50-, and 100-year rainfall events are given in the table below for each county in South Carolina. The intensity values for time of concentration of 5, 10, 15, 30, and 60 minutes are also listed in the table for the same frequencies. To use these values compute the time of concentration for the drainage area using the velocity method in the NRCS TR-55 manual. Pick the appropriate county in the tables below to determine the appropriate coefficients. Then apply the equation to obtain the intensity value.

CHARLESTON

Frequency (years)	Rational Coefficients			Rainfall Intensity ("/hr) for Time of Concentration (T_c)				
	a	b	c	T_c = 5	T_c = 10	T_c = 15	T_c = 30	T_c = 60
2	72.6900	11.39	0.8390	6.96	5.56	4.67	3.20	2.02
5	61.1600	9.8460	0.7573	7.93	6.36	5.37	3.75	2.45
10	55.1300	8.4120	0.6972	9.02	7.23	6.12	4.33	2.90
25	45.5300	6.2570	0.6179	10.20	8.13	6.89	4.95	3.41
50	42.6800	5.2800	0.5741	11.20	8.92	7.58	5.52	3.88
100	39.5300	4.2970	0.5309	12.10	9.63	8.21	6.05	4.33

Table 4: Runoff Factors for Rational Method

RUNOFF FACTORS FOR RATIONAL METHOD			
	Flat	**Rolling**	**Hilly**
	0% - 2%	**2% - 10%**	**Over 10%**
Pavements & Roofs	0.90	0.90	0.90
Earth shoulders	0.50	0.50	0.50
Drives & Walks	0.75	0.80	0.85
Gravel Pavements	0.50	0.55	0.60
City Business Areas	0.80	0.85	0.85
Unpaved Road, Sandy Soils	0.34	0.45	0.59
Unpaved Road, Silty Soils	0.35	0.47	0.61
Unpaved Road, Clay Soils	0.40	0.53	0.69
Apartment Dwelling Areas	0.50	0.60	0.70
Suburban, Normal Residential	0.45	0.50	0.55
Dense Residential Sections	0.60	0.65	0.70
Lawns, Sandy Soils	0.10	0.15	0.20
Lawns, Heavy Soils	0.17	0.22	0.35
Grass Shoulders	0.25	0.25	0.25
Side Slopes, Earth	0.60	0.60	0.60
Side Slopes, Turf	0.30	0.30	0.30
Median Areas, Turf	0.25	0.30	0.30
Cultivated Land, Clay & Loam	0.50	0.55	0.60
Cultivated Land, Sand & Gravel	0.25	0.30	0.35
Industrial Areas, Light	0.50	0.70	0.80
Industrial Areas, Heavy	0.60	0.80	0.90
Parks & Cemeteries	0.10	0.15	0.25
Playgrounds	0.20	0.25	0.30
Woodland & Forest	0.10	0.15	0.20
Meadows & Pasture Land	0.25	0.30	0.35
Unimproved Areas	0.10	0.20	0.30
Rail Yards	0.25	0.30	NA
Expressways & Freeways *	0.60*	0.70*	0.75*

* The designer can also calculate weighted 'C' values for expressways and freeways using the values in the table for pavement, side slopes and planted medians.

Revised 3/16/09

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HYDROLOGIC AND HYDRAULIC REPORT

Sullivan's Island Multi-Basin Stormwater Drainage Improvement
Phase 1

FEMA DR-4241-SC at

Sullivan's Island, SC

APPENDIX B

SOUTH BASIN – PUMP STATION STORMWATER DESIGN CONSIDERATIONS

J – 27091.0000

December 2021

STATION 18 PUMP STATION
STORMWATER DESIGN CONSIDERATIONS

Project: Sullivan's Island Multi-Basin Stormwater Drainage Job: 27091.0000
Proposed Pump Station 18 Evaluation **Individual FM To Outfall** Date: 2/2/19
Thomas & Hutton Engineering Co. Revised: **10/29/21**
Stormwater Design Considerations By: CGB/MFY

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DESIGN FLOW - 10 Year Storm Event

Description	10 yr Flow Rate		
Station 18 PS Basin	12 cfs	=	5,390 gpm

Proposed Force main size of:	15.35"	16"	nominal PVC	9.34	Velocity (fps)	To high
Proposed Force main size of:	16.41"	16"	nominal DIP	8.17	Velocity (fps)	To high
Proposed Force main size of:	17.20"	18"	nominal PVC	7.44	Velocity (fps)	Use 18"
Proposed Force main size of:	18.31"	18"	nominal DIP	6.57	Velocity (fps)	Use 18"

EQUIVALENT LENGTH OF FORCE MAIN TO STA. 18 to Manifold

Description	Quantity	Unit Equiv. Length of Straight Pipe	Equivalent Length of Force Main
Force Main	2200 l.f.	1 l.f.	2200 l.f.
45° Bend	20 ea.	21 l.f.	420 l.f.
90° Bend	2 ea.	46 l.f.	92 l.f.
Check Valve	1 ea.	165 l.f.	165 l.f.
Wye	1 ea.	200 l.f.	200 l.f.
Tee (Branch)	0 ea.	100 l.f.	0 l.f.
Tee (Thru)	0 ea.	85 l.f.	0 l.f.
Plug Valve	0.5 ea.	25 l.f.	12.5 l.f.
		Total Equivalent Length of Force Main	3,090 l.f.

TOTAL DYNAMIC HEAD (TDH)

Total Dynamic Head (TDH) = Static Head + Friction Head

Static Head

Static Head = Force Main Discharge Elevation (high point on FM) – L.W.L.

Static Head - At Build Out:

FM Discharge El. = 6.50 feet
Pumps Off: = -2.00 feet
= 8.50 feet

Friction Head

Equiv. Length of FM = 3,090 ft
C-factor = 130

The force main will be constructed of **DIP *or* PVC** pipe. A Hazen-Williams coefficient of C = ***130*** will be used to calculate friction head. The force main velocity will be designed for a range of 3.5 to 10 ft/sec.

Calculate Friction Head (Hf) Associated with Force main
Hf = Friction Head (Feet) (Based on Hazen-Williams Formula, Hf = 10.44 x EQ x GPM^1.85 / (D^4.8655 x C^1.85)
(See Reference Note 1) where: EQ = Equivalent Length of Discharge Line, including fittings, in feet
GPM = Discharge Rate, in Gallons Per Minute
D = Inside Diameter of Discharge Line, in inches
C = Hazen-Williams Coefficient

GPM	EQ	D	C	Hf	
5390	3090	17.20	130	30.9	PVC
5390	3090	18.31	130	22.8	DIP

	PVC	DIP
Total Friction Head =	**30.9 Feet**	**22.8**
Head Loss through Pump Station =	**2.0 Feet**	**2.0**
Total Static Head =	**8.5 Feet**	**8.5**
Condition 1 - Friction Head in FM line (Manifold to Outfall) =	**1.4 Feet (Condtion 1 PS 18 only)**	**1.0**
Condition 2 - Friction Head in FM line (Manifold to Outfall) =	**6.2 Feet (Condtion 2 PS 18 & PS 19)**	**4.0**
Total Dynamic Head (TDH) Condition 1 =	**42.8 Feet**	**34.3**
Total Dynamic Head (TDH) Condition 2 =	**47.6 Feet**	**37.3**

STATION 18.5 PUMP STATION
STORMWATER DESIGN CONSIDERATIONS

DESIGN FLOW - 10 Year Storm Event

Description	10 yr Flow Rate		
Station 18.5 PS Basin	**14.5** cfs	=	6,510 gpm

Proposed Force main size of: **19.06"** **20"** **nominal PVC** | 7.32 | Velocity (fps) **Acceptable**
Proposed Force main size of: **20.70"** **20"** **nominal DIP** | 6.20 | Velocity (fps) **Acceptable**

EQUIVALENT LENGTH OF FORCE MAIN TO STA. 19 to Manifold

Description	Quantity	Unit Equiv. Length of Straight Pipe	Equivalent Length of Force Main
Force Main	1720 l.f.	1 l.f.	1720 l.f.
45° Bend	12 ea.	26 l.f.	312 l.f.
90° Bend	2 ea.	50 l.f.	100 l.f.
Check Valve	1 ea.	150 l.f.	150 l.f.
Wye	0 ea.	235 l.f.	0 l.f.
Tee (Branch)	0 ea.	100 l.f.	0 l.f.
Tee (Thru)	0 ea.	78 l.f.	0 l.f.
Plug Valve	0.5 ea.	30 l.f.	15 l.f.
		Total Equivalent Length of Force Main	2,297 l.f.

TOTAL DYNAMIC HEAD (TDH)

Total Dynamic Head (TDH) = Static Head + Friction Head

Static Head

Static Head = Force Main Discharge Elevation (high point on FM) – L.W.L.

Static Head - At Build Out:

FM Discharge El. = 6.50 feet
Pumps Off: = -2.00 feet
= 8.50 feet

Friction Head

Equiv. Length of FM = 2,297 ft
C-factor = 130

The force main will be constructed of **DIP *or* *PVC*** ipe. A Hazen-Williams coefficient of C = ***130*** will be used to calculate friction head. The force main velocity will be designed for a range of 3.5 to 10 ft/sec.

Calculate Friction Head (Hf) Associated with Force main
Hf = Friction Head (Feet) (Based on Hazen-Williams Formula, Hf = 10.44 x EQ x GPM^1.85 / (D^4.8655 x C^1.85)
(See Reference Note 1) where: EQ = Equivalent Length of Discharge Line, including fittings, in feet
GPM = Discharge Rate, in Gallons Per Minute
D = Inside Diameter of Discharge Line, in inches
C = Hazen-Williams Coefficient

GPM	EQ	D	C	Hf	
6510	2297	19.06	130	19.8	PVC
6510	2297	20.70	130	13.2	DIP

	PVC	DIP
Total Friction Head =	**19.8 Feet**	**13.2**
Head Loss through Pump Station =	**2.0 Feet**	**2.0**
Total Static Head =	**8.5 Feet**	**8.5**
Condition 1 - Friction Head in 24" line (Manifold to Outfall) =	**2.0 Feet (Condtion 1 PS 18.5 only)**	**1.3**
Condition 2 - Friction Head in 24" line (Manifold to Outfall) =	**6.2 Feet (Condtion 2 PS 18 & PS 18.5)**	**4.0**
Total Dynamic Head (TDH) Condition 1 =	**32.3 Feet**	**25.0**
Total Dynamic Head (TDH) Condition 2 =	**36.4 Feet**	**27.7**

COMBINED PUMP STATIONS
STORMWATER DESIGN CONSIDERATIONS

Project: Sullivan's Island Multi-Basin Stormwater Drainage Job: 27091.0000
Proposed Pump Station Evaluation - @ Combined Manifold Date: 2/2/19
Thomas & Hutton Engineering Co. Revised: 6/16/21
Stormwater Design Considerations By: CGB/MFY

THOMAS & HUTTON

DESIGN FLOW

Description	10 yr Flow Rate				
Station 18 PS Basin	**12.0**	cfs	=	5,390	gpm
Station 18.5 PS Basin	**14.5**	cfs	=	6,510	gpm
Combined	**26.5**	cfs		11,900	gpm

11,900 gpm **Combined**

Proposed Force main size of:	**22.76"**	**24"**	**nominal PVC**	**9.38**	Velocity (fps)	**To high**
Proposed Force main size of:	**24.67"**	**24"**	**nominal DIP**	**7.99**	Velocity (fps)	**To high**
Proposed Force main size of:	**28.21"**	**30"**	**nominal PVC**	**6.11**	Velocity (fps)	**Acceptable**
Proposed Force main size of:	**30.81"**	**30"**	**nominal DIP**	**5.12**	Velocity (fps)	**Acceptable**

6510 gpm **Station 18.5 PS Basin**

5.13	Velocity (fps)
4.37	Velocity (fps)

5390 gpm **Station 18 PS Basin**

4.25	Velocity (fps)
3.62	Velocity (fps)

EQUIVALENT LENGTH OF PROPOSED FORCE MAIN MANIFOLD TO OUTFALL

Description	Quantity	Unit Equiv. Length of Straight Pipe	Equivalent Length of Force Main
Force Main	1250 l.f.	1 l.f.	1250 l.f.
45° Bend	8 ea.	30 l.f.	240 l.f.
90° Bend	0 ea.	79 l.f.	0 l.f.
Check Valve	1 ea.	95 l.f.	95 l.f.
Tee (Branch)	0 ea.	140 l.f.	0 l.f.
Tee (Thru)	0 ea.	115 l.f.	0 l.f.
Plug Valve	0 ea.	30 l.f.	0 l.f.
Total Equivalent Length of Force Main			1,585 l.f.

TOTAL DYNAMIC HEAD (TDH)

Total Dynamic Head (TDH) = Static Head + Friction Head

Static Head

Static Head = Force Main Discharge Elevation (high point on FM) – L.W.L.

Friction Head

Equiv. Length of FM = 1,585 ft
C-factor = 130

The force main will be constructed of **DIP *or* PVC** pipe. A Hazen-Williams coefficient of C = ***130*** will be used to calculate friction head. The force main velocity will be designed for a range of 3.5 to 10 ft/sec.

Calculate Friction Head (Hf) Associated with Force main
Hf = Friction Head (Feet) (Based on Hazen-Williams Formula, Hf = 10.44 x EQ x GPM^1.85 / (D^4.8655 x C^1.85)
(See Reference Note 1) where: EQ = Equivalent Length of Discharge Line, including fittings, in feet
GPM = Discharge Rate, in Gallons Per Minute
D = Inside Diameter of Discharge Line, in inches
C = Hazen-Williams Coefficient

GPM	EQ	D	C	Hf	
5390	1585	28.21	130	1.4	PVC
5700	1585	30.81	130	1.0	DIP

CONDITION 1 PS 18 only Friction Head = 1.4 Feet PVC
1.0 Feet DIP

GPM	EQ	D	C	Hf	
6510	1585	28.21	130	2.0	PVC
6510	1585	30.81	130	1.3	DIP

CONDITION 1 PS 19 only Friction Head = 2.0 Feet PVC

1.3 Feet **DIP**

GPM	EQ	D	C	Hf	
11900	1585	28.21	130	6.2	PVC
11900	1585	30.81	130	4.0	DIP

CONDITION 2 PS 18 & PS 19 Combined Friction Head = **6.2 Feet** **PVC**
4.0 Feet **DIP**

THOMAS & HUTTON

HYDROLOGIC AND HYDRAULIC REPORT

Sullivan's Island Multi-Basin Stormwater Drainage Improvement
Phase 1

FEMA DR-4241-SC at

Sullivan's Island, SC

APPENDIX C

DRAINAGE COMPUTATION TABLE

J – 27091.0000

December 2021

thomasandhutton.com

Sullivan's Island Multi-Basin Stormwater Drainage Improvement
Drainage Computations
Rational Method used to generate Q
Darcy-Weisbach Method used to determine friction losses

THOMAS & HUTTON

By: CGB
Date: 12/07/21
Job No.: 27091
Design Storm: 10 Year
Sta 18 PS El: **3.50**
Sta 18.5 PS El: **3.50**
Revised:

DRAINAGE COMPUTATION TABLE

From	To	Area Incr. (ac)	Area Total (ac)	C	Time of Flow Inlet (min)	Time of Flow Pipe (min)	Tc (min)	I (in/hr)	Q (cfs)	Line Size (in)	Line Length (ft)	Reynold's Number	D-W f	Friction Loss (ft)	HGL Upper (ft)	HGL Lower (ft)	TOP
GI-4	GI-3	3.18	3.18	0.25	**10**	0.0	10	6.6	5.24	**24**	**62**	2.7E+05	0.024	0.03	3.59	3.56	5.50
GI-3	GI-2	1.91	5.09	0.25		0.6	11	6.5	8.25	**24**	**16**	4.3E+05	0.024	0.02	3.56	3.54	4.75
GI-2	GI-1	0.95	6.04	0.25		0.1	11	6.5	9.77	**36**	**153**	3.4E+05	0.022	0.03	3.54	3.50	5.00
GI-1	**Sta 18 PS**	0.46	6.50	0.25		1.8	13	6.2	10.05	**36**	**17**	3.5E+05	0.022	0.00	3.50	3.50	5.00
																	0.05
GI-21	GI-18	1.26	1.26	0.25	**10**	0.0	10	6.6	2.08	**18**	**29**	1.4E+05	0.027	0.01	3.58	3.57	5.50
GI-18	GI-15	0.54	1.80	0.25		0.4	10	6.5	2.93	**24**	**79**	1.5E+05	0.025	0.01	3.57	3.55	5.50
GI-15	GI-14	0.10	1.90	0.25		1.4	12	6.3	2.99	**24**	**30**	1.6E+05	0.025	0.01	3.55	3.55	5.70
GI-14	GI-13	0.24	2.14	0.25		0.5	12	6.2	3.33	**24**	**80**	1.7E+05	0.025	0.02	3.55	3.53	6.00
GI-13	GI-12	0.10	2.24	0.25		1.3	14	6.0	3.38	**24**	**59**	1.8E+05	0.025	0.01	3.53	3.52	5.93
GI-12	GI-11	0.08	2.32	0.25		0.9	15	5.9	3.43	**24**	**73**	1.8E+05	0.025	0.02	3.52	3.50	5.40
GI-11	GI-5	0.15	2.47	0.25		1.1	16	5.8	3.56	**36**	**42**	1.2E+05	0.023	0.00	3.50	3.50	5.30
GI-5	JB-24	0.18	2.65	0.25		1.4	17	5.6	3.70	**36**	**37**	1.3E+05	0.023	0.00	3.50	3.50	5.75
JB-24	**Sta 18.5 PS**	0.42	3.07	0.25		1.2	18	5.4	4.18	**36**	**13**	1.5E+05	0.023	0.00	3.50	3.50	5.50
GI-10	GI-9	0.32	0.32	0.25	**10**	0.0	10	6.6	0.53	**24**	**33**	2.8E+04	0.029	0.00	3.51	3.51	5.00
GI-9	GI-7	0.45	0.77	0.25		3.3	13	6.1	1.17	**24**	**98**	6.1E+04	0.026	0.00	3.51	3.50	5.00
GI-7	GI-6	0.36	1.13	0.25		4.4	18	5.5	1.56	**24**	**72**	8.1E+04	0.026	0.00	3.50	3.50	5.00
GI-6	GI-5	0.26	1.39	0.25		2.4	20	5.2	1.82	**36**	**72**	6.3E+04	0.024	0.00	3.50	3.50	5.00
GI-5	JB-24	0.18	1.57	0.25		4.7	25	4.8	1.88	**36**	**37**	6.5E+04	0.024	0.00	3.50	3.50	5.00
JB-24	**Sta 18.5 PS**	0.42	1.99	0.25		2.3	27	4.6	2.28	**36**	**13**	8.0E+04	0.024	0.00	3.50	3.50	5.00

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HYDROLOGIC AND HYDRAULIC REPORT

Sullivan's Island Multi-Basin Stormwater Drainage Improvement Phase 1

FEMA DR-4241-SC at

Sullivan's Island, SC

APPENDIX D

TECHNICAL MEMORANDUM

EVALUATION OF PUMP STATION 18 & 18.5

J – 27091.0000

December 2021

ESTD 1946
75H
THOMAS & HUTTON

682 JOHNNIE DODDS BOULEVARD, SUITE 100 | POST OFFICE BOX 1522
MT. PLEASANT, SC 29464 | 843.849.0200
THOMASANDHUTTON.COM

TECHNICAL MEMORANDUM

BY: **Robert Hickey, P.E., Mark Yodice, P.E.**

DATE: **August 25, 2021**

SUBJECT: **Evaluation of Pump Station 18 and 18.5 and other stormwater improvements for Sullivan's Island**

JOB NO.: **27091.0000**

Purpose

The purpose of this memorandum is to provide information related to an evaluation of proposed storm water Pump Stations at Station (Sta) 18 and Sta 18.5 located on Sullivan's Island, South Carolina. These proposed storm water pumping systems are needed to provide storm water drainage in an area lacking any outlet on Sullivan's Island to mitigate flooding during rainfall events. The specific goal is to look at conditions during the 100-year, 5-day storm event. The pumps are sized for the design event of the 10-year, 24-hour storm.

This evaluation includes the review of three scenarios; one in which the pump stations designed and operated as a duplex station and two in which the pump stations are designed and operated as a triplex station. Pumps used to model the duplex scenario were provided to Thomas and Hutton by Peter Carlson of Flygt on 7/13/2021 and 7/20/2021. The pumps used to model one triplex scenario were provided to Thomas and Hutton in a report by Romtec Utilities on 8/4/2021, while pumps used to model the second triplex scenario were selected by the engineer as an alternate during the model evaluation.

The hydrograph used in the stormwater model for the project was provided by Mark Yodice on 8/10/2021 and consists of historical rainfall data from Hurricane Joaquin which affected the Charleston metro area from October 1-5, 2015. This is to model a 100-yr, 5-day storm event to determine how the proposed pumps handle this larger event. Appendix A for information regarding the storm hydrograph. All pumps were designed for the base condition of the 10-year, 24-hour event.

Hydraulic Model Update

A hydraulic model was created using Bentley SewerCAD to evaluate pumping capacity of each of the proposed scenarios, as shown below. Please note that pump curves for each of the three scenarios are provided in Appendix C.

- Duplex station using pump curves provided by Flygt
- Triplex station using pump curves provided by Romtec Utilities
- Triplex station using duty points alternate

In each of the scenarios, the Hurricane Joaquin hydrograph (to simulate a 100-year, 5-day storm event) was used in conjunction with the rational method to create hourly stormwater inflow for each of the storm water basis. These flows were input at the modeled catch basins located upstream of the respective pump stations to evaluate flow through the system drainage pipes as well as pump station and manifolded force main network.

An extended period study was run for 120 hours, with increments of 0.1 hours to monitor modeled flow rate into the wet well, as well as pumping rates out of the wet well. Wet well profiles and elevations in the model were provided by Romtec and edited by Mark Yodice on 8/12/2021. The following is a summary of the results found by running the extended period survey.

Summary of Results

Duplex Station: For the proposed conditions of the pump station evaluation, neither Pump Station 18 nor 18.5 was overloaded during the 120-hour storm event. The pumps in each pump station were able to convey storm water out of the respective pump station at a rate equal to or faster than the inflow into the respective pump station. Thus, minimal flooding is expected under the duplex scenario. For most of the modeled storm event, the flow was conveyed by only the lead pump. **Table 1** below shows flows conveyed by the pump stations under two conditions: lead pump only and lead/lag pump running simultaneously. Also shown in the table are the rainfall intensities which result in the noted flow rate for the respective stormwater basins.

	Pump Station 18		Pump Station 18.5	
	Flow Rate (cfs)	Intensity (in/hr.)	Flow Rate (cfs)	Intensity (in/hr.)
Lead Pump On	15.84	2.04	20.2	1.68
Lag Pump On	18.16	2.34	26.7	2.23

Table 1: Flow Rates Under Duplex Conditions

Triplex Station with Romtec Pumps: For the proposed conditions of the pump station evaluation, both Pump Station 18 and 18.5 were overloaded during the 120-hour storm event. The pumps in each pump station were not able to convey storm water out of the respective pump station at an equal rate to the inflow into the respective pump station. Thus, nuisance flooding is expected under this triplex scenario under the 100-year, 5-day condition. See EX. 1 in Appendix B for estimated flooding extents during the modeled storm event. Assuming that flood water can be directed back to the pump station from all low points, the model indicates that flood waters could be drained and conveyed thru the pump station within approximately one to two hours after the peak of the storm event. This is based upon an hourly intensity of over 2 in/hr.

For most of the modeled storm event, the flow was conveyed by only the lead pump. **Table 2** below shows flows conveyed by the pump stations under conditions in which one pump, two pumps and three pumps are running. Also shown in the table are the rainfall intensities which result in the noted flow rate for the respective stormwater basins.

	Pump Station 18		Pump Station 18.5	
	Flow Rate (cfs)	Intensity (in/hr.)	Flow Rate (cfs)	Intensity (in/hr.)
Single Pump	10.44	1.35	10.98	0.92
Double Pump	11.26	1.45	16.32	1.36
Triple Pump	13.05	1.68	22.26	1.86

Table 2: Flow Rates Under Triplex Conditions with Romtec Provided Pumps

Triplex Station with Alternate Pumps: For the proposed conditions of the pump station evaluation, neither Pump Station 18 nor 18.5 was overloaded during the 120-hour storm event. The pumps in each pump station were able to convey storm water out of the respective pump station at a rate equal to or faster than the inflow into the respective pump station. Thus, flooding is not expected under this triplex scenario during the 100-year, 5-day event. For most of the modeled storm event, the flow was conveyed by only the lead pump. **Table 3** below shows flows conveyed by the pump stations under conditions in which one pump, two pumps and three pumps are running. Also shown in the table are the rainfall intensities which result in the noted flow rate for the respective stormwater basins.

	Pump Station 18		Pump Station 18.5	
	Flow Rate (cfs)	Intensity (in/hr.)	Flow Rate (cfs)	Intensity (in/hr.)
One Pump	11.21	1.44	11.71	0.98
Two Pumps	15.04	1.94	19	1.58
Three Pumps	16.05	2.07	24.56	2.05

Table 3: Flow Rates Under Triplex Conditions with alternate Selected Pumps

Discussion

The FEMA grant, which the Town of Sullivan's Island received, as written, requires the product to handle flood volumes and flow rates of the 10-year storm, 24-hour event as the design level of protection with "the intent of the proposed project is to provide a level of protection to the 100-year, 5-day precipitation event…". The amount of rain for each event is:

- 10-year 24-hour storm event (handle) 6.6 inches
- 100-year, 5-day prescription (provide protection against) 13.1 inches

To address these goals, three options for pump set up were reviewed. Attached is a simple comparison of the three options. The attached also comments to the force main sizes (velocities are a bit high during the peak of the storms). With the three-pump option using the smaller horsepower pumps and the increased force main sizes, the system would be able to handle 2.2 in/hr. (PS Sta 18) and 2.5 in/hr. (PS Sta 18.5). The peak intensity of the 100-year, 5-day storm event (which is basically the Joaquin Storm, Joaquin dropped 15.84 inches over 5 days so a bit more than the NOAA rain amount of 13.1 inches is 2.06 in/hr. Therefore, any nuisance flooding may not occur since the model uses an event with rainfall excessing the NOAA specified 100-year, 5-day storm for the local.

The Joaquin Storm graph is the guide for the 100-year, 5-day event and an estimate of the shallow ponding limits with the option of the smaller horsepower pumps follows. We estimate the ponding would last a bit less than an hour of course (based upon more rain than the 100-year, 5-day event) before the pumps draw the water down without the addition of a jockey pump.

Since the design storm is the 10-year, 24-hour event, the three-pump scenario Option 2 will handle the smaller intensity storms, like the 2-year event, better because of the varying flows from different storms. Scenario 2 offers a much smaller horsepower setup so the ongoing operating costs will be more affordable and a bit easier for operators to maintain. A smaller jockey pump to assist during the 100-year, 5-day event may be warranted but is not the base design. A jockey pump would also address the possible groundwater fluctuations getting into the system. Therefore, based upon these matters above, the 2nd scenario was selected by the Town.

Basically, any event over 2 in/hr. causes stormwater to start backing up (assuming all rainwater from the basin is being routed through the pump station, a.k.a. ignoring ground infiltration under any scenario).

Below are some of the quick results looking at the worst-case scenario when all pumps are running during the 100-year, 5-day event using pumps in Option 2.

Pipe	Size (inches)	Velocity (fps)	Flow Rate (cfs)	Intensity (in/hr.)
18	18	10.9	17.6	2.2
18.5	20	11.2	22.2	2.5
Combined	30	9.2	39.8	

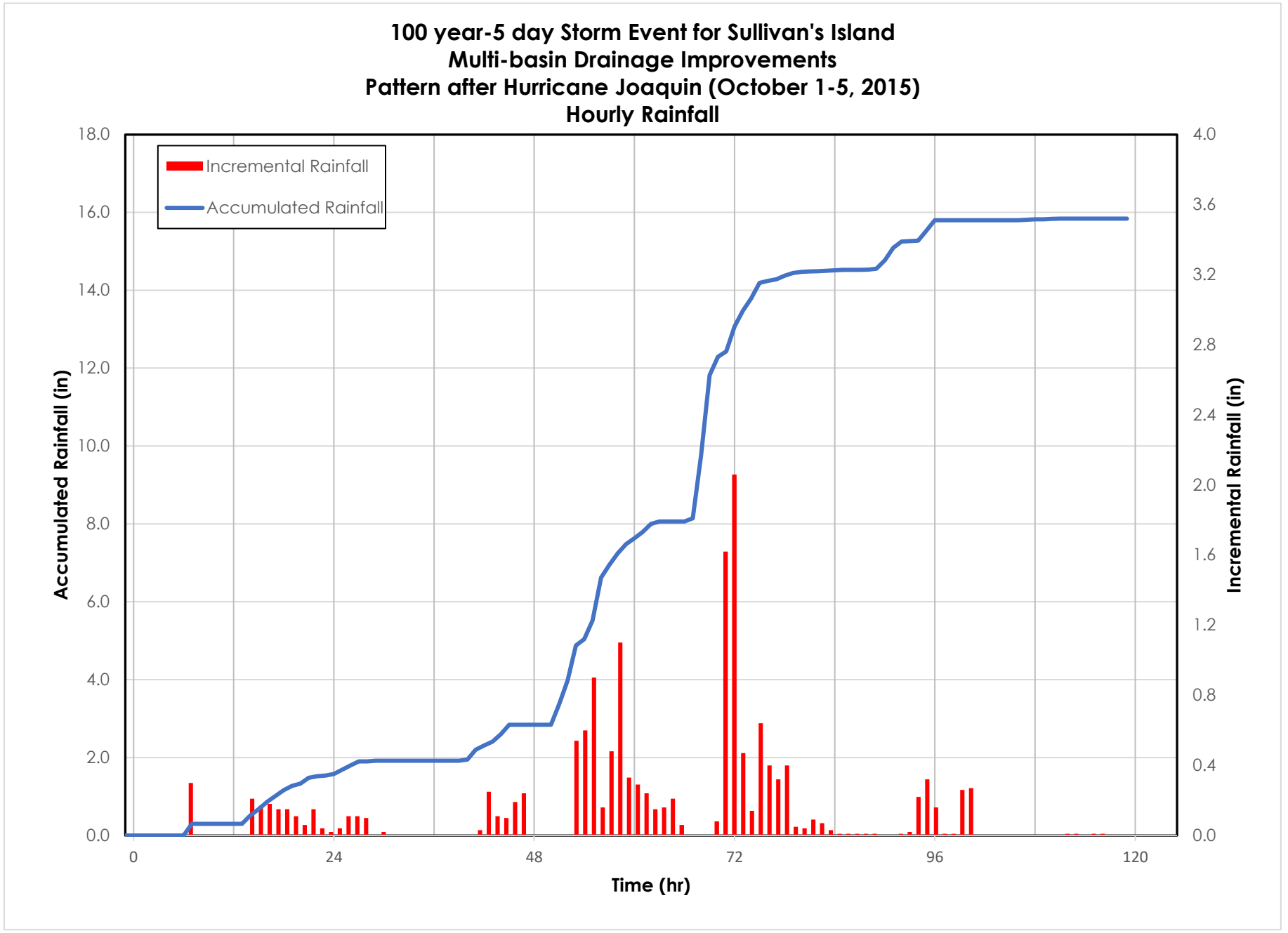
This scenario can serve the pump stations with the smaller (25 and 35 hp) pumps.

Keep in mind, these velocities are for the worst-case scenario, when all three pumps in both pump stations are running. Under "normal" circumstances when single pumps are running, the velocities will be more in the 3-6 fps range across the system.

For force main sizes less than the above fluid velocities are in the 10.1 to 15.1 fps range which is too high for this application.

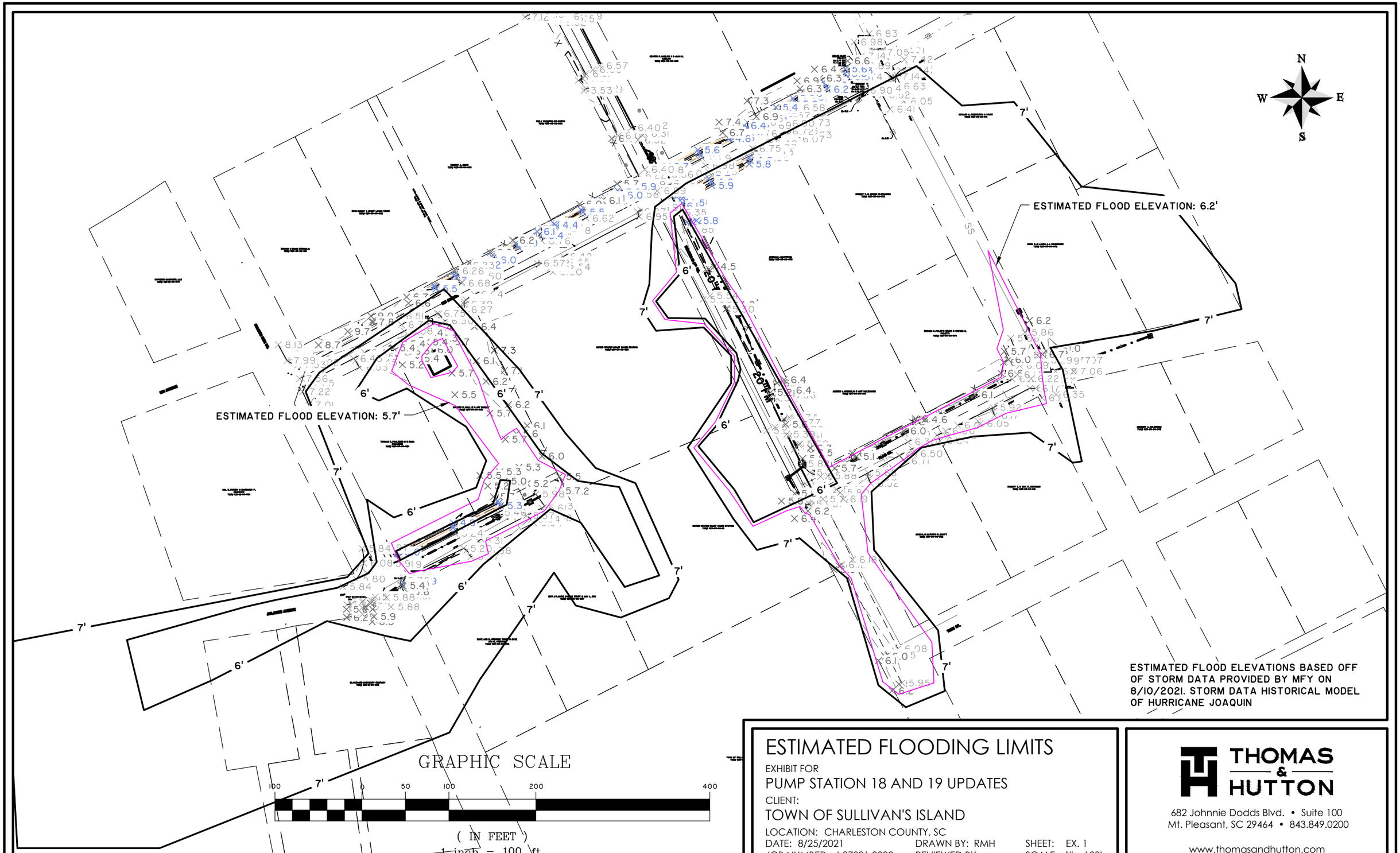
APPENDIX A

HYDROGRAPH – HURRICANE JOAQUIN


100 year-5 day Storm Event for Sullivan's Island
Multi-basin Drainage Improvements
Pattern after Hurricane Joaquin (October 1-5, 2015)
Hourly Rainfall
Incremental Rainfall
Accumulated Rainfall
Accumulated Rainfall (in)
Incremental Rainfall (in)
Time (hr)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
0.0
0.4
0.8
1.2
1.6
2.0
2.4
2.8
3.2
3.6
4.0
0
24
48
72
96
120

APPENDIX B

EXHIBITS



ESTIMATED FLOOD ELEVATIONS BASED OFF OF STORM DATA PROVIDED BY MFY ON 8/10/2021. STORM DATA HISTORICAL MODEL OF HURRICANE JOAQUIN

GRAPHIC SCALE

100 0 50 100 200 400

(IN FEET)

1 inch = 100 ft.

ESTIMATED FLOODING LIMITS

EXHIBIT FOR

PUMP STATION 18 AND 19 UPDATES

CLIENT:

TOWN OF SULLIVAN'S ISLAND

LOCATION: CHARLESTON COUNTY, SC

DATE: 8/25/2021 DRAWN BY: RMH SHEET: EX. 1

JOB NUMBER: J-27091.0000 REVIEWED BY: SCALE: 1" = 100'

THOMAS & HUTTON

682 Johnnie Dodds Blvd. • Suite 100
Mt. Pleasant, SC 29464 • 843.849.0200

www.thomasandhutton.com

APPENDIX C

PUMP CURVES

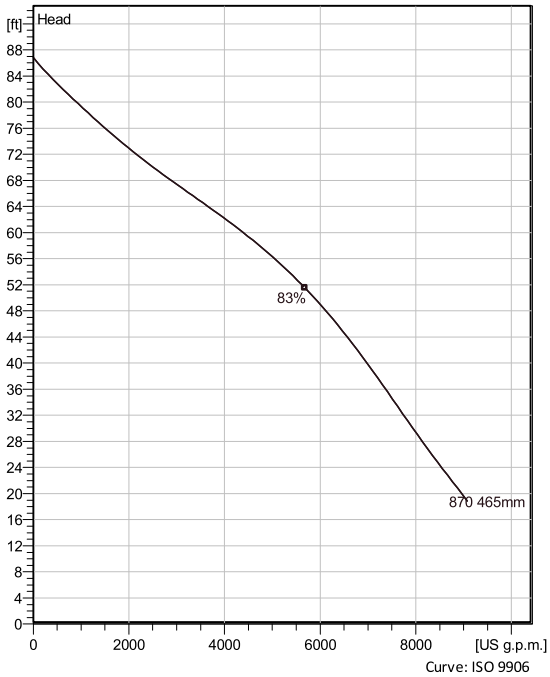
DUPLEX PUMP STATION

NP 3356/665 3~ 870

Patented self cleaning semi-open channel impeller, ideal for pumping in waste water applications. Modular based design with high adaptation grade.

Technical specification

Curves according to: Water, pure ,39.2 °F,62.42 lb/ft³,1.6891E-5 ft²/s



Curve: ISO 9906

Configuration

Motor number
N0665.000 35-45-8AA-W 100hp

Installation type
P - Semi permanent, Wet

Impeller diameter
465 mm

Discharge diameter
9/16 inch

Pump information

Impeller diameter
465 mm

Discharge diameter
9/16 inch

Inlet diameter
350 mm

Maximum operating speed
880 rpm

Number of blades
3

Max. fluid temperature
40 °C

Materials

Impeller
Hard-Iron ™

Project		**Created by**	PETER CARLSON
Block		**Created on**	7/13/2021 **Last update** 7/13/2021

NP 3356/665 3~ 870

Technical specification

Motor - General

Motor number N0665.000 35-45-8AA-W 100hp	**Phases** 3~	**Rated speed** 880 rpm	**Rated power** 100 hp
ATEX approved No	**Number of poles** 8	**Rated current** 128 A	**Stator variant** 1
Frequency 60 Hz	**Rated voltage** 460 V	**Insulation class** H	**Type of Duty**
Version code 000			

Motor - Technical

Power factor - 1/1 Load 0.80	**Motor efficiency - 1/1 Load** 91.0 %	**Total moment of inertia** 55.5 lb ft²	**Starts per hour max.** 0
Power factor - 3/4 Load 0.77	**Motor efficiency - 3/4 Load** 92.0 %	**Starting current, direct starting** 660 A	
Power factor - 1/2 Load 0.68	**Motor efficiency - 1/2 Load** 92.0 %	**Starting current, star-delta** 220 A	

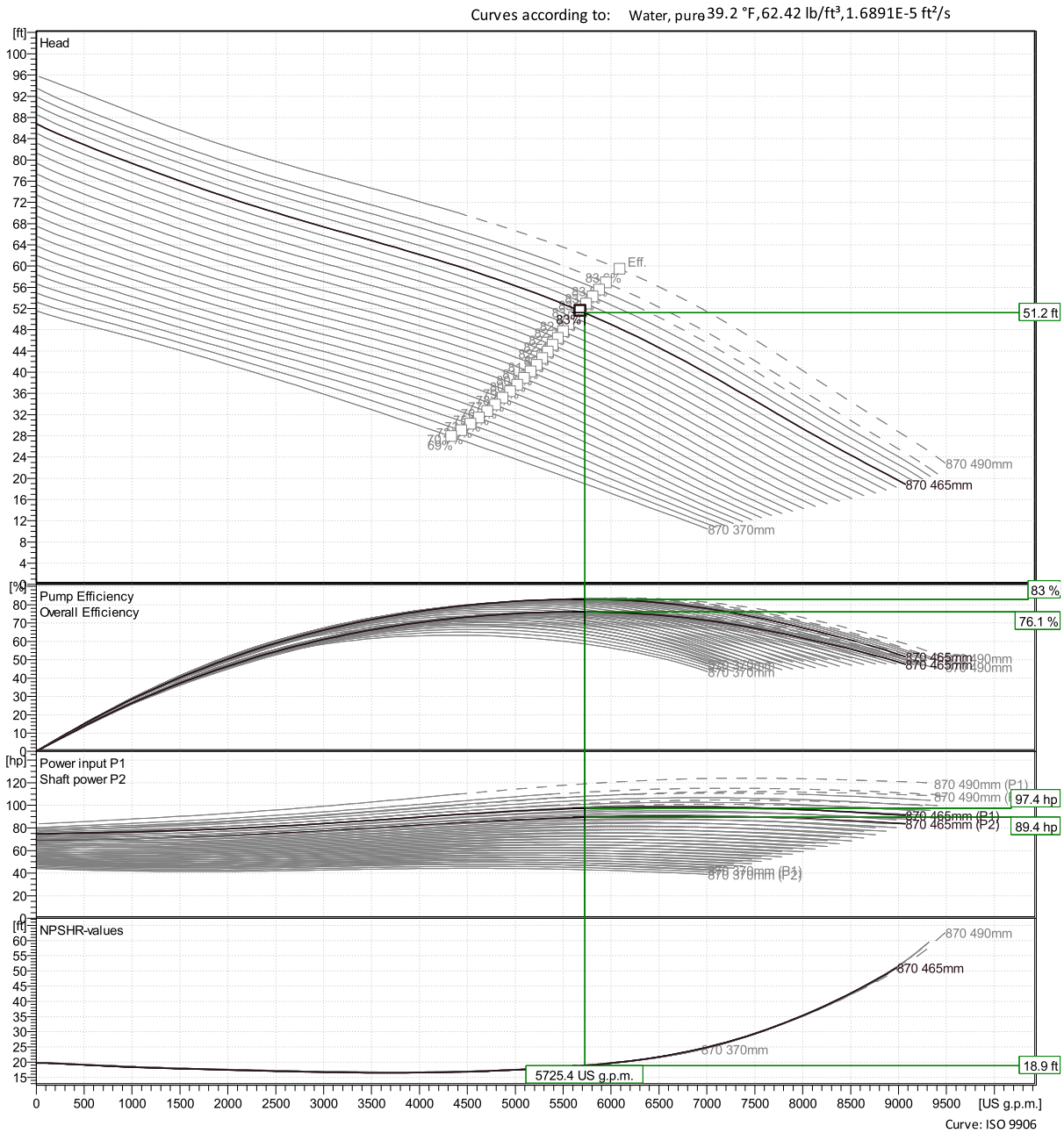
Project	**Created by**	PETER CARLSON	
Block	**Created on**	7/13/2021	**Last update** 7/13/2021

NP 3356/665 3~ 870

Performance curve

Duty point

Flow	Head
5730 US g.p.m.	51.2 ft

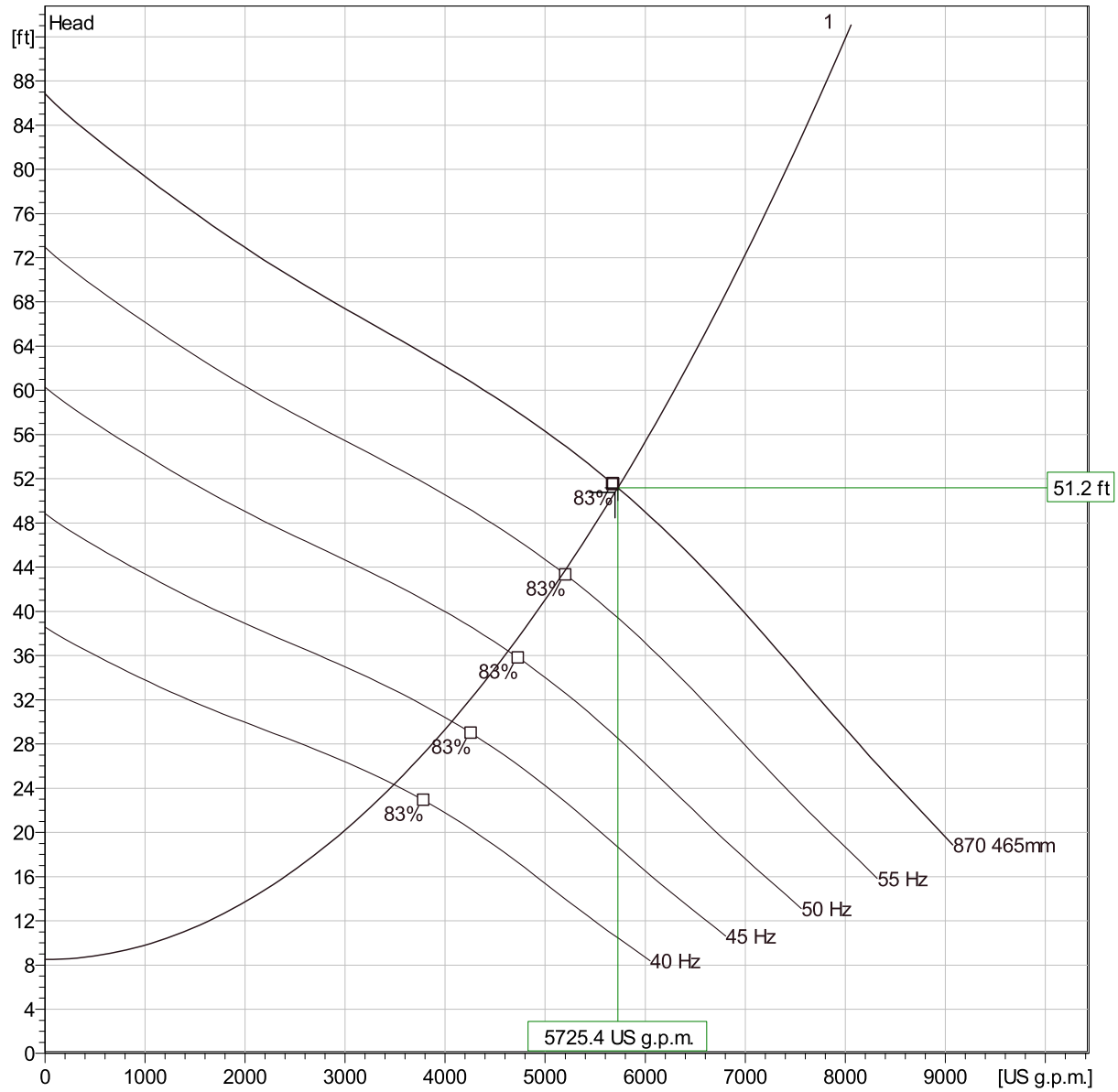


Project	**Created by**	PETER CARLSON	
Block	**Created on**	7/13/2021	**Last update** 7/13/2021

NP 3356/665 3~ 870

Duty Analysis

Curves according to: Water, pure ,39.2 °F,62.42 lb/ft³,1.6891E-5 ft²/s



Operating characteristics

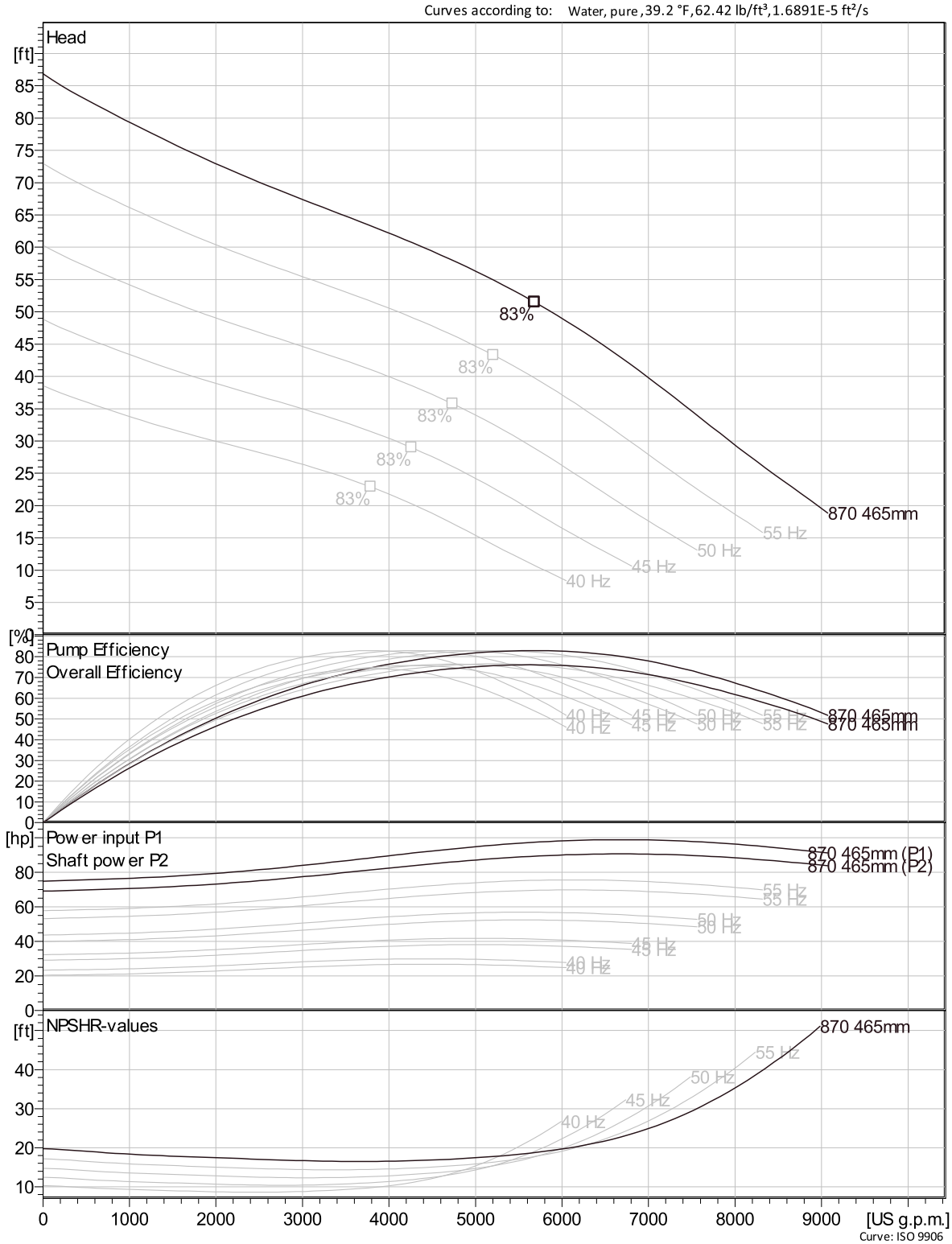
Pumps / Systems	Flow	Head	Shaft power	Flow	Head	Shaft power	Hydr.eff.	Specific Energy	NPSHre
1	5730 US g.p.m	51.2 ft	89.4 hp	5730 US g.p.m	51.2 ft	89.4 hp	83 %	212 kWh/US M	18.9 ft

Project		**Created by**	PETER CARLSON		
Block		**Created on**	7/13/2021	**Last update**	7/13/2021

NP 3356/665 3~ 870

VFD Curve

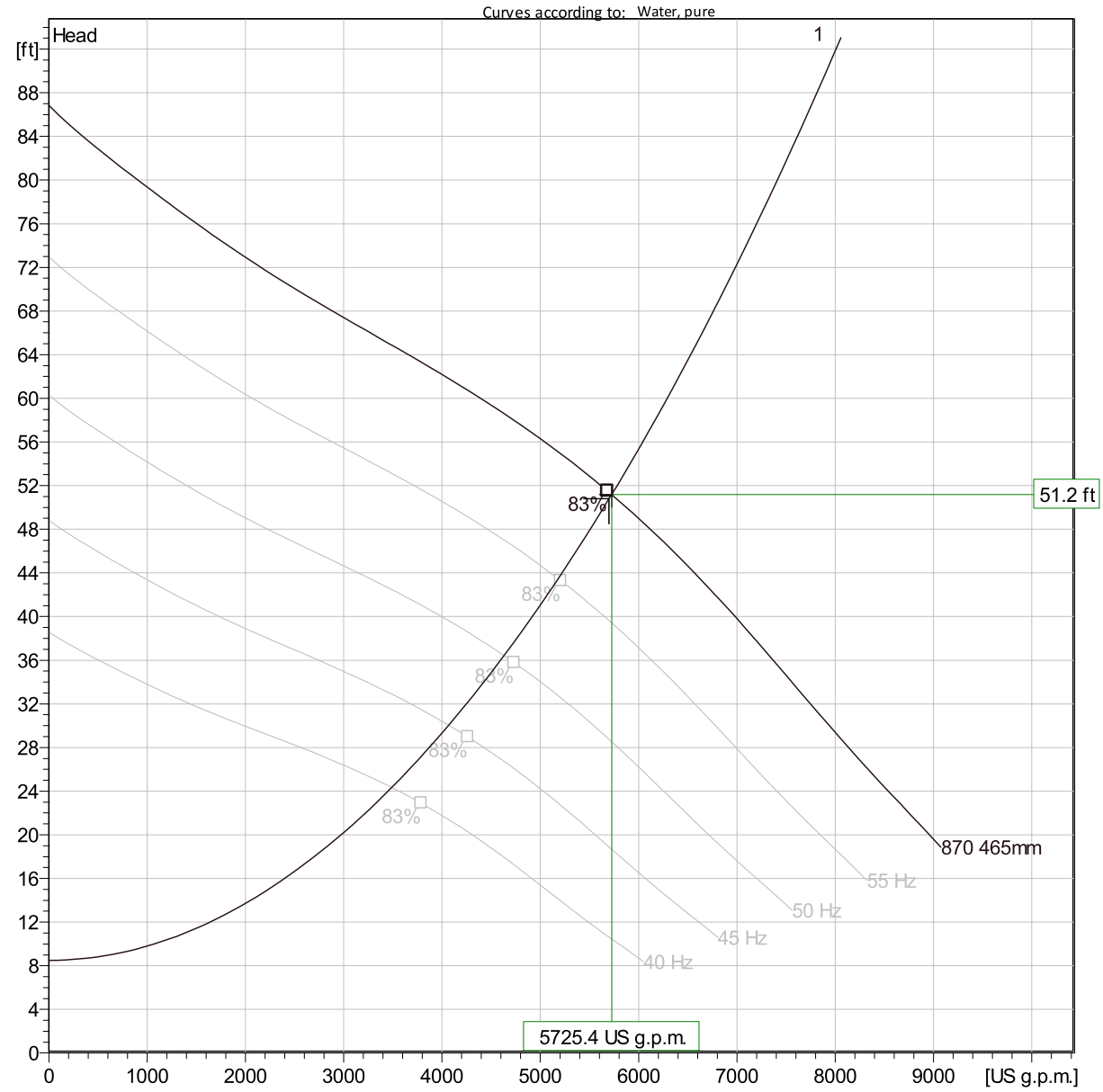
Curves according to: Water, pure ,39.2 °F,62.42 lb/ft³,1.6891E-5 ft²/s



Project	**Created by**	PETER CARLSON	
Block	**Created on**	7/13/2021	**Last update** 7/13/2021

NP 3356/665 3~ 870

VFD Analysis



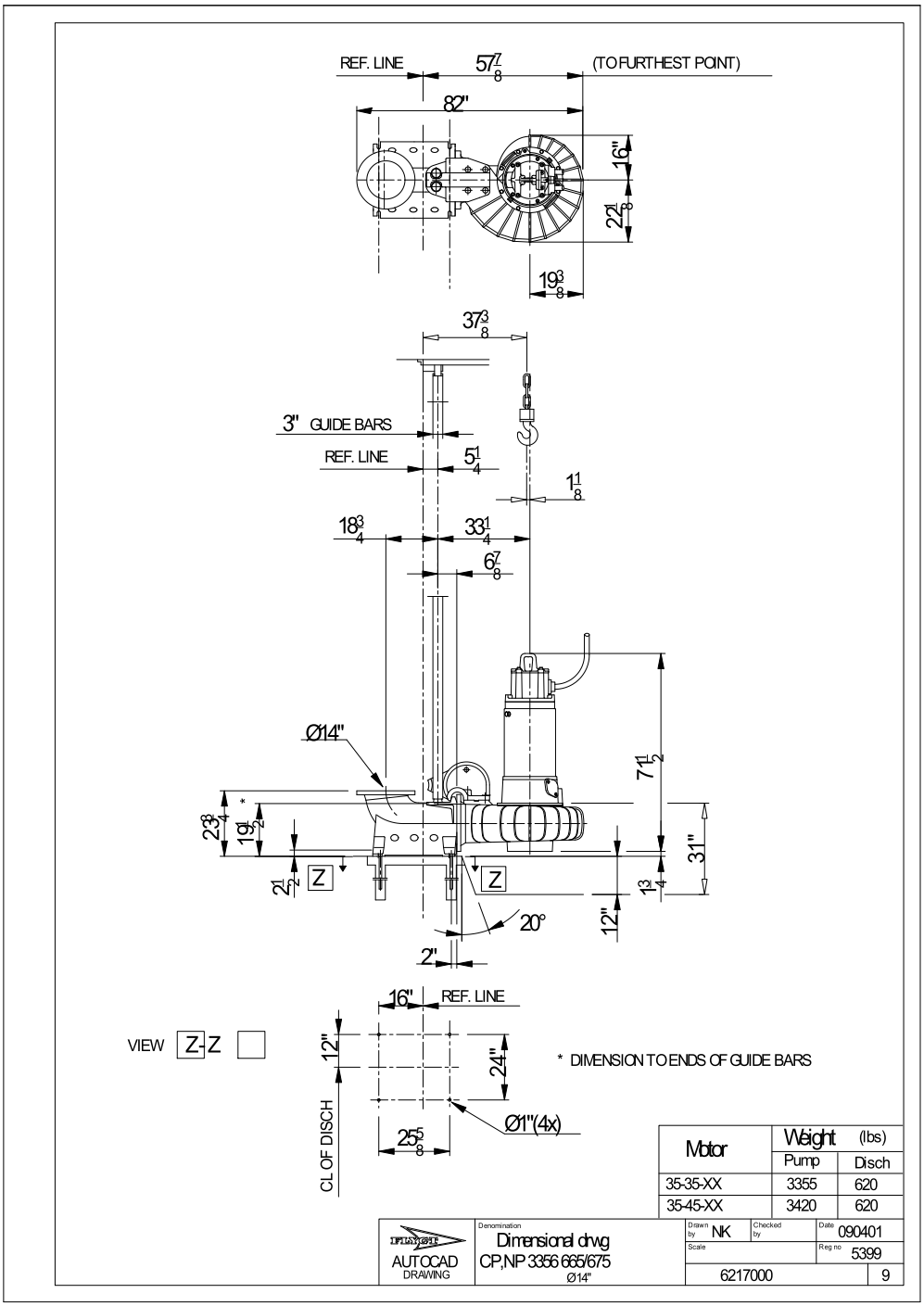
Operating characteristics

Pumps / Systems	Frequency	Flow	Head	Shaft power	Flow	Head	Shaft power	Hydr.eff.	Specific Energy	NPSHre
1	60 Hz	5730 US g.p.m	51.2 ft	89.4 hp	5730 US g.p.m	51.2 ft	89.4 hp	83 %	212 kWh/US M	18.9 ft
1	55 Hz	5210 US g.p.m	43.9 ft	69.7 hp	5210 US g.p.m	43.9 ft	69.7 hp	83 %	180 kWh/US M	16.4 ft
1	50 Hz	4660 US g.p.m	36.8 ft	52.2 hp	4660 US g.p.m	36.8 ft	52.2 hp	82.9 %	151 kWh/US M	13.9 ft
1	45 Hz	4090 US g.p.m	30.3 ft	37.9 hp	4090 US g.p.m	30.3 ft	37.9 hp	82.8 %	126 kWh/US M	11.6 ft
1	40 Hz	3510 US g.p.m	24.5 ft	26.4 hp	3510 US g.p.m	24.5 ft	26.4 hp	82.5 %	105 kWh/US M	9.39 ft

Project	**Created by**	PETER CARLSON	
Block	**Created on**	7/13/2021	**Last update** 7/13/2021

NP 3356/665 3~ 870

Dimensional drawing



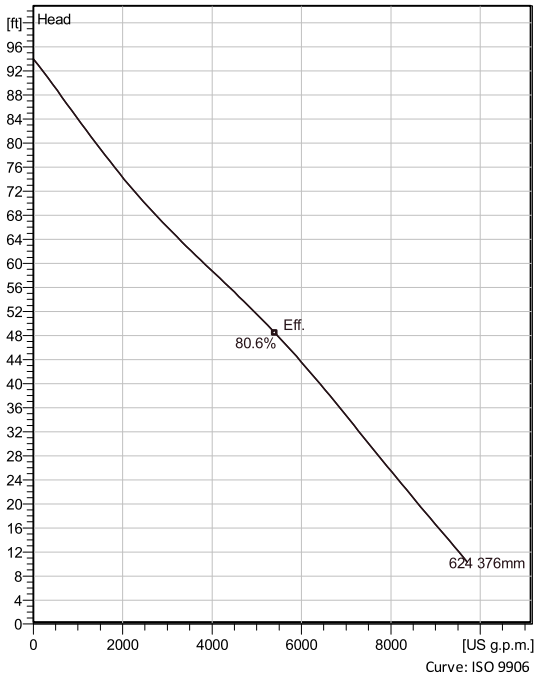
Project		**Created by**	PETER CARLSON
Block		**Created on**	7/13/2021 **Last update** 7/13/2021

NP 3301 LT 3~ 624

Patented self cleaning semi-open channel impeller, ideal for pumping in waste water applications. Modular based design with high adaptation grade.

Technical specification

Curves according to: Water, pure ,39.2 °F,62.42 lb/ft³,1.6891E-5 ft²/s



Curve: ISO 9906

Configuration

Motor number
N3301.185 35-29-6AA-W 85hp

Installation type
P - Semi permanent, Wet

Impeller diameter
376 mm

Discharge diameter
1/2 inch

Pump information

Impeller diameter
376 mm

Discharge diameter
1/2 inch

Inlet diameter
350 mm

Maximum operating speed
1185 rpm

Number of blades
2

Max. fluid temperature
40 °C

Materials

Impeller
Hard-Iron ™

Project		**Created by**	PETER CARLSON
Block		**Created on**	7/20/2021 **Last update** 7/20/2021

NP 3301 LT 3~ 624

Technical specification

Motor - General

Motor number N3301.185 35-29-6AA-W 85hp	**Phases** 3~	**Rated speed** 1185 rpm	**Rated power** 85 hp
ATEX approved No	**Number of poles** 6	**Rated current** 109 A	**Stator variant** 1
Frequency 60 Hz	**Rated voltage** 460 V	**Insulation class** H	**Type of Duty** S1
Version code 185			

Motor - Technical

Power factor - 1/1 Load 0.80	**Motor efficiency - 1/1 Load** 91.0 %	**Total moment of inertia** 28.7 lb ft²	**Starts per hour max.** 30
Power factor - 3/4 Load 0.75	**Motor efficiency - 3/4 Load** 91.5 %	**Starting current, direct starting** 685 A	
Power factor - 1/2 Load 0.64	**Motor efficiency - 1/2 Load** 90.5 %	**Starting current, star-delta** 228 A	

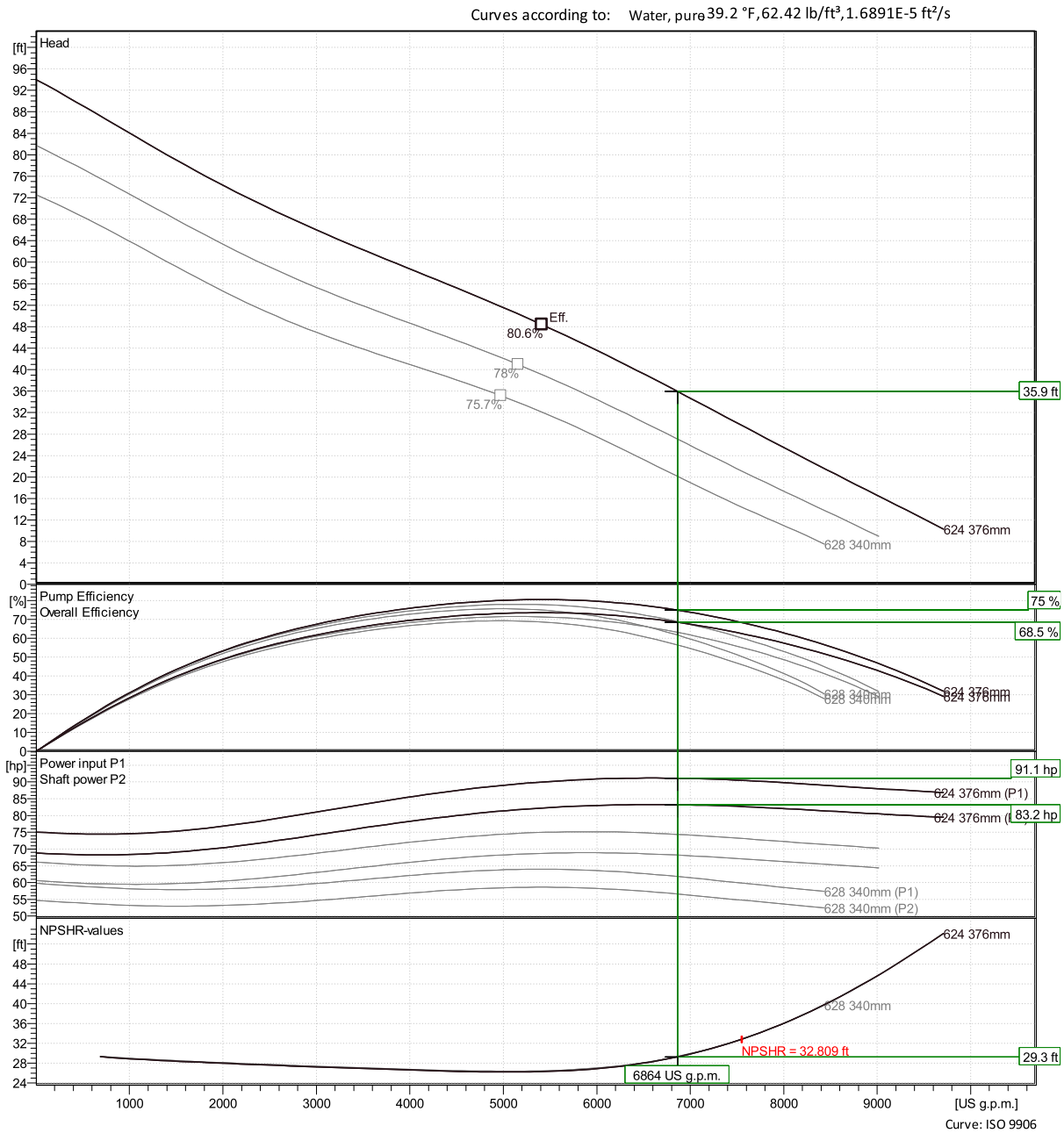
Project	**Created by**	PETER CARLSON	
Block	**Created on**	7/20/2021	**Last update** 7/20/2021

NP 3301 LT 3~ 624

Performance curve

Duty point

Flow	Head
6860 US g.p.m.	35.9 ft

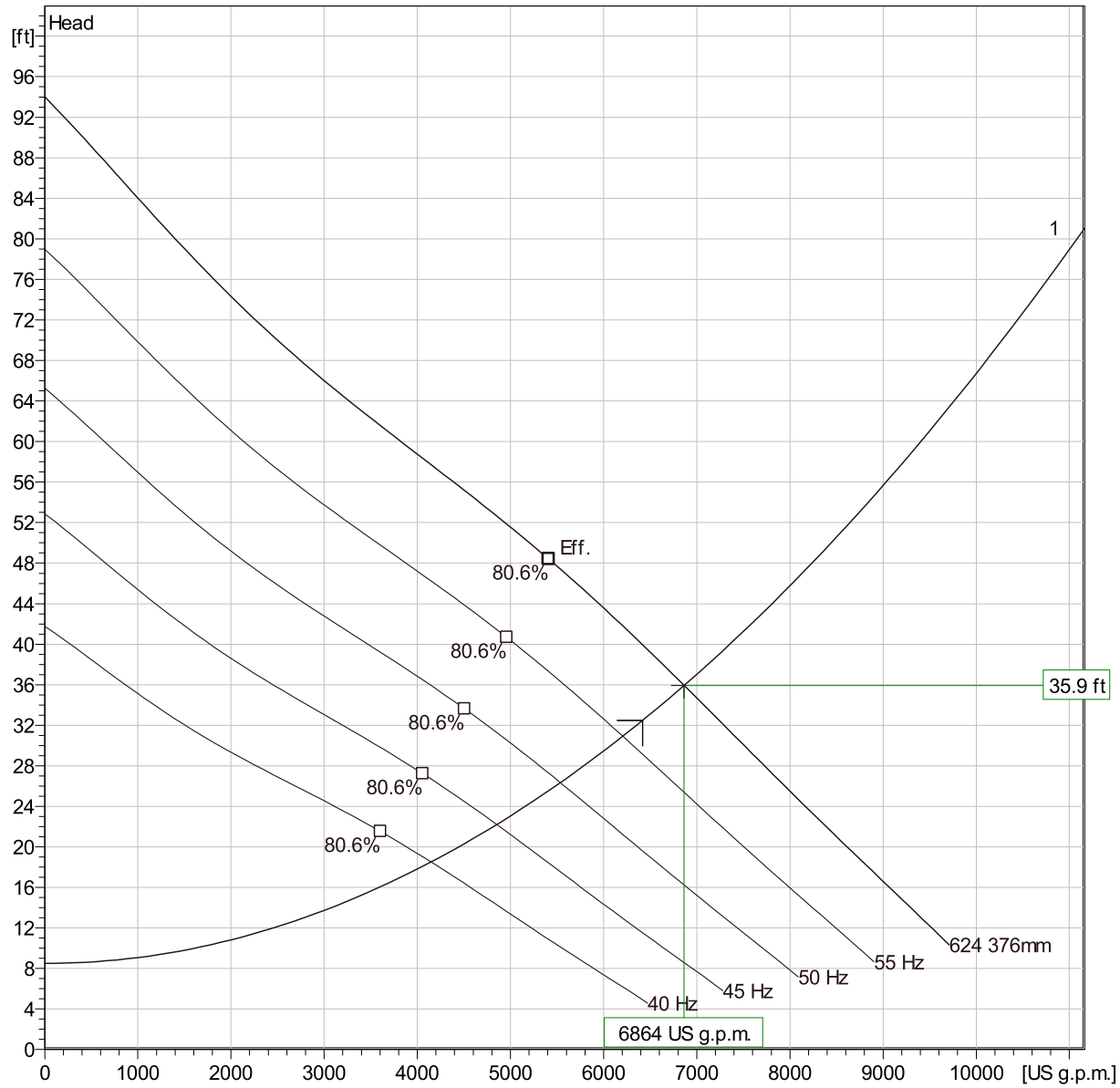


Project	**Created by**	PETER CARLSON	
Block	**Created on**	7/20/2021	**Last update** 7/20/2021

NP 3301 LT 3~ 624

Duty Analysis

Curves according to: Water, pure ,39.2 °F,62.42 lb/ft³,1.6891E-5 ft²/s



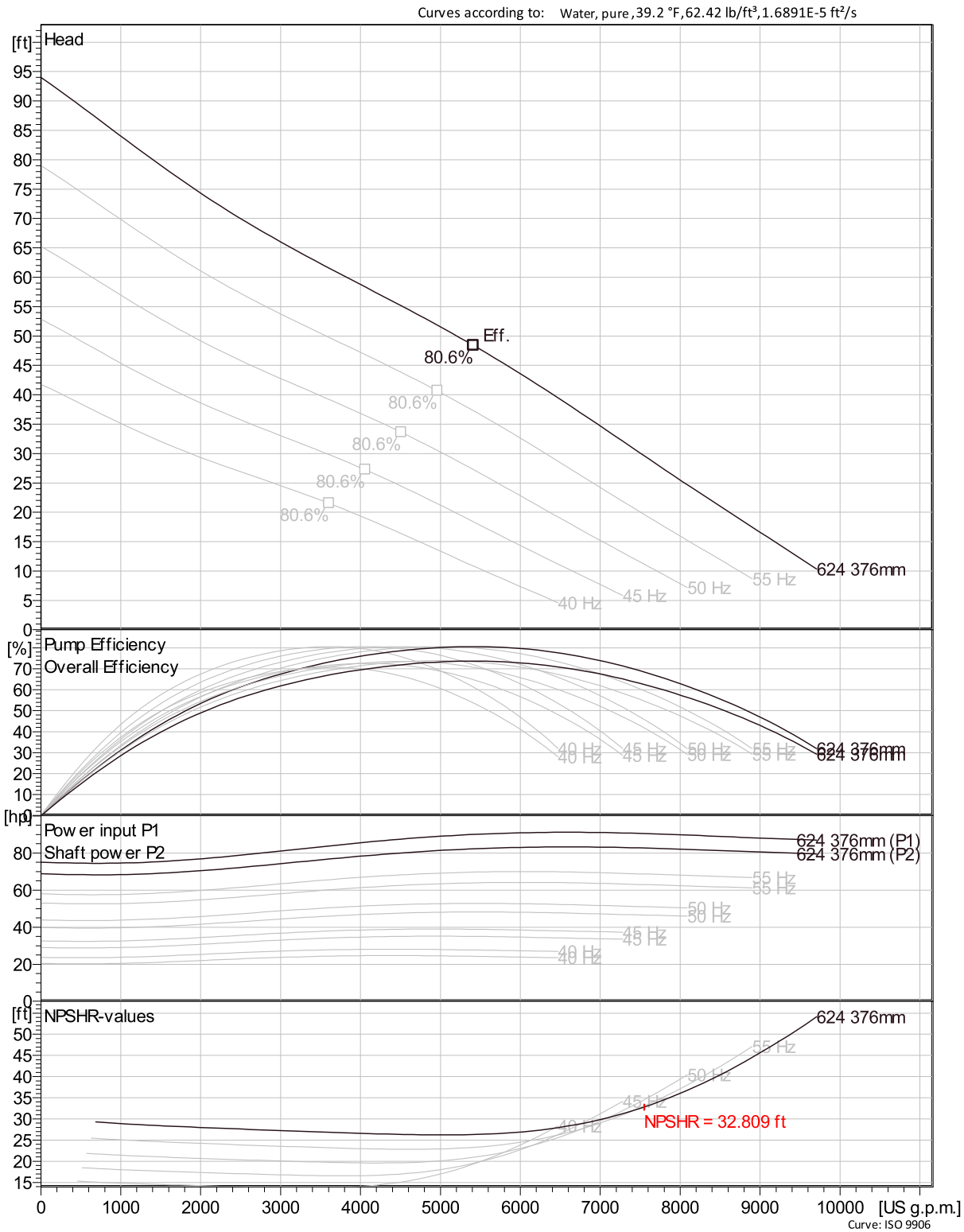
Operating characteristics

Pumps / Systems	Flow	Head	Shaft power	Flow	Head	Shaft power	Hydr.eff.	Specific Energy	NPSHre
1	6860 US g.p.m	35.9 ft	83.2 hp	6860 US g.p.m	35.9 ft	83.2 hp	75 %	165 kWh/US M	29.3 ft

Project		**Created by**	PETER CARLSON		
Block		**Created on**	7/20/2021	**Last update**	7/20/2021

NP 3301 LT 3~ 624

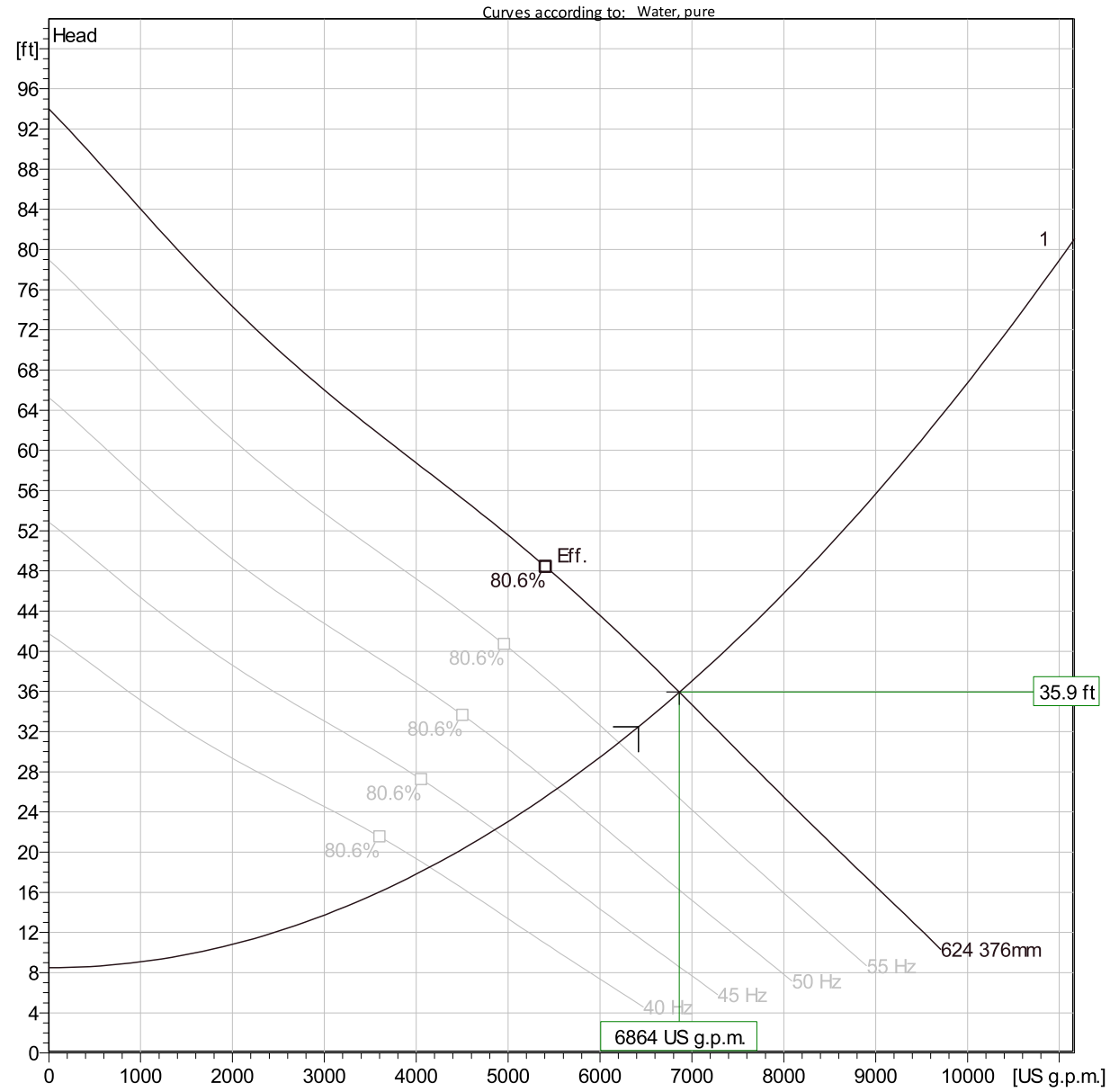
VFD Curve



Project	**Created by**	PETER CARLSON	
Block	**Created on**	7/20/2021	**Last update** 7/20/2021

NP 3301 LT 3~ 624

VFD Analysis



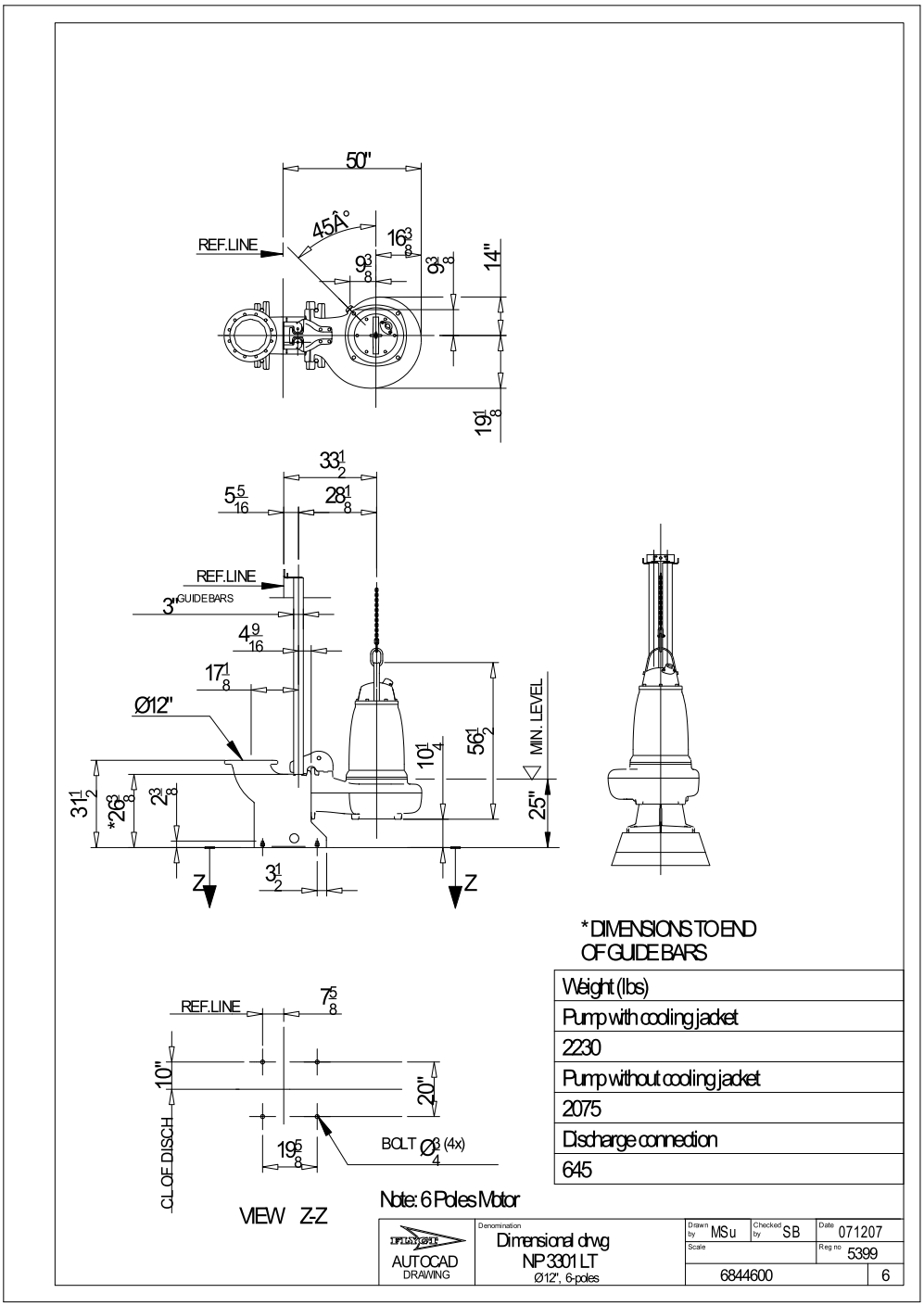
Operating characteristics

Pumps / Systems	Frequency	Flow	Head	Shaft power	Flow	Head	Shaft power	Hydr.eff.	Specific Energy	NPSHre
1	60 Hz	6860 US g.p.m	35.9 ft	83.2 hp	6860 US g.p.m	35.9 ft	83.2 hp	75 %	165 kWh/US M	29.3 ft
1	55 Hz	6210 US g.p.m	30.9 ft	64.1 hp	6210 US g.p.m	30.9 ft	64.1 hp	75.7 %	140 kWh/US M	25.1 ft
1	50 Hz	5540 US g.p.m	26.3 ft	48.2 hp	5540 US g.p.m	26.3 ft	48.2 hp	76.6 %	119 kWh/US M	21.3 ft
1	45 Hz	4850 US g.p.m	22.2 ft	35.1 hp	4850 US g.p.m	22.2 ft	35.1 hp	77.6 %	99.8 kWh/US M	17.6 ft
1	40 Hz	4150 US g.p.m	18.5 ft	24.6 hp	4150 US g.p.m	18.5 ft	24.6 hp	78.9 %	84.1 kWh/US M	14.3 ft

Project	**Created by**	PETER CARLSON	
Block	**Created on**	7/20/2021	**Last update** 7/20/2021

NP 3301 LT 3~ 624

Dimensional drawing



Project		**Created by**	PETER CARLSON
Block		**Created on**	7/20/2021 **Last update** 7/20/2021

TRIPLEX PUMP STATION

ROMTEC SELECTION

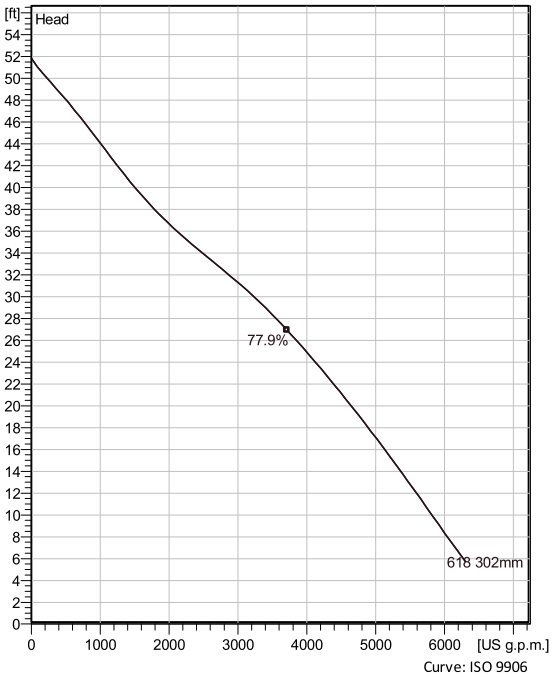
PUMP STATION 18

NP 3202 LT 3~ 618

Patented self cleaning semi-open channel impeller, ideal for pumping in waste water applications. Modular based design with high adaptation grade.

Technical specification

Curves according to: Water, pure ,39.2 °F,62.42 lb/ft³,1.6891E-5 ft²/s



Curve: ISO 9906

Configuration

Motor number
N3202.185 30-18-6AA-W 35hp

Installation type
P - Semi permanent, Wet

Impeller diameter
302 mm

Discharge diameter
1/2 inch

Pump information

Impeller diameter
302 mm

Discharge diameter
1/2 inch

Inlet diameter
300 mm

Maximum operating speed
1165 rpm

Number of blades
2

Max. fluid temperature
40 °C

Materials

Impeller
Hard-Iron ™

Project		**Created by**	Ryan Palmer
Block		**Created on**	7/29/2021 **Last update** 7/29/2021

NP 3202 LT 3~ 618

Technical specification

Motor - General

Motor number N3202.185 30-18-6AA-W 35hp	**Phases** 3~	**Rated speed** 1165 rpm	**Rated power** 35 hp
ATEX approved No	**Number of poles** 6	**Rated current** 42 A	**Stator variant** 4
Frequency 60 Hz	**Rated voltage** 460 V	**Insulation class** H	**Type of Duty** S1
Version code 185			

Motor - Technical

Power factor - 1/1 Load 0.88	**Motor efficiency - 1/1 Load** 89.0 %	**Total moment of inertia** 10.8 lb ft²	**Starts per hour max.** 30
Power factor - 3/4 Load 0.85	**Motor efficiency - 3/4 Load** 90.0 %	**Starting current, direct starting** 225 A	
Power factor - 1/2 Load 0.79	**Motor efficiency - 1/2 Load** 90.5 %	**Starting current, star-delta** 75 A	

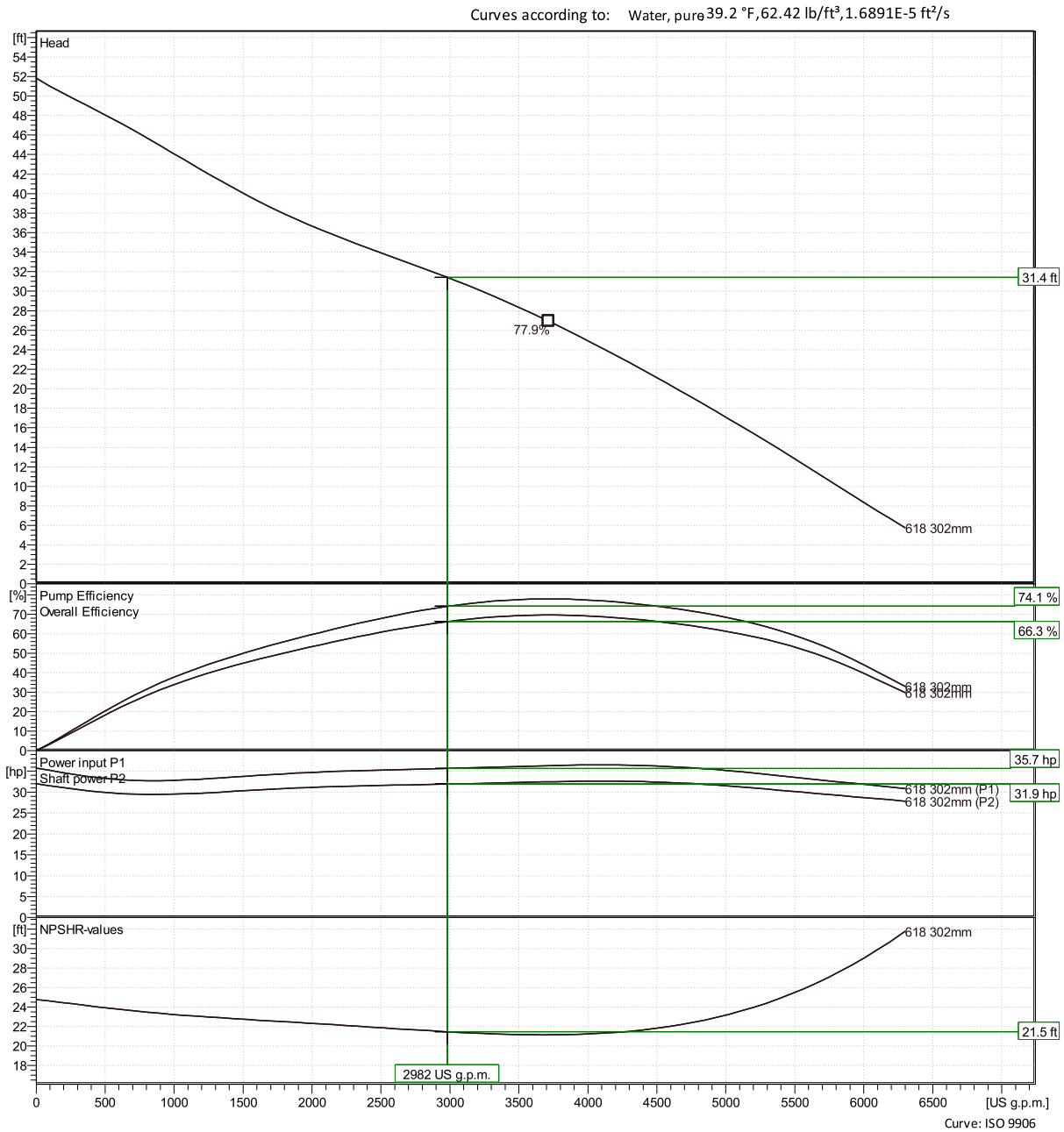
Project	**Created by**	Ryan Palmer	
Block	**Created on**	7/29/2021	**Last update** 7/29/2021

NP 3202 LT 3~ 618

Performance curve

Duty point

Flow	Head
2980 US g.p.m.	31.4 ft



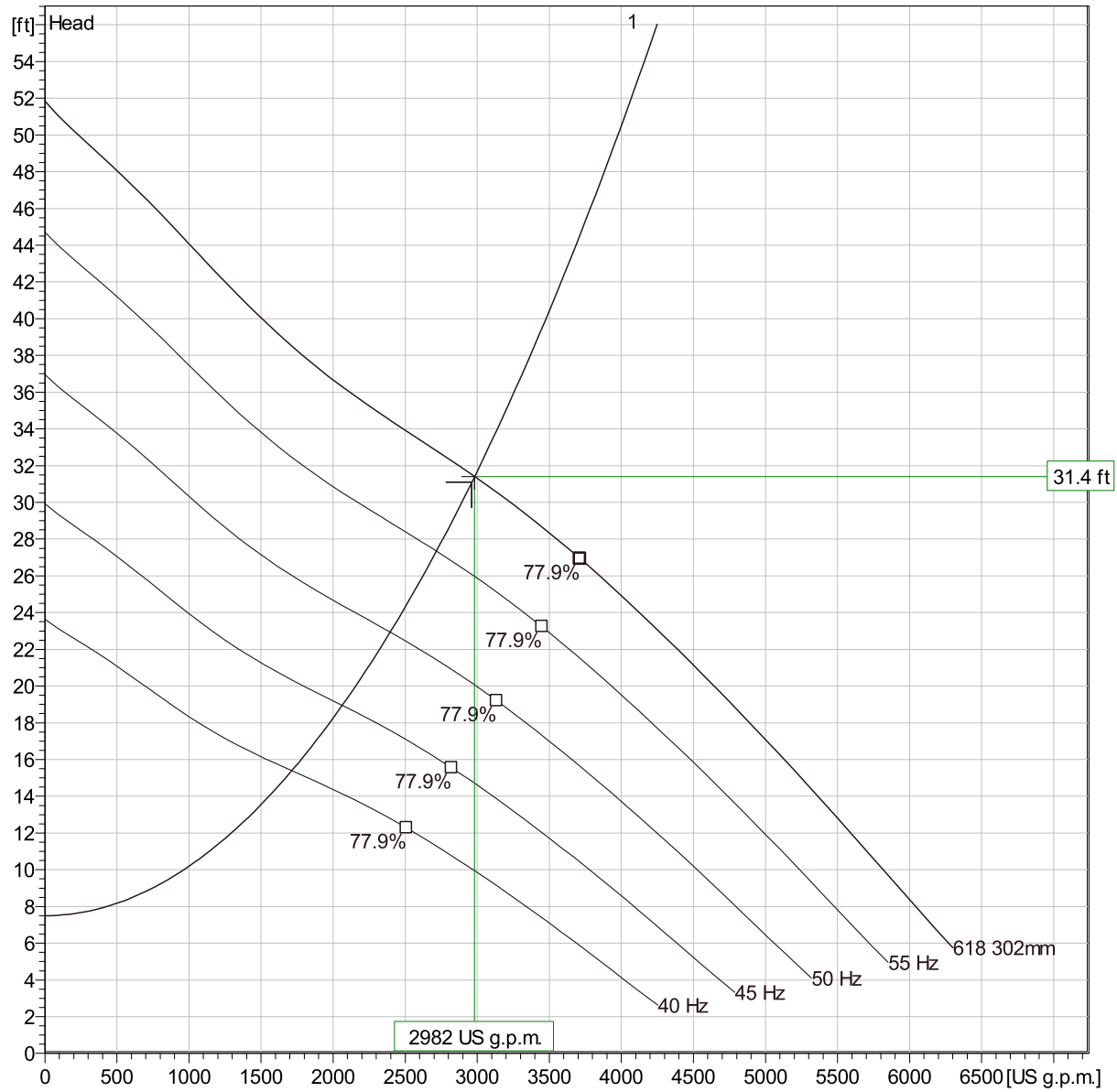
Curve: ISO 9906

Project		**Created by**	Ryan Palmer		
Block		**Created on**	7/29/2021	**Last update**	7/29/2021

NP 3202 LT 3~ 618

Duty Analysis

Curves according to: Water, pure ,39.2 °F,62.42 lb/ft³,1.6891E-5 ft²/s



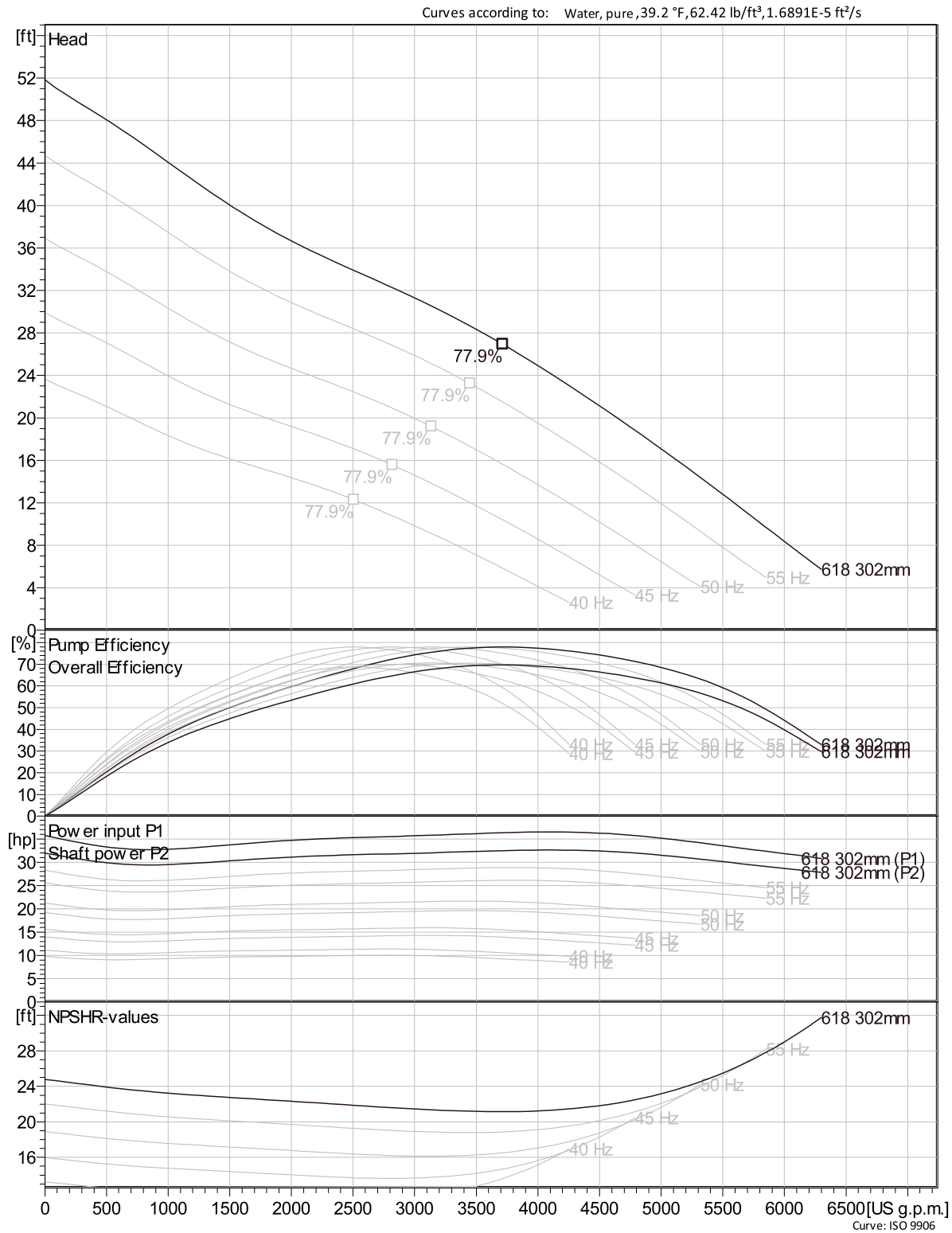
Operating characteristics

Pumps / Systems	Flow	Head	Shaft power	Flow	Head	Shaft power	Hydr.eff.	Specific Energy	NPSHre
1	2980 US g.p.m	31.4 ft	31.9 hp	2980 US g.p.m	31.4 ft	31.9 hp	74.1 %	149 kWh/US M	21.5 ft

Project		**Created by**	Ryan Palmer		
Block		**Created on**	7/29/2021	**Last update**	7/29/2021

NP 3202 LT 3~ 618

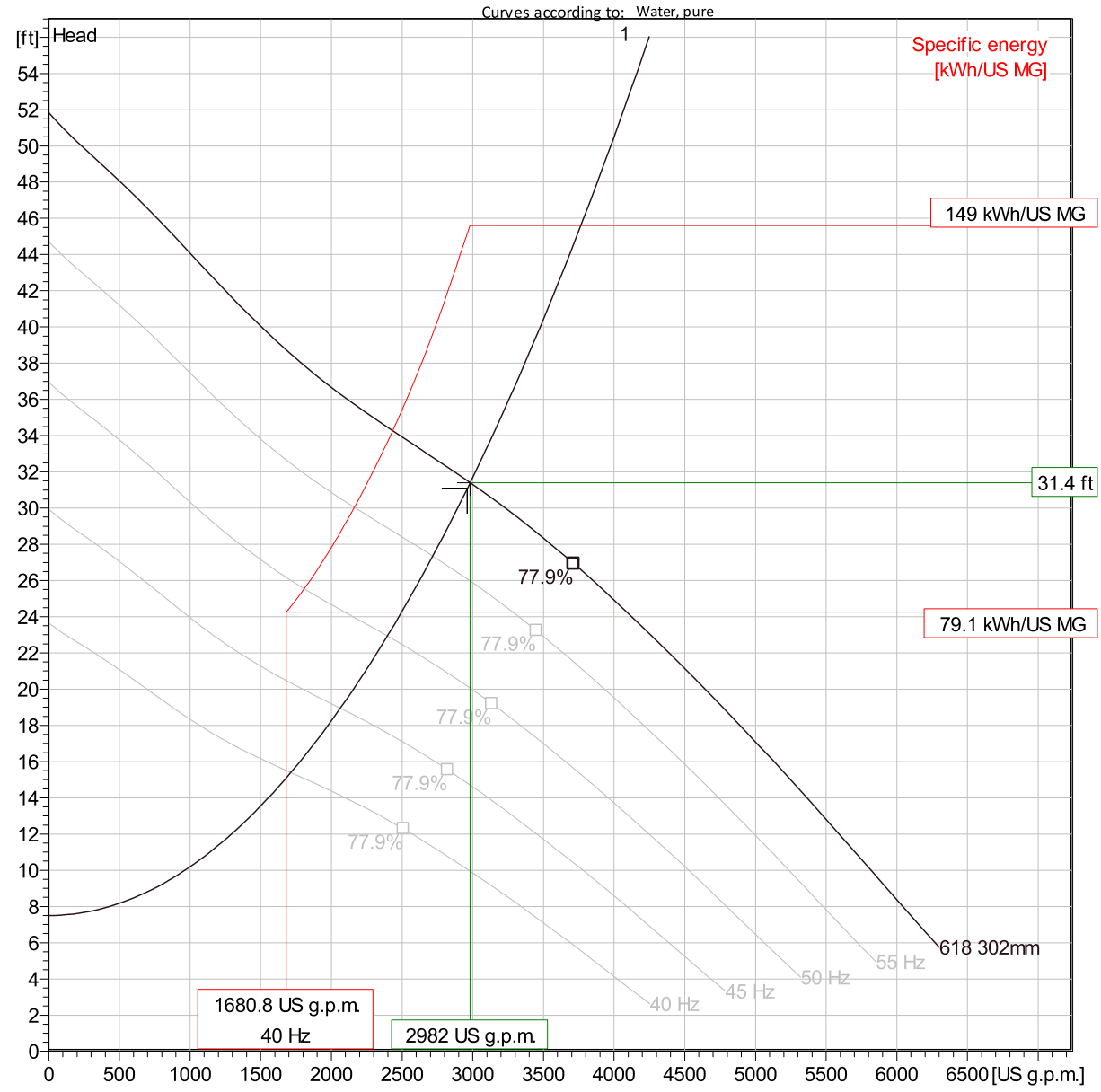
VFD Curve



Project		**Created by**	Ryan Palmer		
Block		**Created on**	7/29/2021	**Last update**	7/29/2021

NP 3202 LT 3~ 618

VFD Analysis



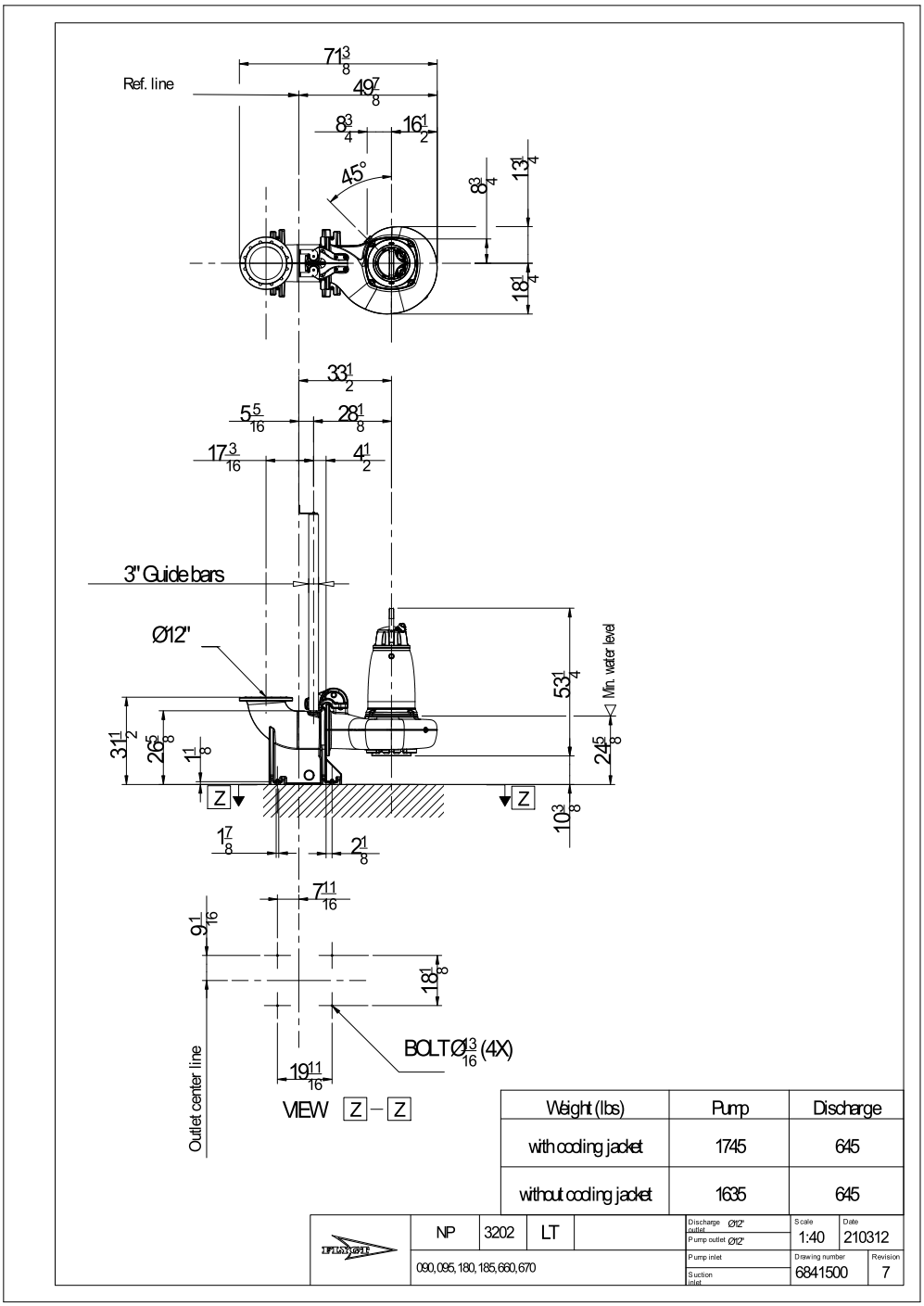
Operating characteristics

Pumps / Systems	Frequency	Flow	Head	Shaft power	Flow	Head	Shaft power	Hydr.eff.	Specific Energy	NPSHre
1	60 Hz	2980 US g.p.m	31.4 ft	31.9 hp	2980 US g.p.m	31.4 ft	31.9 hp	74.1 %	149 kWh/US M	21.5 ft
1	55 Hz	2680 US g.p.m	26.8 ft	24.7 hp	2680 US g.p.m	26.8 ft	24.7 hp	73.4 %	127 kWh/US M	18.8 ft
1	50 Hz	2360 US g.p.m	22.5 ft	18.5 hp	2360 US g.p.m	22.5 ft	18.5 hp	72.4 %	108 kWh/US M	16.2 ft
1	45 Hz	2030 US g.p.m	18.6 ft	13.5 hp	2030 US g.p.m	18.6 ft	13.5 hp	70.8 %	92 kWh/US M	13.7 ft
1	40 Hz	1680 US g.p.m	15.1 ft	9.42 hp	1680 US g.p.m	15.1 ft	9.42 hp	68.2 %	79.1 kWh/US M	11.5 ft

Project	**Created by**	Ryan Palmer	
Block	**Created on**	7/29/2021	**Last update** 7/29/2021

NP 3202 LT 3~ 618

Dimensional drawing



Weight (lbs)	Pump	Discharge
with cooling jacket	1745	645
without cooling jacket	1635	645

NP	3202	LT		Discharge outlet Ø12"	Scale 1:40	Date 210312
090, 095, 180, 185, 660, 670				Pump outlet Ø12"		
				Pump inlet	Drawing number 6841500	Revision 7
				Suction inlet		

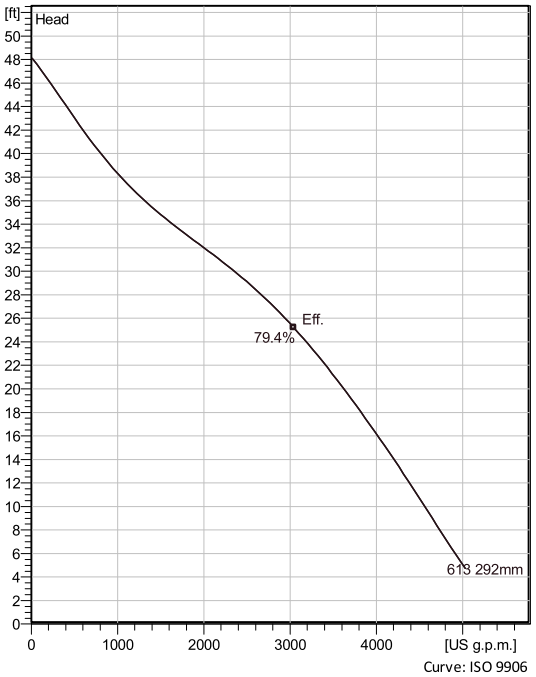
Project		**Created by**	Ryan Palmer
Block		**Created on**	7/29/2021 **Last update** 7/29/2021

PUMP STATION 19
NP 3171 LT 3~ 613

Patented self cleaning semi-open channel impeller, ideal for pumping in waste water applications. Modular based design with high adaptation grade.

Technical specification

Curves according to: Water, pure ,39.2 °F,62.42 lb/ft³,1.6891E-5 ft²/s



Curve: ISO 9906

Configuration

Motor number
N3171.185 25-18-6BB-W 25hp

Installation type
P - Semi permanent, Wet

Impeller diameter
292 mm

Discharge diameter
3/8 inch

Pump information

Impeller diameter
292 mm

Discharge diameter
3/8 inch

Inlet diameter
250 mm

Maximum operating speed
1160 rpm

Number of blades
2

Max. fluid temperature
40 °C

Materials

Impeller
Hard-Iron ™

Project		**Created by**	Ryan Palmer
Block		**Created on**	7/29/2021 **Last update** 7/29/2021

NP 3171 LT 3~ 613

Technical specification

Motor - General

Motor number N3171.185 25-18-6BB-W 25hp	**Phases** 3~	**Rated speed** 1160 rpm	**Rated power** 25 hp
ATEX approved No	**Number of poles** 6	**Rated current** 32 A	**Stator variant** 7
Frequency 60 Hz	**Rated voltage** 460 V	**Insulation class** H	**Type of Duty** S1
Version code 185			

Motor - Technical

Power factor - 1/1 Load 0.85	**Motor efficiency - 1/1 Load** 86.0 %	**Total moment of inertia** 6.34 lb ft²	**Starts per hour max.** 30
Power factor - 3/4 Load 0.80	**Motor efficiency - 3/4 Load** 87.5 %	**Starting current, direct starting** 177 A	
Power factor - 1/2 Load 0.70	**Motor efficiency - 1/2 Load** 87.5 %	**Starting current, star-delta** 59 A	

Project	**Created by**	Ryan Palmer	
Block	**Created on**	7/29/2021	**Last update** 7/29/2021

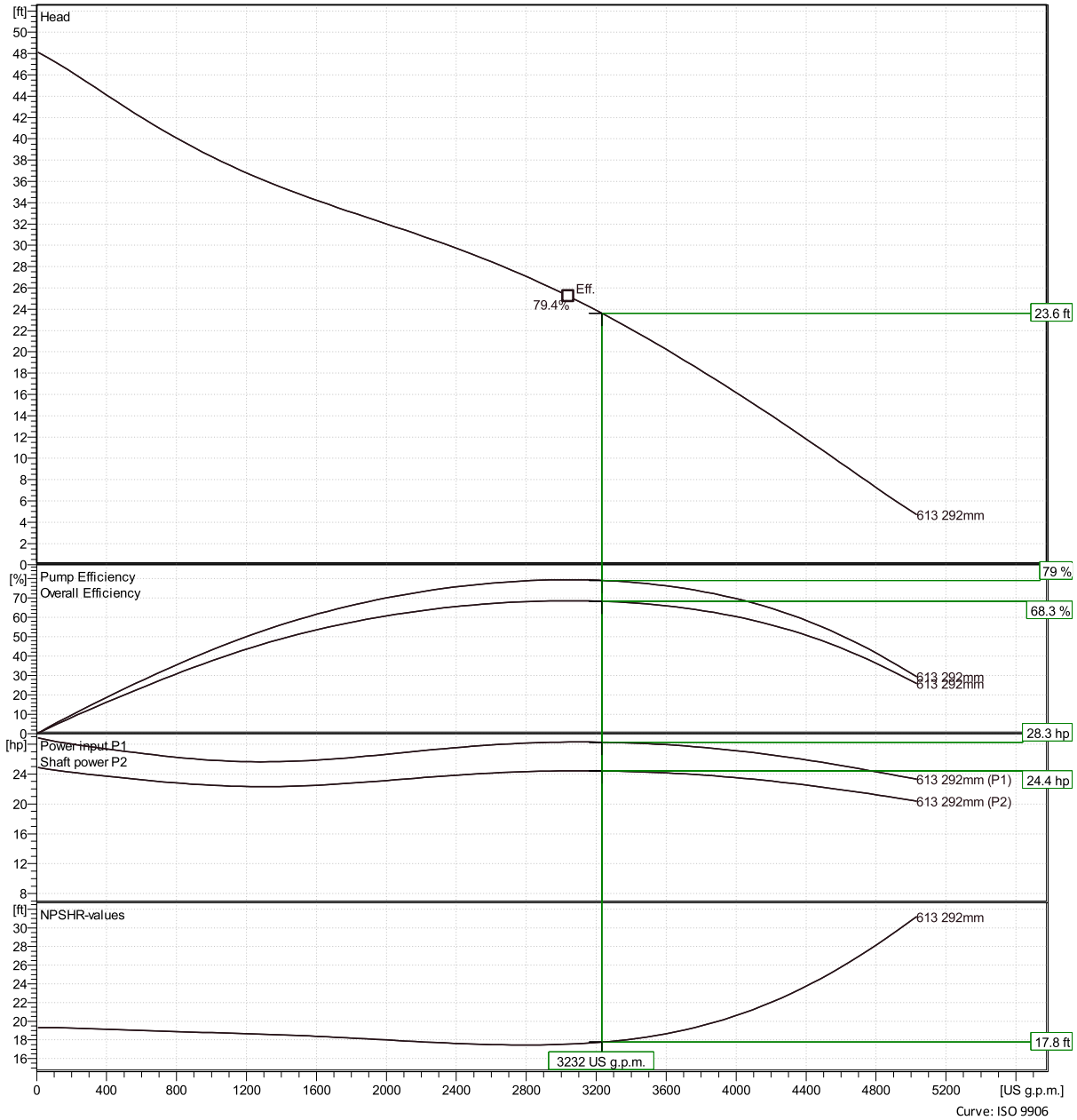
NP 3171 LT 3~ 613

Performance curve

Duty point

Flow	Head
3230 US g.p.m.	23.6 ft

Curves according to: Water, pure 39.2 °F, 62.42 lb/ft³, 1.6891E-5 ft²/s



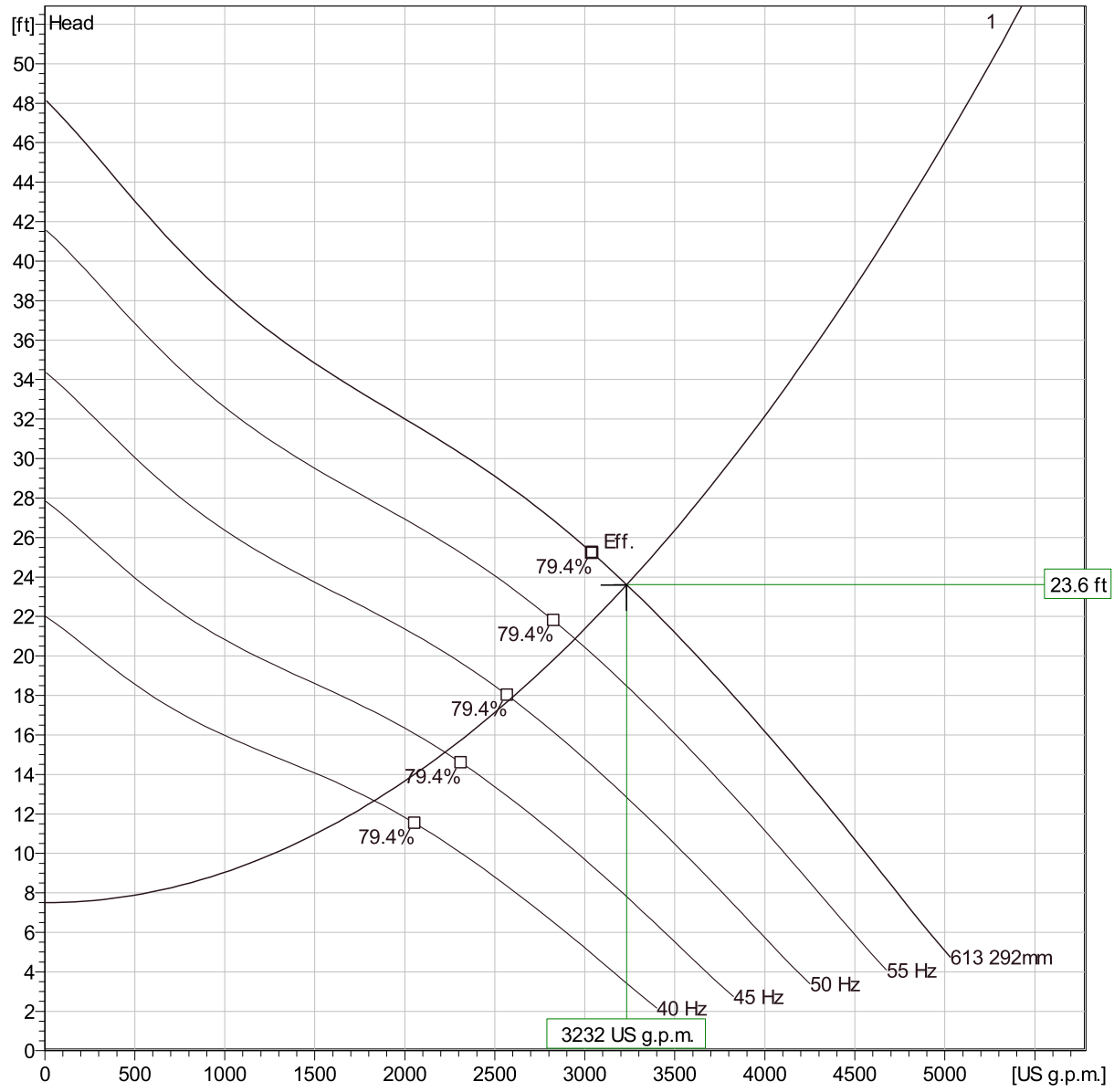
Curve: ISO 9906

Project		**Created by**	Ryan Palmer		
Block		**Created on**	7/29/2021	**Last update**	7/29/2021

NP 3171 LT 3~ 613

Duty Analysis

Curves according to: Water, pure ,39.2 °F,62.42 lb/ft³,1.6891E-5 ft²/s



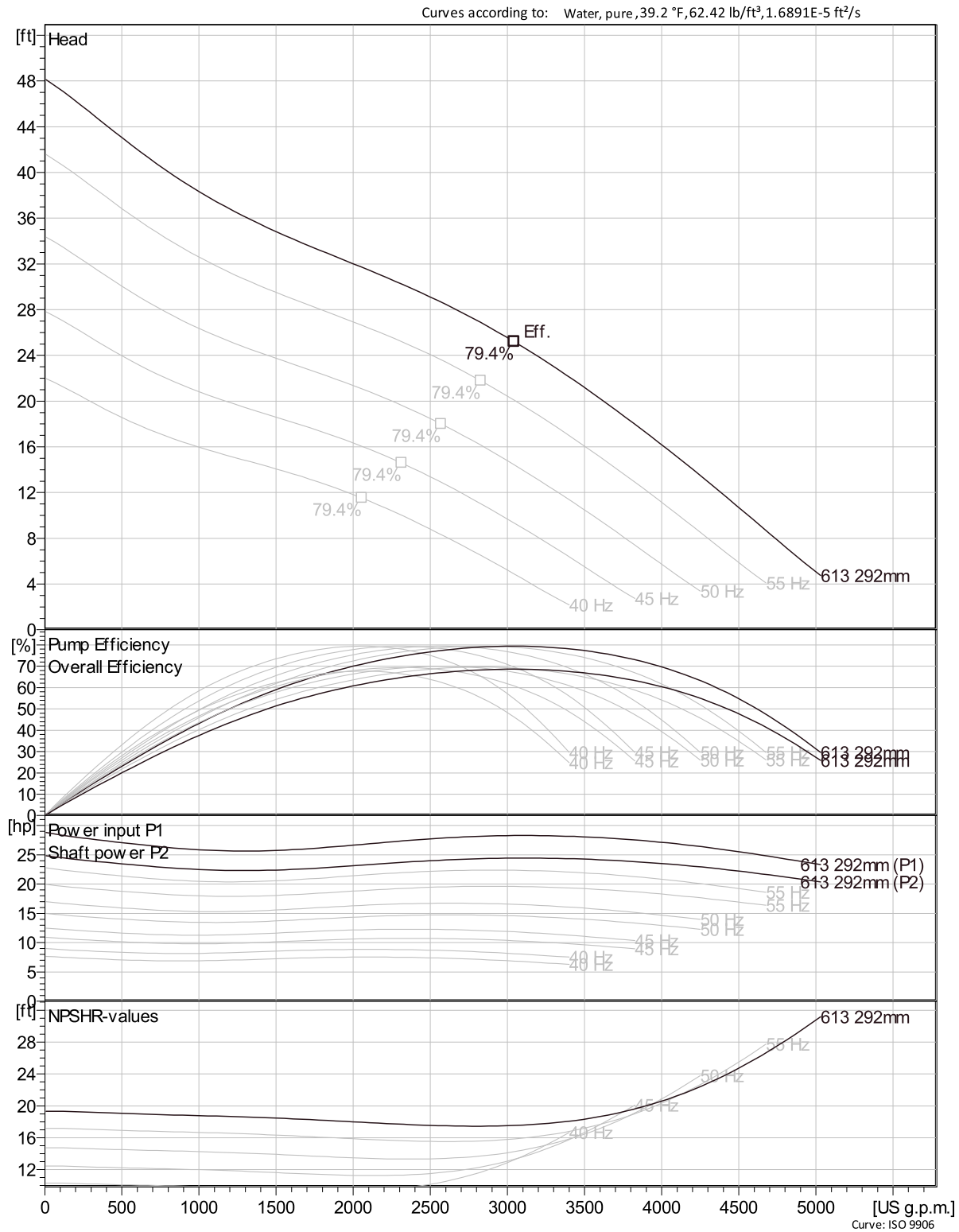
Operating characteristics

Pumps / Systems	Flow	Head	Shaft power	Flow	Head	Shaft power	Hydr.eff.	Specific Energy	NPSHre
1	3230 US g.p.m	23.6 ft	24.4 hp	3230 US g.p.m	23.6 ft	24.4 hp	79 %	109 kWh/US M	17.8 ft

Project		**Created by**	Ryan Palmer		
Block		**Created on**	7/29/2021	**Last update**	7/29/2021

NP 3171 LT 3~ 613

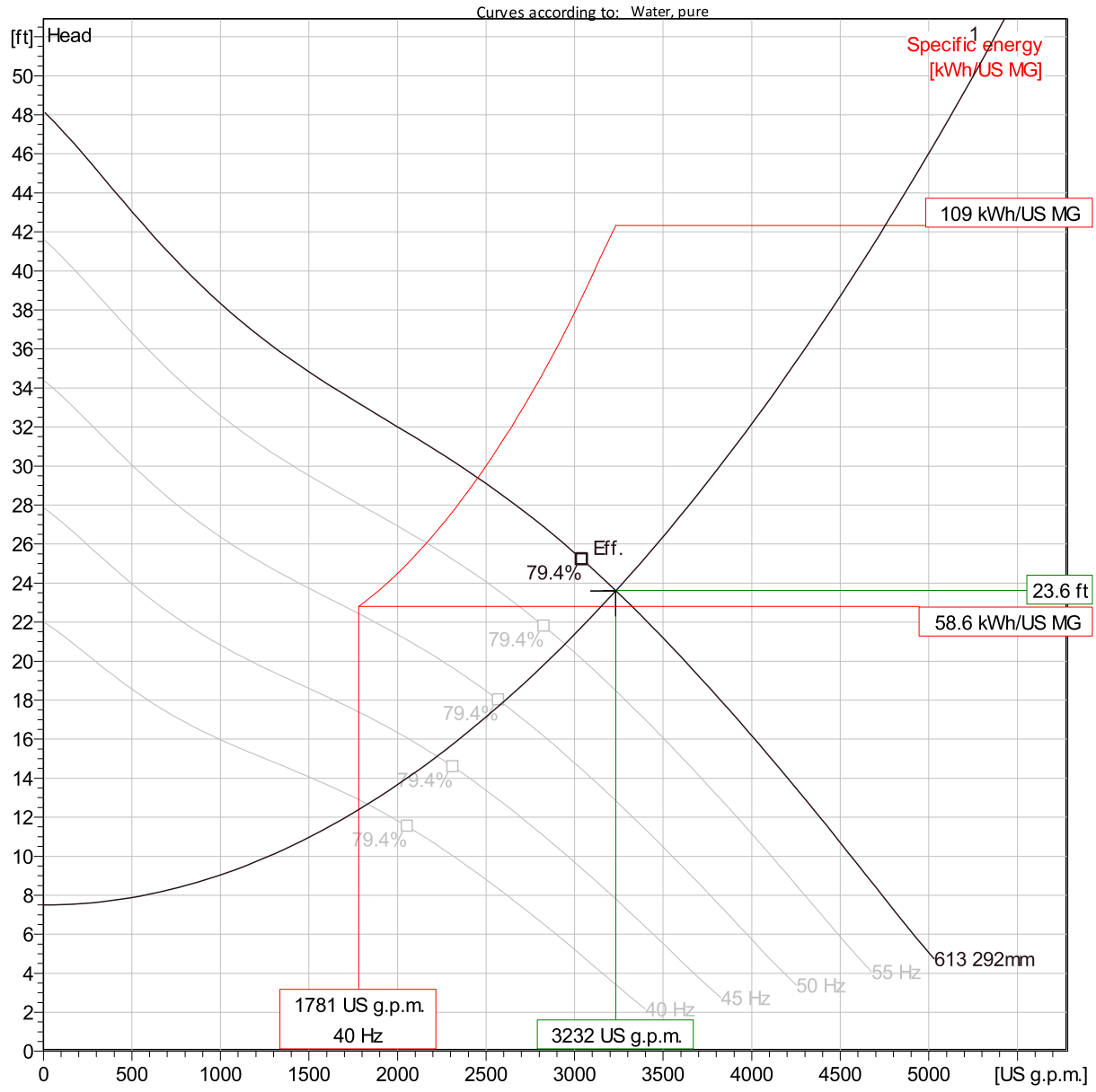
VFD Curve



Project	**Created by**	Ryan Palmer	
Block	**Created on**	7/29/2021	**Last update** 7/29/2021

NP 3171 LT 3~ 613

VFD Analysis



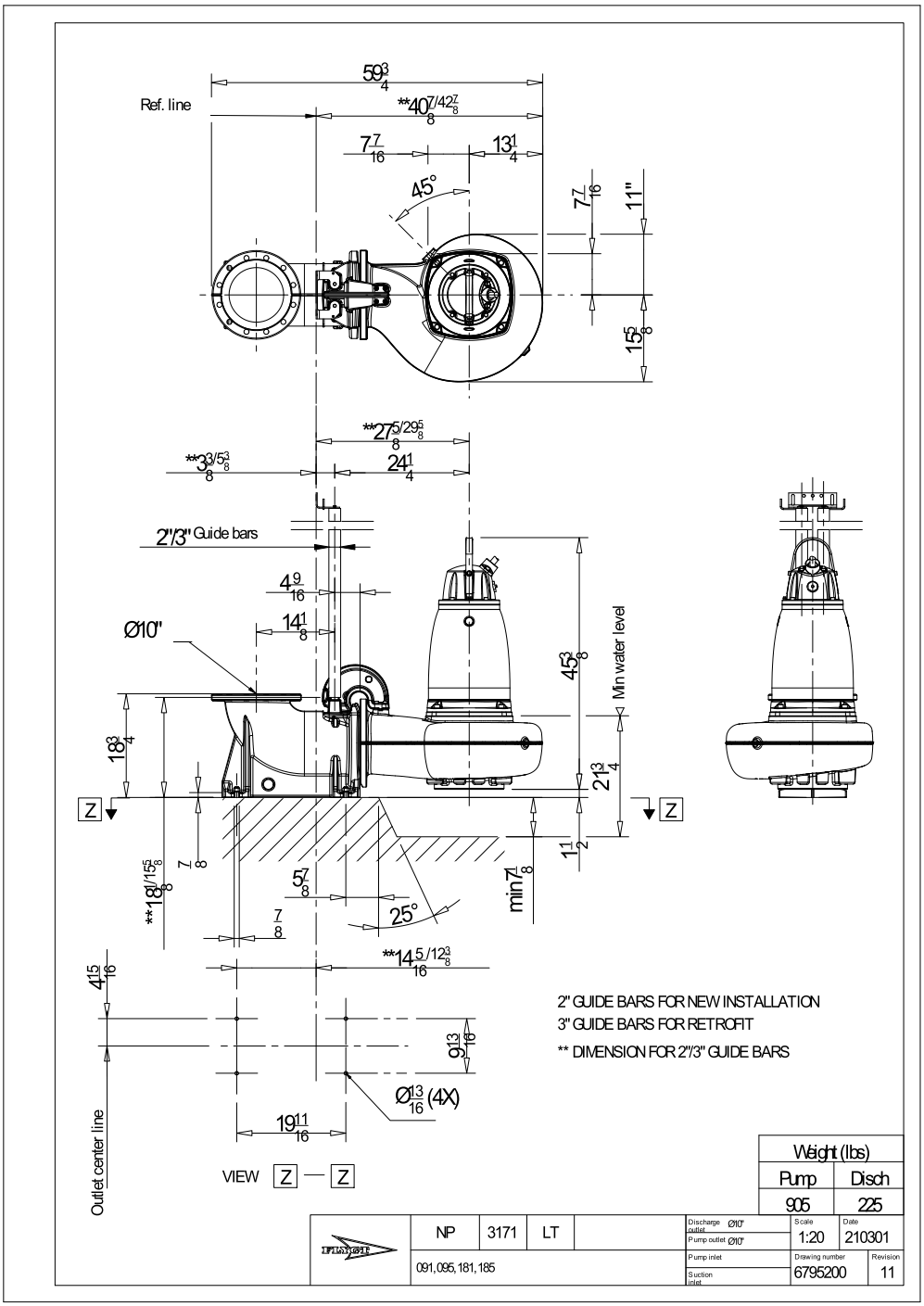
Operating characteristics

Pumps / Systems	Frequency	Flow	Head	Shaft power	Flow	Head	Shaft power	Hydr.eff.	Specific Energy	NPSHre
1	60 Hz	3230 US g.p.m	23.6 ft	24.4 hp	3230 US g.p.m	23.6 ft	24.4 hp	79 %	109 kWh/US M	17.8 ft
1	55 Hz	2890 US g.p.m	20.3 ft	18.7 hp	2890 US g.p.m	20.3 ft	18.7 hp	79.3 %	92.1 kWh/US M	15.3 ft
1	50 Hz	2540 US g.p.m	17.4 ft	14.1 hp	2540 US g.p.m	17.4 ft	14.1 hp	79.4 %	78.3 kWh/US M	13.1 ft
1	45 Hz	2170 US g.p.m	14.8 ft	10.2 hp	2170 US g.p.m	14.8 ft	10.2 hp	79.2 %	67.1 kWh/US M	11 ft
1	40 Hz	1780 US g.p.m	12.4 ft	7.15 hp	1780 US g.p.m	12.4 ft	7.15 hp	78.1 %	58.6 kWh/US M	9.11 ft

Project	**Created by**	Ryan Palmer	
Block	**Created on**	7/29/2021	**Last update** 7/29/2021

NP 3171 LT 3~ 613

Dimensional drawing



Project		**Created by**	Ryan Palmer
Block		**Created on**	7/29/2021 **Last update** 7/29/2021

TRIPLEX PUMP STATION

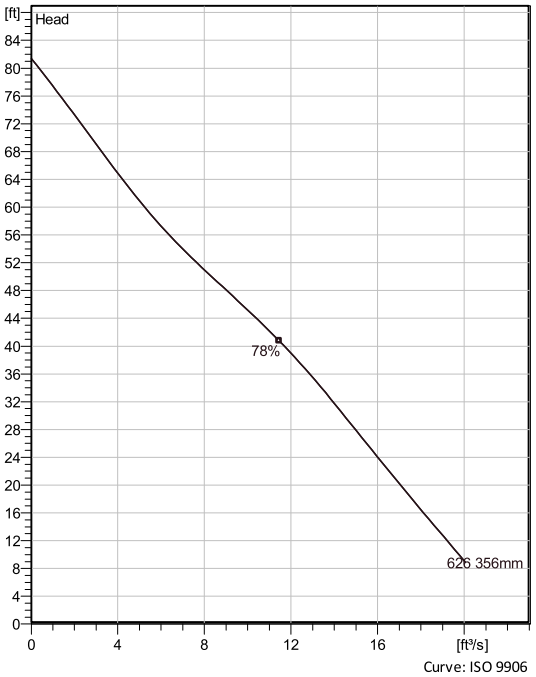
ENGINEER SELECTION

NP 3301 LT 3~ 626

Patented self cleaning semi-open channel impeller, ideal for pumping in waste water applications. Modular based design with high adaptation grade.

Technical specification

Curves according to: Water, pure ,39.2 °F,62.428 lb/ft³,1.6889E-5 ft²/s



Curve: ISO 9906

Configuration

Motor number
N3301.185 35-25-6AA-W 70hp

Installation type
P - Semi permanent, Wet

Impeller diameter
356 mm

Discharge diameter
1/2 inch

Pump information

Impeller diameter
356 mm

Discharge diameter
1/2 inch

Inlet diameter
350 mm

Maximum operating speed
1185 rpm

Number of blades
2

Max. fluid temperature
40 °C

Materials

Impeller
Hard-Iron ™

Project		**Created by**	
Block	0	**Created on**	8/27/2021 **Last update** 8/27/2021

NP 3301 LT 3~ 626

Technical specification

Motor - General

Motor number N3301.185 35-25-6AA-W 70hp	**Phases** 3~	**Rated speed** 1185 rpm	**Rated power** 70 hp
ATEX approved No	**Number of poles** 6	**Rated current** 107 A	**Stator variant** 6
Frequency 60 Hz	**Rated voltage** 380 V	**Insulation class** H	**Type of Duty** S1
Version code 185			

Motor - Technical

Power factor - 1/1 Load 0.81	**Motor efficiency - 1/1 Load** 91.0 %	**Total moment of inertia** 25 lb ft²	**Starts per hour max.** 30
Power factor - 3/4 Load 0.77	**Motor efficiency - 3/4 Load** 92.0 %	**Starting current, direct starting** 655 A	
Power factor - 1/2 Load 0.67	**Motor efficiency - 1/2 Load** 91.5 %	**Starting current, star-delta** 218 A	

Project		**Created by**			
Block	0	**Created on**	8/27/2021	**Last update**	8/27/2021

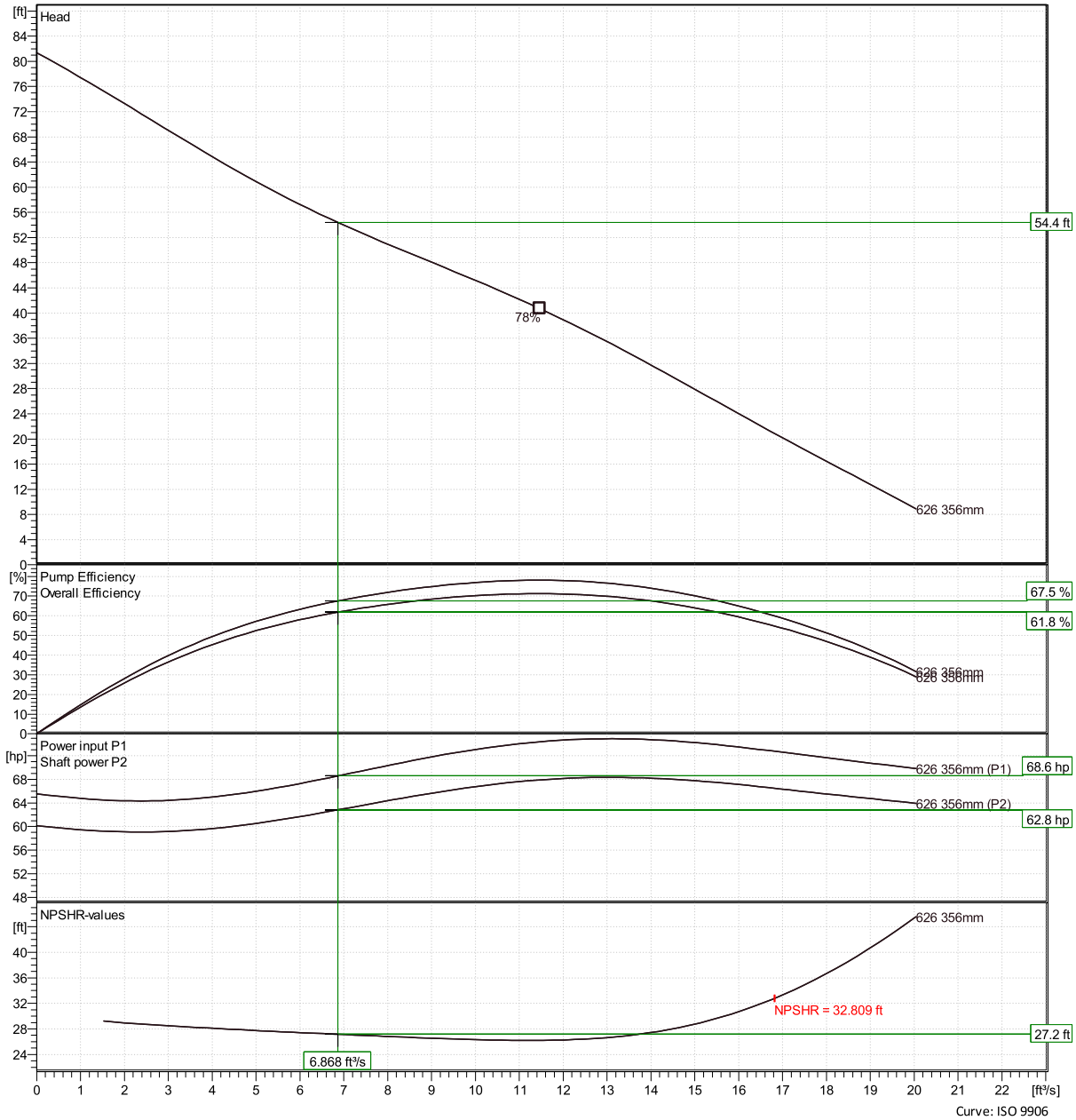
NP 3301 LT 3~ 626

Performance curve

Duty point

Flow	Head
6.87 ft³/s	54.4 ft

Curves according to: Water, pure 39.2 °F, 62.428 lb/ft³, 1.6889E-5 ft²/s



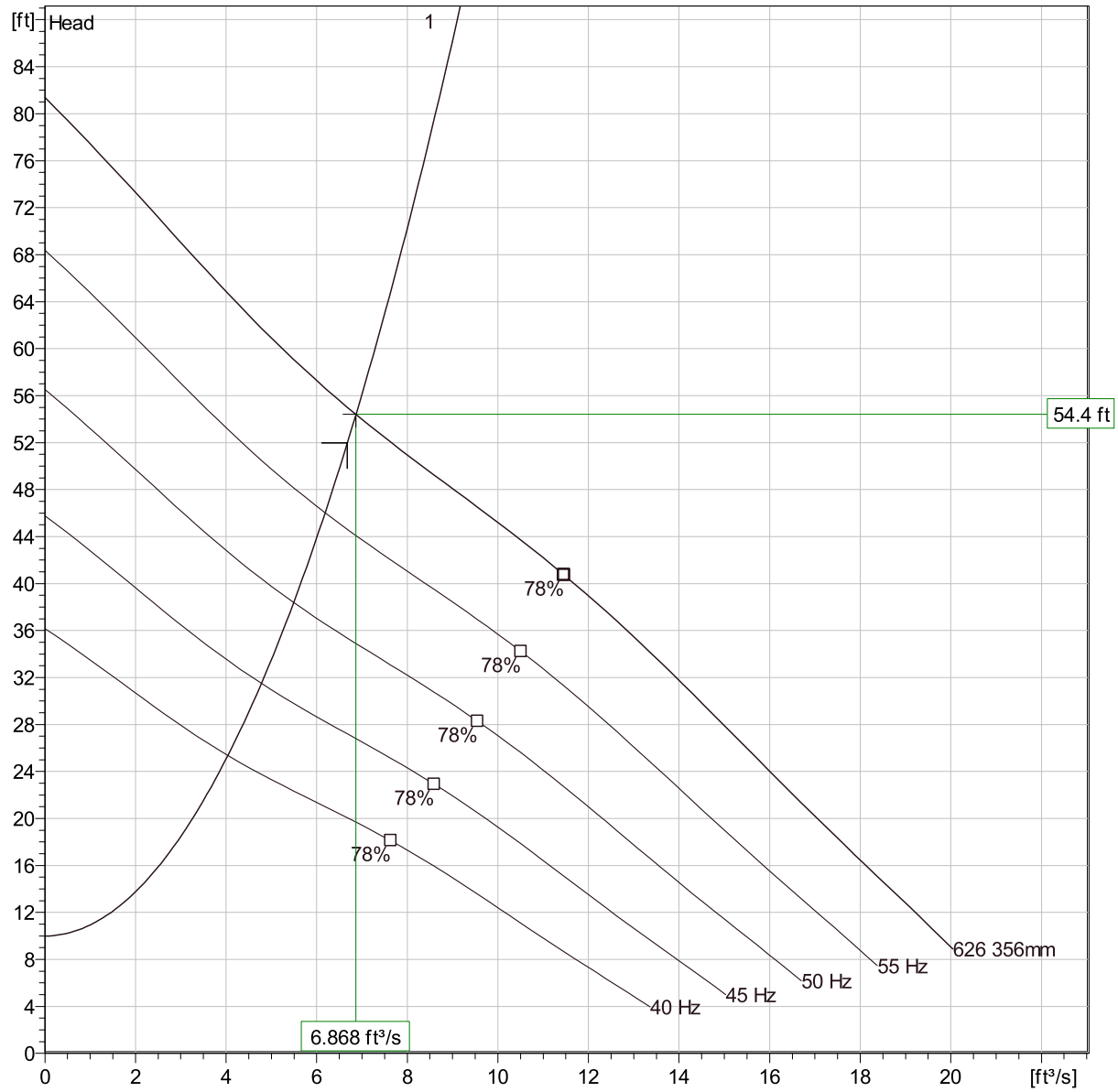
Curve: ISO 9906

Project		**Created by**			
Block	0	**Created on**	8/27/2021	**Last update**	8/27/2021

NP 3301 LT 3~ 626

Duty Analysis

Curves according to: Water, pure ,39.2 °F,62.428 lb/ft³,1.6889E-5 ft²/s



Operating characteristics

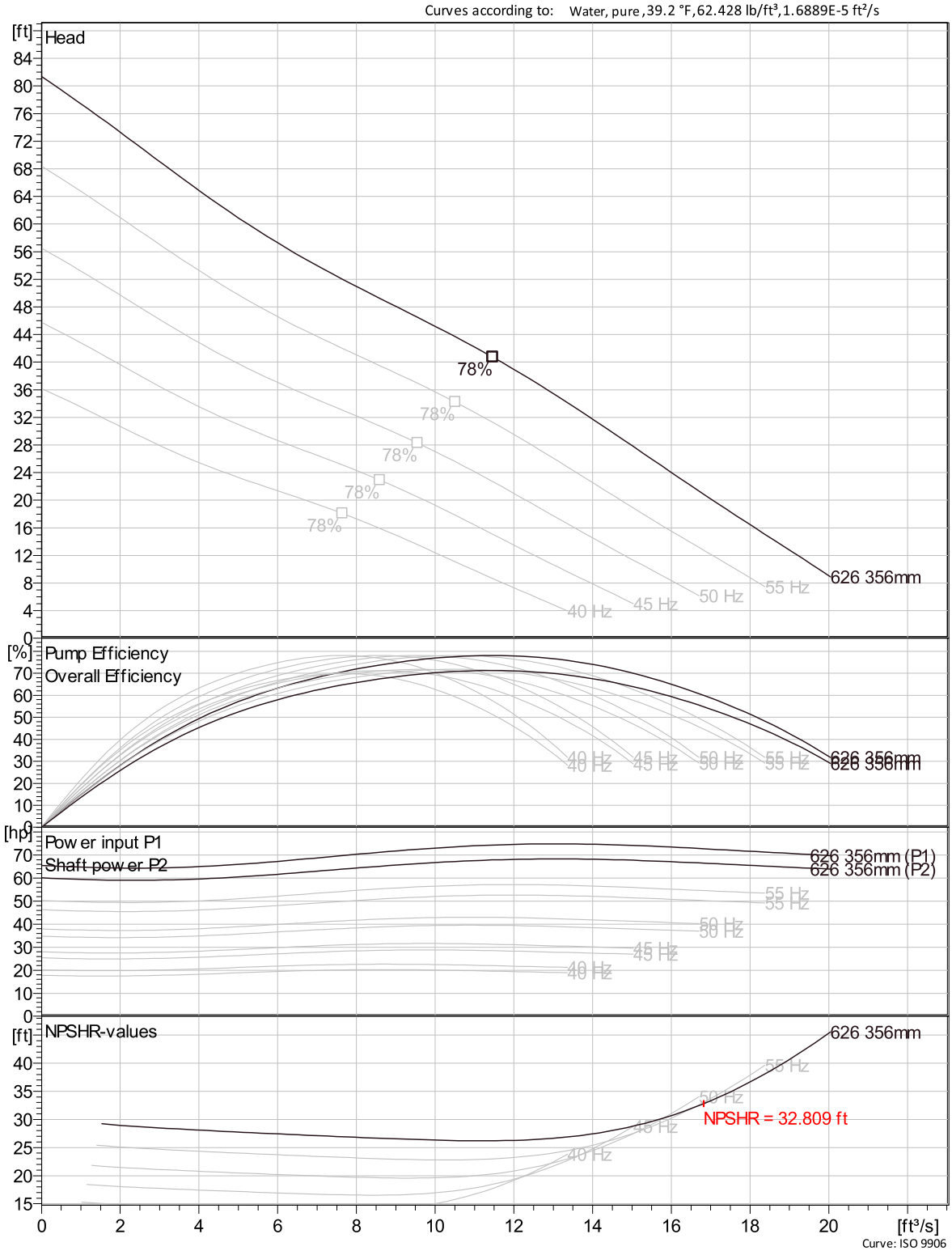
Pumps / Systems	Flow	Head	Shaft power	Flow	Head	Shaft power	Hydr.eff.	Specific Energy	NPSHre
1	6.87 ft³/s	54.4 ft	62.8 hp	6.87 ft³/s	54.4 ft	62.8 hp	67.5 %	277 kWh/US M	27.2 ft

Project		**Created by**			
Block	0	**Created on**	8/27/2021	**Last update**	8/27/2021

NP 3301 LT 3~ 626

VFD Curve

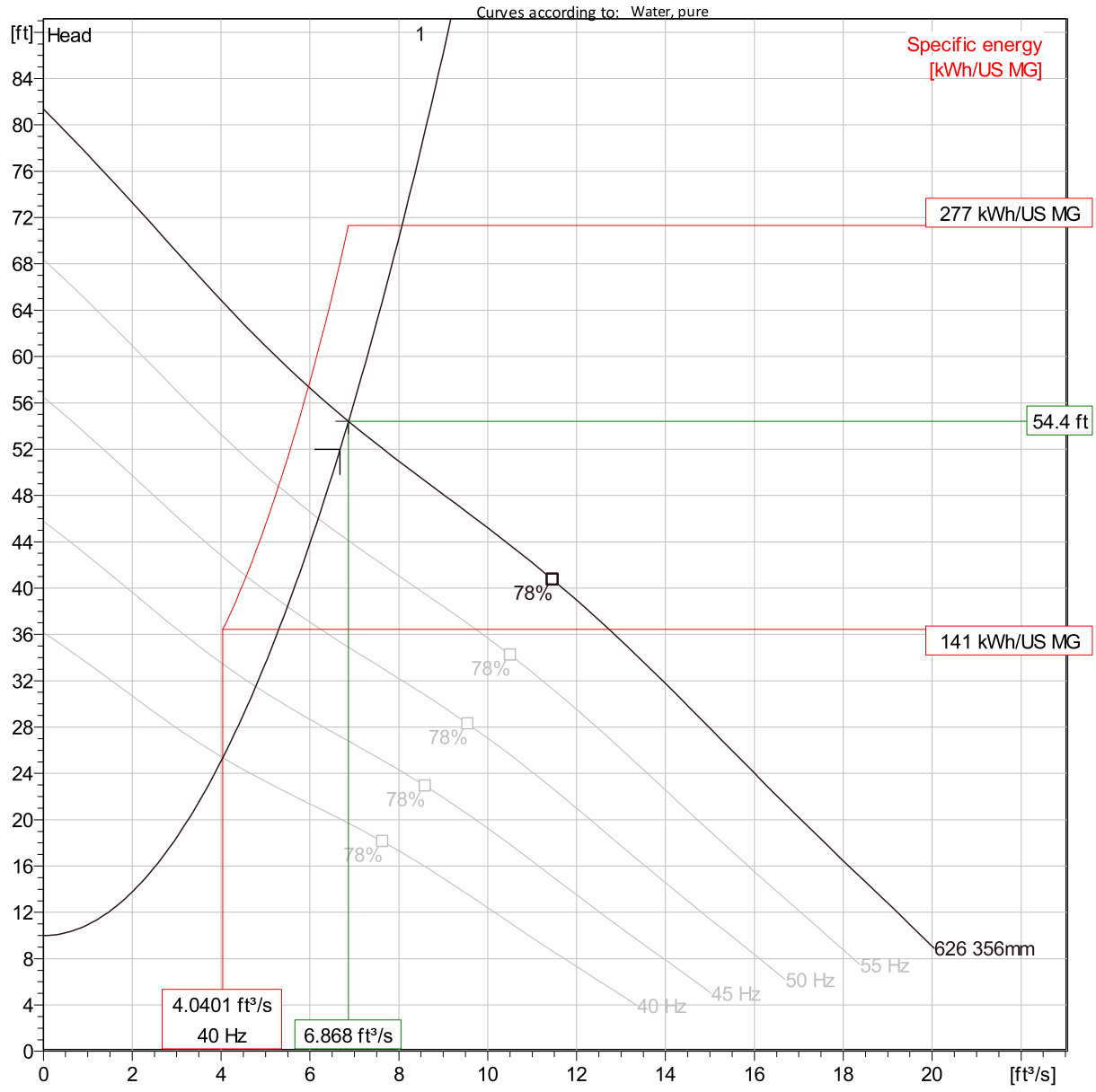
Curves according to: Water, pure ,39.2 °F,62.428 lb/ft³,1.6889E-5 ft²/s



Project		**Created by**			
Block	0	**Created on**	8/27/2021	**Last update**	8/27/2021

NP 3301 LT 3~ 626

VFD Analysis



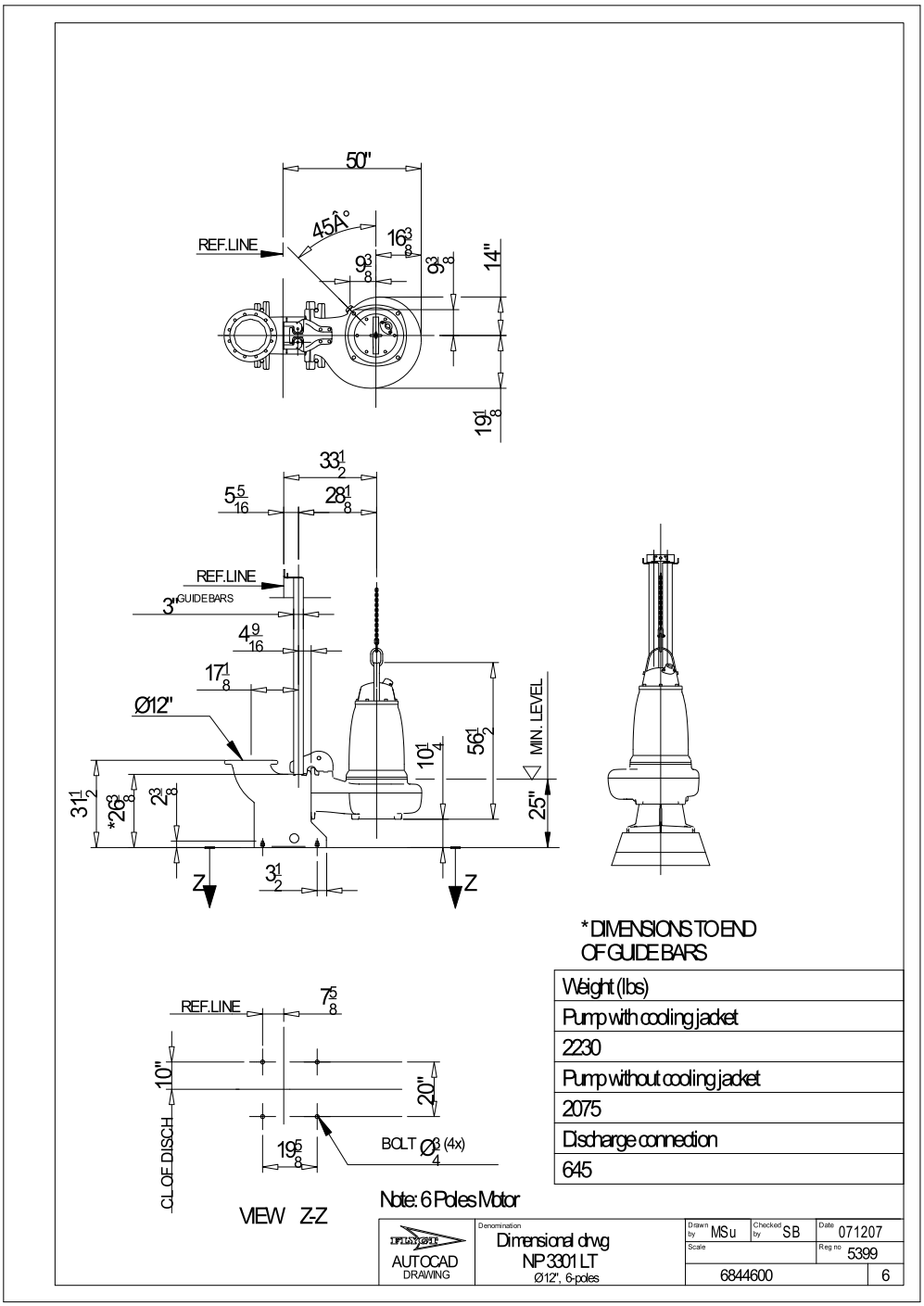
Operating characteristics

Pumps / Systems	Frequency	Flow	Head	Shaft power	Flow	Head	Shaft power	Hydr.eff.	Specific Energy	NPSHre
1	60 Hz	6.87 ft³/s	54.4 ft	62.8 hp	6.87 ft³/s	54.4 ft	62.8 hp	67.5 %	277 kWh/US M	27.2 ft
1	55 Hz	6.19 ft³/s	46 ft	48.3 hp	6.19 ft³/s	46 ft	48.3 hp	67 %	235 kWh/US M	23.7 ft
1	50 Hz	5.49 ft³/s	38.4 ft	36.1 hp	5.49 ft³/s	38.4 ft	36.1 hp	66.2 %	199 kWh/US M	20.4 ft
1	45 Hz	4.78 ft³/s	31.5 ft	26.2 hp	4.78 ft³/s	31.5 ft	26.2 hp	65.2 %	167 kWh/US M	17.2 ft
1	40 Hz	4.04 ft³/s	25.4 ft	18.3 hp	4.04 ft³/s	25.4 ft	18.3 hp	63.6 %	141 kWh/US M	14.3 ft

Project		**Created by**			
Block	0	**Created on**	8/27/2021	**Last update**	8/27/2021

NP 3301 LT 3~ 626

Dimensional drawing



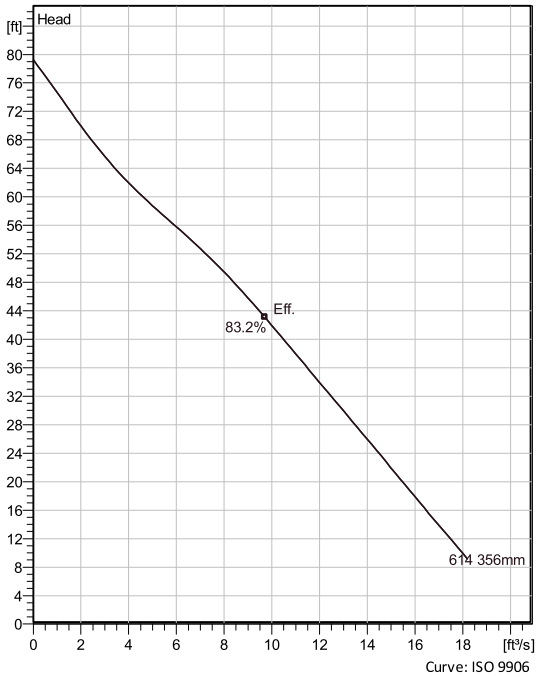
Project		**Created by**	
Block	0	**Created on**	8/27/2021 **Last update** 8/27/2021

NP 3202 LT 3~ 614

Patented self cleaning semi-open channel impeller, ideal for pumping in waste water applications. Modular based design with high adaptation grade.

Technical specification

Curves according to: Water, pure ,39.2 °F,62.428 lb/ft³,1.6889E-5 ft²/s



Curve: ISO 9906

Configuration

Motor number
N3202.185 30-29-6AA-W 60hp

Installation type
P - Semi permanent, Wet

Impeller diameter
356 mm

Discharge diameter
1/2 inch

Pump information

Impeller diameter
356 mm

Discharge diameter
1/2 inch

Inlet diameter
300 mm

Maximum operating speed
1170 rpm

Number of blades
2

Max. fluid temperature
40 °C

Materials

Impeller
Hard-Iron ™

Project		**Created by**	
Block	0	**Created on**	8/27/2021 **Last update** 8/27/2021

NP 3202 LT 3~ 614

Technical specification

Motor - General

Motor number N3202.185 30-29-6AA-W 60hp	**Phases** 3~	**Rated speed** 1170 rpm	**Rated power** 60 hp
ATEX approved No	**Number of poles** 6	**Rated current** 88 A	**Stator variant** 7
Frequency 60 Hz	**Rated voltage** 380 V	**Insulation class** H	**Type of Duty** S1
Version code 185			

Motor - Technical

Power factor - 1/1 Load 0.85	**Motor efficiency - 1/1 Load** 90.5 %	**Total moment of inertia** 15.5 lb ft²	**Starts per hour max.** 30
Power factor - 3/4 Load 0.81	**Motor efficiency - 3/4 Load** 91.0 %	**Starting current, direct starting** 545 A	
Power factor - 1/2 Load 0.72	**Motor efficiency - 1/2 Load** 90.5 %	**Starting current, star-delta** 182 A	

Project		**Created by**			
Block	0	**Created on**	8/27/2021	**Last update**	8/27/2021

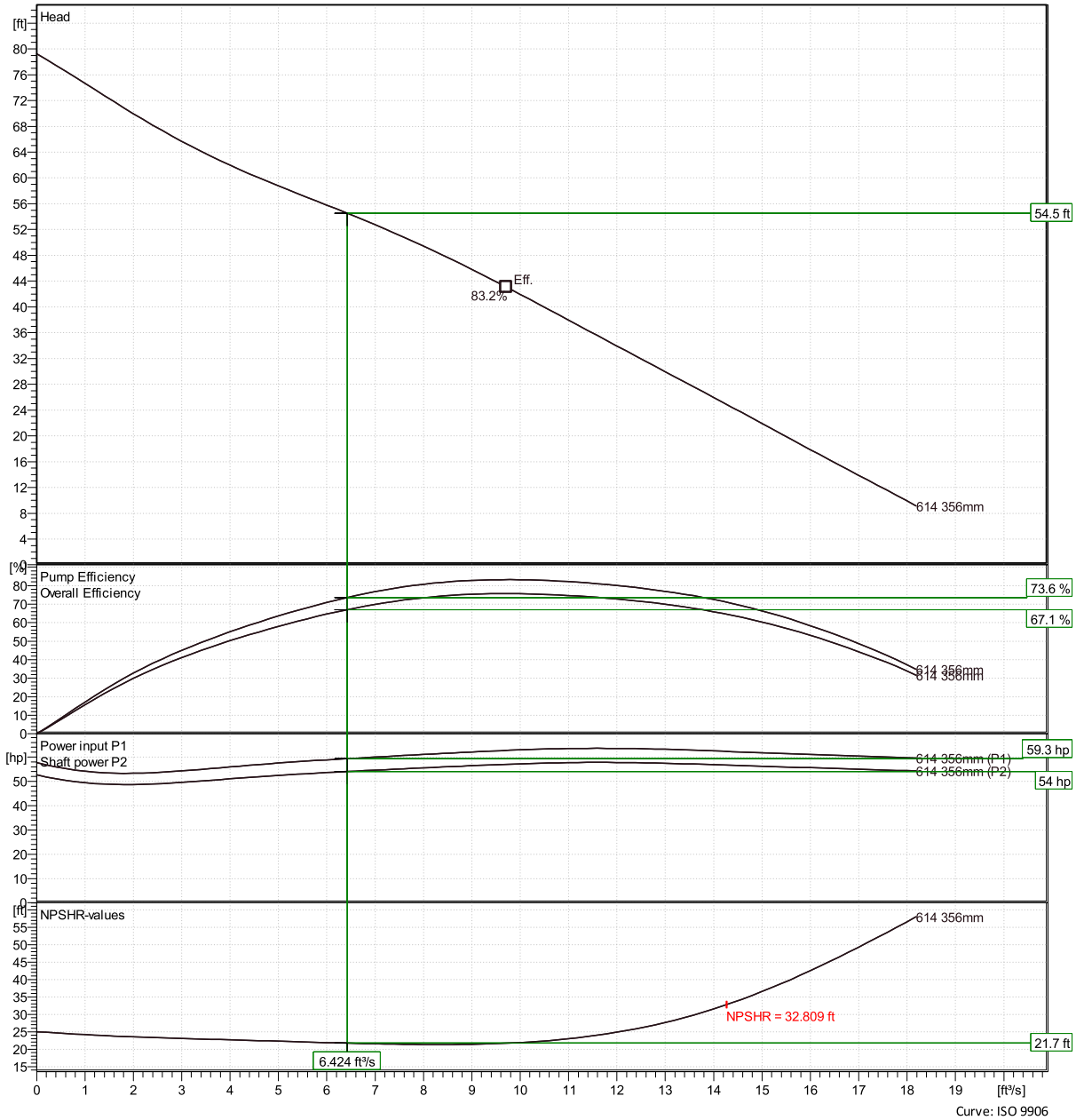
NP 3202 LT 3~ 614

Performance curve

Duty point

Flow	Head
6.42 ft³/s	54.5 ft

Curves according to: Water, pure 39.2 °F, 62.428 lb/ft³, 1.6889E-5 ft²/s



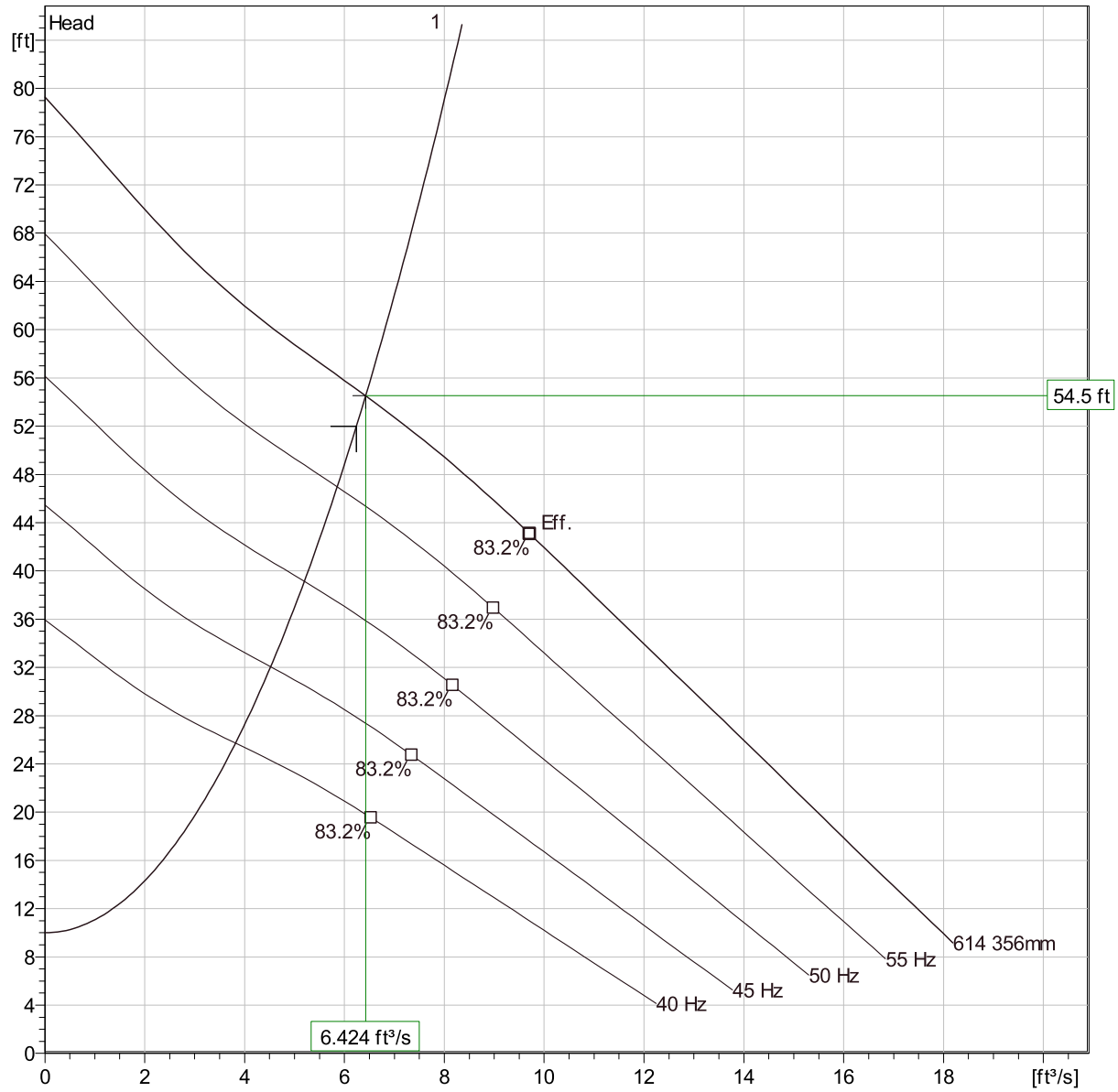
Curve: ISO 9906

Project		**Created by**			
Block	0	**Created on**	8/27/2021	**Last update**	8/27/2021

NP 3202 LT 3~ 614

Duty Analysis

Curves according to: Water, pure ,39.2 °F,62.428 lb/ft³,1.6889E-5 ft²/s



Operating characteristics

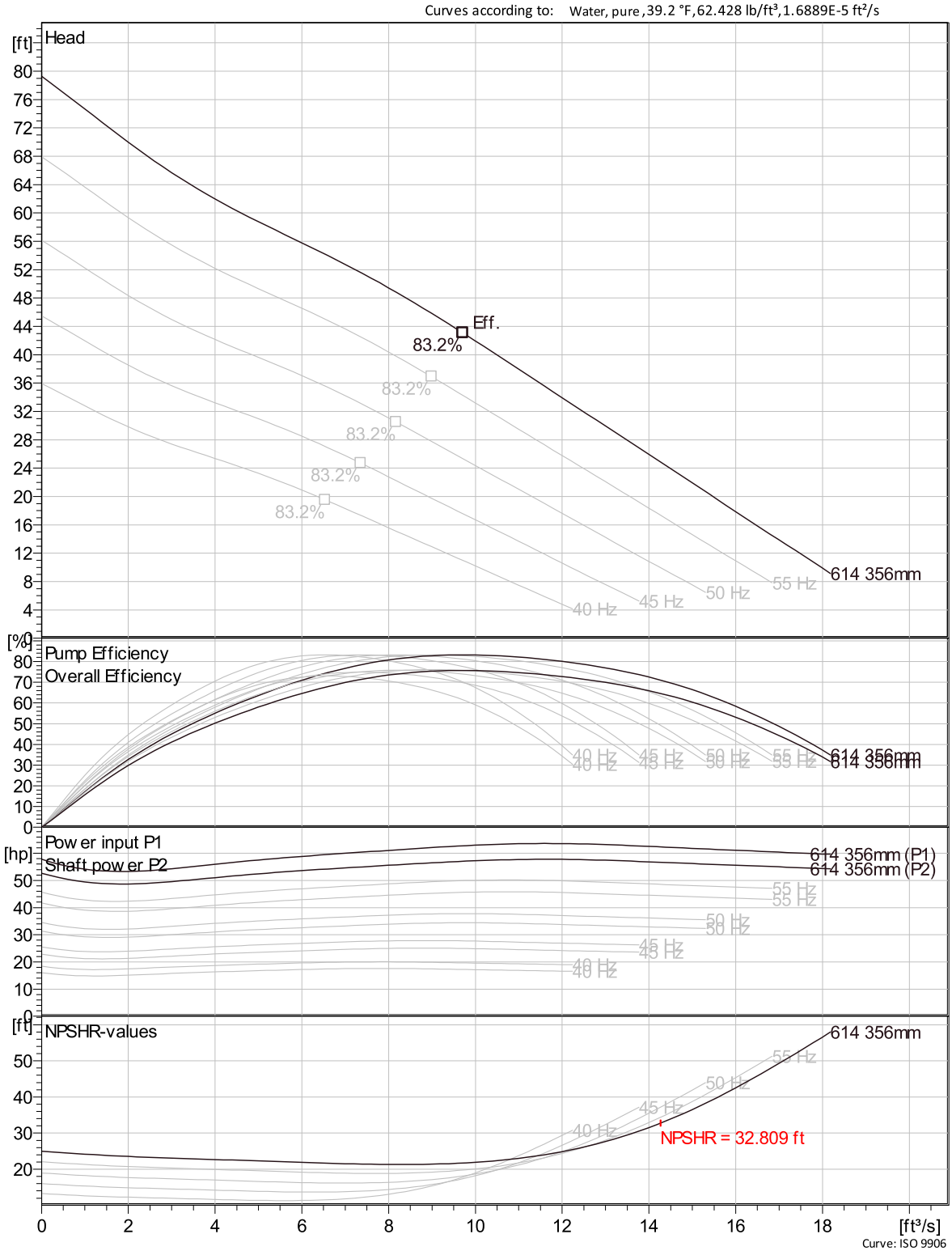
Pumps / Systems	Flow	Head	Shaft power	Flow	Head	Shaft power	Hydr.eff.	Specific Energy	NPSHre
1	6.42 ft³/s	54.5 ft	54 hp	6.42 ft³/s	54.5 ft	54 hp	73.6 %	256 kWh/US M	21.7 ft

Project		**Created by**			
Block	0	**Created on**	8/27/2021	**Last update**	8/27/2021

NP 3202 LT 3~ 614

VFD Curve

Curves according to: Water, pure ,39.2 °F,62.428 lb/ft³,1.6889E-5 ft²/s

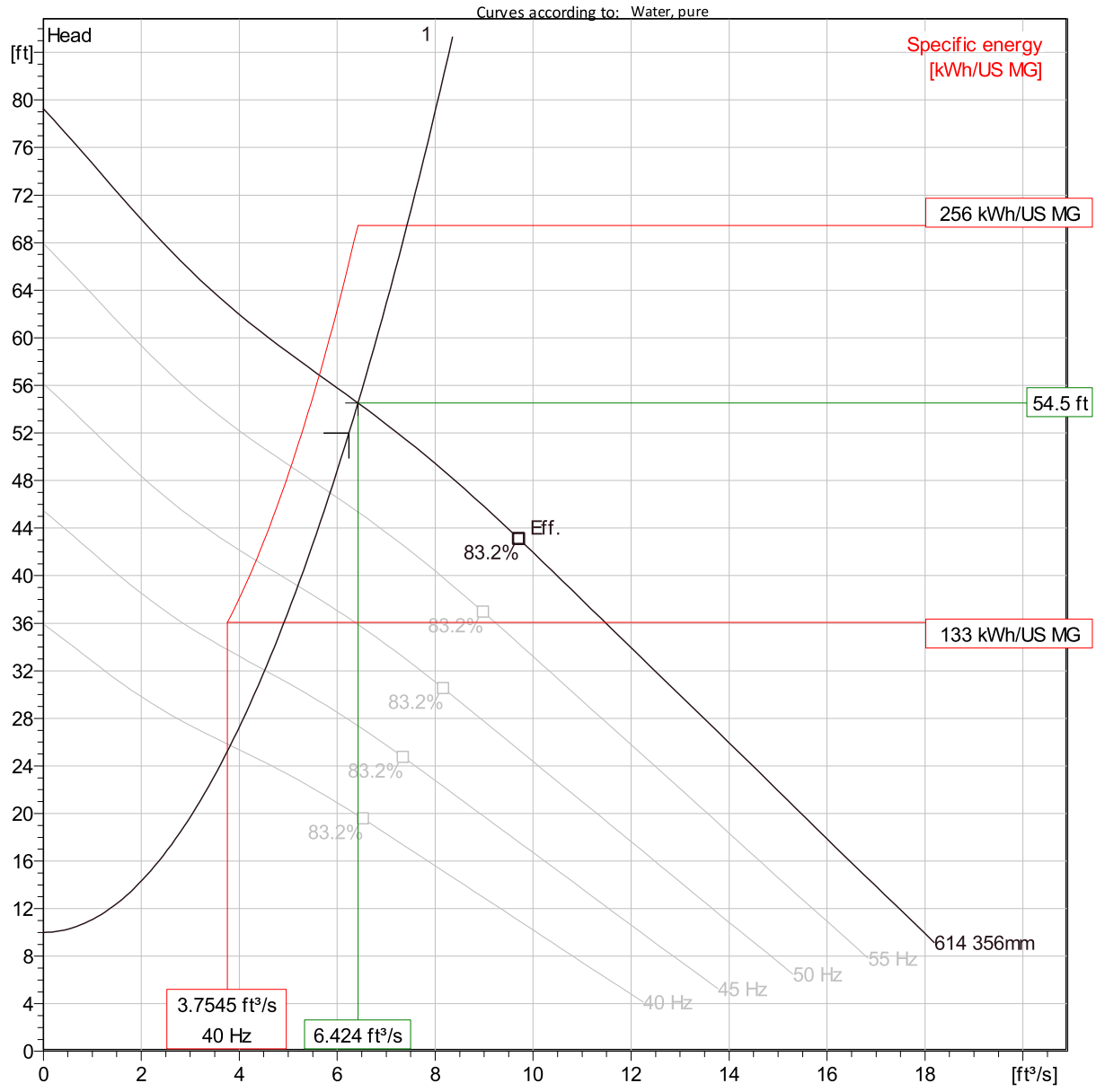


Curve: ISO 9906

Project		**Created by**			
Block	0	**Created on**	8/27/2021	**Last update**	8/27/2021

NP 3202 LT 3~ 614

VFD Analysis



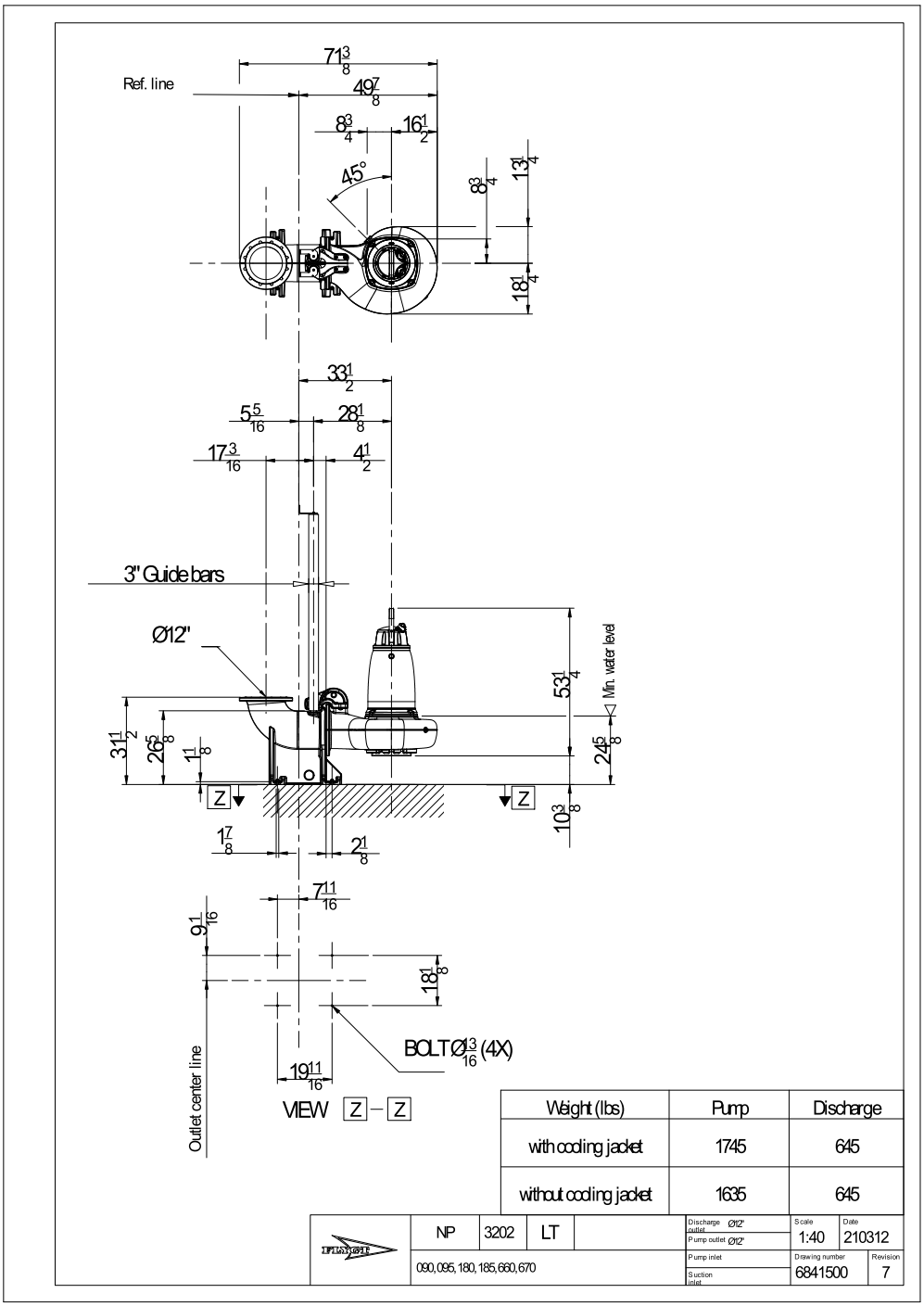
Operating characteristics

Pumps / Systems	Frequency	Flow	Head	Shaft power	Flow	Head	Shaft power	Hydr.eff.	Specific Energy	NPSHre
1	60 Hz	6.42 ft³/s	54.5 ft	54 hp	6.42 ft³/s	54.5 ft	54 hp	73.6 %	256 kWh/US M	21.7 ft
1	55 Hz	5.78 ft³/s	46 ft	41.4 hp	5.78 ft³/s	46 ft	41.4 hp	72.9 %	217 kWh/US M	18.9 ft
1	50 Hz	5.12 ft³/s	38.3 ft	31 hp	5.12 ft³/s	38.3 ft	31 hp	72 %	184 kWh/US M	16.3 ft
1	45 Hz	4.45 ft³/s	31.4 ft	22.5 hp	4.45 ft³/s	31.4 ft	22.5 hp	70.6 %	156 kWh/US M	13.8 ft
1	40 Hz	3.75 ft³/s	25.2 ft	15.7 hp	3.75 ft³/s	25.2 ft	15.7 hp	68.5 %	133 kWh/US M	11.5 ft

Project		**Created by**			
Block	0	**Created on**	8/27/2021	**Last update**	8/27/2021

NP 3202 LT 3~ 614

Dimensional drawing



Weight (lbs)	Pump	Discharge
with cooling jacket	1745	645
without cooling jacket	1635	645

	NP	3202	LT	Discharge outlet Ø12"	Scale 1:40	Date 210312
	090, 095, 180, 185, 660, 670			Pump outlet Ø12"		
				Pump inlet	Drawing number 6841500	Revision 7
				Suction inlet		

Project		**Created by**	
Block	0	**Created on**	8/27/2021 **Last update** 8/27/2021

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HYDROLOGIC AND HYDRAULIC REPORT

Sullivan's Island Multi-Basin Stormwater Drainage Improvement
Phase 1

FEMA DR-4241-SC at

Sullivan's Island, SC

APPENDIX E

EXHIBITS

J – 27091.0000

December 2021

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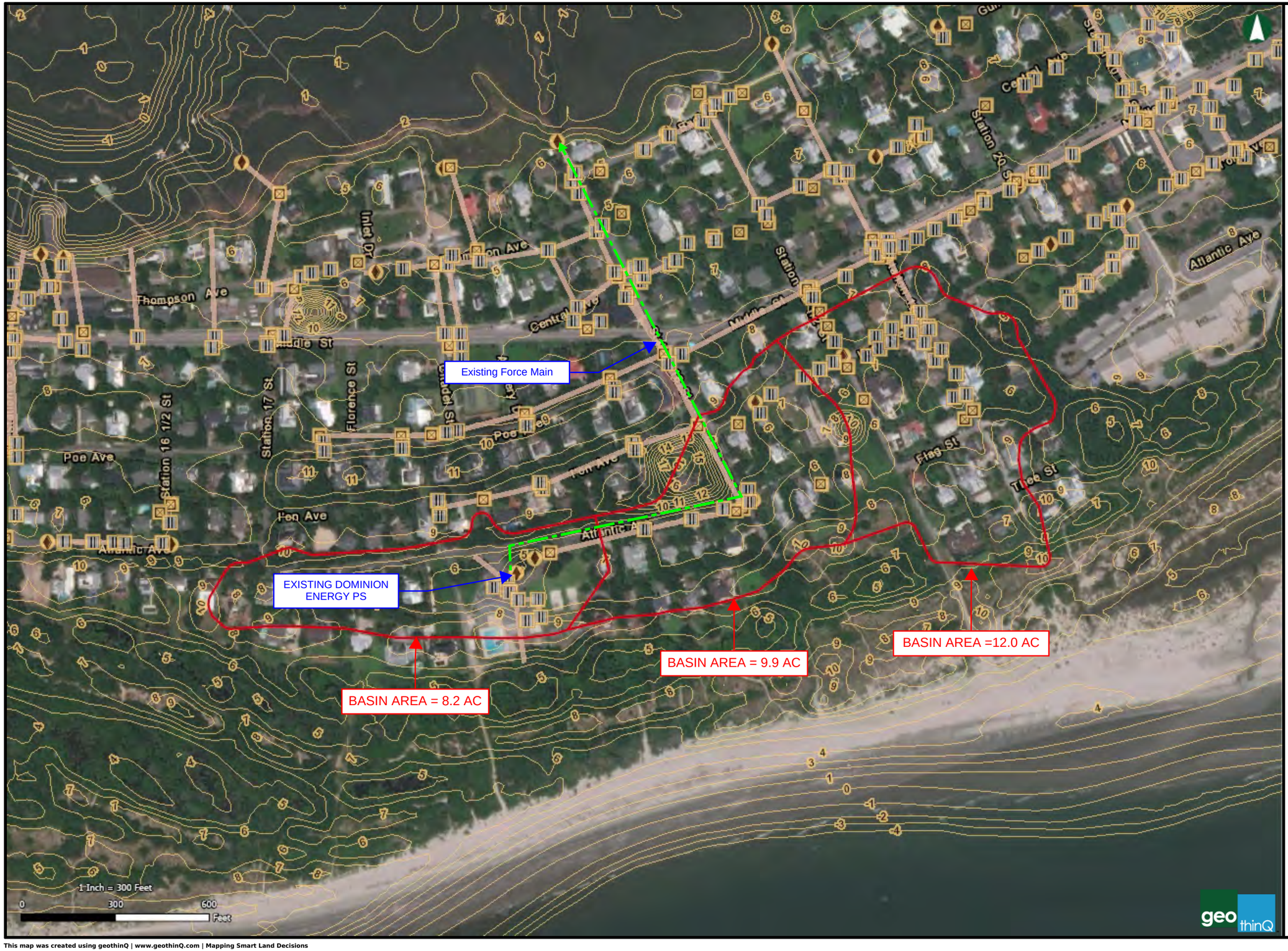

Town of Sullivan's Island

Multi-Basin Drainage Improvement

12/02/2021

- Pipes
- Culverts
- Inlets
- Junctions
- Outlets
- Existing Force Main

Existing Stormwater Drainage System

Proposed Outfall Structure

Proposed Force Main

Proposed Force Main Manifold

Existing Force Main

Proposed Sta 18 Pump Station

Proposed Sta 18.5 Pump Station

Existing Dominion Energy Pump Station

BASIN AREA =12.0 AC

BASIN AREA = 9.9 AC

BASIN AREA = 8.2 AC

1 Inch = 300 Feet

0 300 600 Feet

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Town of Sullivan's Island

Multi-Basin Drainage Improvement

12/02/2021

- Pipes
- Culverts
- Inlets
- Junctions
- Outlets
- Proposed Pump Station
- Proposed Force Main
- Existing Force Main

Proposed Stormwater Drainage System - Force Main

Z:\27091\27091.0000\Engineering\Drawings\Exhibits\27091 DUAL PS Sta18 and 18.5 Location 505C.dwg — Dec 8, 2021 — 2:59:04 PM

MARSH/INTRACOASTAL WATERWAY

PROPOSED OUTFALL

SW FM

SW FM

SW FM

Station 19 St

Central Ave

Station 20 St

Middle St

SW FM

PROPOSED STORMWATER FORCE MAIN

SW FM

SW FM

Middle St

Station 18 St

PROPOSED STORMWATER FORCE MAIN MANIFOLD

Station 19 St

Hag St

TMS # 529-09-00-083

TMS # 529-09-00-084
1807 ATLANTIC,
SULLIVANS ISLAND 29482

PROPOSED PUMP STATION STATION 18

EXISTING PROPERTY LINE

PROPOSED 36" STORM DRAINAGE PIPE

PROPOSED GRATE INLET (TYP)

TMS # 529-09-00-113

PROPOSED 36" STORM DRAINAGE PIPE

PROPOSED PUMP STATION 18.5

TMS # 529-09-00-087

PROPOSED GRATE INLET (TYP)

Sullivans Island

TMS # 529-09-00-112

N
W
E
S

ft Corporation © 2021 Maxar ©CNES (2021) Distribution Airbus DS © 2021 TomT

PROPOSED STORMWATER DRAINAGE SYSTEM

SULLIVAN'S ISLAND, SC

PREPARED FOR:

TOWN OF SULLIVAN'S ISLAND

PREPARED BY:

THOMAS & HUTTON

682 Johnnie Dodds Blvd. • Suite 100
Mt. Pleasant, SC 29464 • 843.849.0200

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JOB NO:	J-27091
DRAWN:	CGB
REVIEWED:	MFY

DATE:	06/21/2021
SCALE:	1" = 50'
SHEET:	1 OF 1

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DELIVERABLE 2:

An Analysis that Documents the Feasibility and Effectiveness for the Mitigation Project Demonstrated Through Conformance with Accepted Engineering Practices, Established Codes, Standards, Modeling Techniques, or Best Practices Certified by a Registered Design Professional.

I hereby state that the design for the Town of Sullivan's Island stormwater improvement complies with the following local, state, and known federal regulations:

- 10-year, 24-hour storm event. 6.6 inches of rainfall in a 24-hour period.
- Charleston County drainage design requirements.
- SCDHEC OCRM design requirements.
- SCDHEC Bureau of Water design requirements.
- South Carolina Department of Transportation drainage design and right-of-way impact requirements.
- Town of Sullivan's Island codes and regulations.
- Improvements to prevent damaging flood waters from the 100-year, 5-day storm event (13.1 inches).

The design was conducted using engineering Best Management Practices and these techniques:

1. Rational Method to determine peak flow to pump station and to drainage pipes.
2. Bentley sewer CADD to model pump station and force main operation.
3. Darcy-Weisbach Method to determine friction losses.

I hereby state that the design will manage the specified storm event without flooding and that the depicted improvements are the most feasible and effective given the local regulations, site, and easement constraints.

Mark F. Yodice

Mark F. Yodice, PE, SC#13293

August 29, 2022

Date

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DELIVERABLE 3:

Level of Protection, Damage Before and After Mitigation the Proposed Project will Provide to Existing Infrastructure.

This deliverable describes the level of protection the proposed project will provide to existing infrastructures.

This deliverable describes the level of protection of the proposed project. At the Station 18 and Station 18.5 proposed stormwater pump station sites, the proposed equipment is designed to conform with the latest FEMA Firm elevation and the Town of Sullivan's Island Stormwater Ordinance. The current FEMA Flood elevation is 10 (Zone AE) (BFE) from FIRM Map No. 45019C05391C. The Town of Sullivan's Island Ordinance requires electrical to be one (1) foot above flood elevation. Electrical, monitoring, and control equipment is above the BFE plus at least one foot. This project proposes to elevate the electrical, monitoring and control equipment two (2) feet above the base flood elevation.

Permanent standby power or a generator will be installed at each pump station to provide uninterrupted operation in the event of power loss from the utility provider. The generator will also be elevated to two (2) feet above the base flood elevation.

Stormwater collection meets the criteria shown in Section D2.1. Small and normal rainfall events cause flooding in the study area, since there is no outfall. Rainfall must evaporate so flooding is significant, frequent, and long lasting (see **Deliverable 8** for photos of flooding). The proposed project provides an outfall and infrastructure to collect runoff with transporting the stormwater to an outfall. The design criteria used complies with regulatory agencies' requirements and is outlined in the section on **Deliverable 2**. The design is to manage the 10-year, 24-hour storm event and prevent flooding from the 100-year, 5-day event.

Another design goal was to prevent stormwater from preventing or hindering emergency vehicles responding to urgent calls.

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DELIVERABLE 4:

Upstream and Downstream Impacts, USACE Permit, Name and Location of the Flooding Source

This deliverable describes the upstream and downstream impacts of the proposed project.

There will be no negative impacts upstream or downstream due to the proposed project. The stormwater management infrastructure has been designed for the study basin to meet applicable regulations. Those regulations are to design the infrastructure for the 10-year, 24-hour storm event, while being able to manage the 100-year, 5-day event without flooding damage.

All stormwaters will be managed onsite and there will be no impacts to upstream or downstream infrastructure.

Since high tides can back up into a drainage system and affect flooding, the stormwater pump station removes the influence of a high tailwater condition at the outfall. The water will be discharged above high tides and above frequent "King Tides." Work will be conducted above areas where a USCOE or OCRM permit would be required.

This deliverable identifies the name and location of the flooding source.

The purpose of "the Project" is to mitigate flooding in the study basins. The area was constructed years ago and lacked formal drainage and contours create a bowl which leaks on outlet. Normal rainfall causes flooding. Topography in the basin area ranges in elevation from 5.0 to 15.0 NGVD29 without an outlet, so the basin is extremely vulnerable to flood inundation from normal, heavy precipitation and coastal surge events. Any kind of storm floods the basin routinely. This flooding makes roads impassable for residents and emergency services. The flooding also reaches and impacts homes. The proposed project alleviates these negative impacts.

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DELIVERABLE 5:

Provide Description and Map of the Existing Drainage Conditions and the Area of Protection

This deliverable illustrates the area of protection and existing drainage conditions.

The study basin (project area) is a depressed bowl or hole without an outlet. All areas drain to extreme low spots which were caused by work in the 1940's and 1950's as part of the U.S. military's efforts implementing coastal defenses and protecting shipping traffic. Old gun batteries were constructed along with a lighthouse. Work to construct those coastal defenses seems to result in low areas which trap stormwater.

The proposed project will provide stormwater pump stations in the lowest elevations to safely collect, lift, and discharge the stormwater to a receiving body on the back of the Island for each Sta 18 and Sta 18.5, thereby providing an outfall which will not be affected by high tides or "King Tides".

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ATTACHMENT 2

LiDAR and Existing Stormwater Drainage System

South Basin Exhibit

BASIN
STA 19

BASIN
I'ON AVE

BASIN
STA 18 PS

BASIN
SCE&G PS

STATION 18 STREET/ATLANTIC
AVENUE WATERSHED BASIN
(SOUTH BASIN)

1 inch = 300 Feet
0 300 600
Feet

geo thinQ SM

TOWN OF SULLIVAN'S ISLAND

MULTI-BASIN DRAINAGE IMPROVEMENT

08/09/2018

- N/A
- Inlet
- Manhole
- PipeIO
- N/A
- Channel
- Pipes
- Parcels

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LIDAR & EXISTING STORMWATER DRAINAGE SYSTEM SOUTH BASIN EXHIBIT

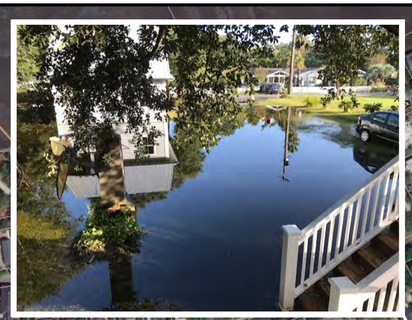


PHOTO PROVIDED BY HOMEOWNER (APPROXIMATELY 2016-2017, VIEW FACING I'ON AVENUE)

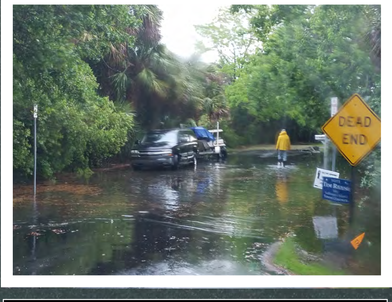
STATION 18 STREET/ATLANTIC AVENUE WATERSHED BASIN

APRIL 2017, ATLANTIC AVENUE DURING AN APPROXIMATE 4.0-INCH RAIN EVENT (2-YEAR STORM EVENT IN CHARLESTON COUNTY ESTIMATED 4.6-INCH IN 24 HOUR)

APRIL 2017, ATLANTIC AVENUE AT SCE&G PROPERTY/PUMP STATION DURING AN APPROXIMATE 4.0-INCH RAIN EVENT (2-YEAR STORM EVENT IN CHARLESTON COUNTY ESTIMATED 4.6-INCH IN 24 HOUR)

APRIL 2017, ATLANTIC AVENUE ADJACENT TO SCE&G PROPERTY DURING AN APPROXIMATE 4.0-INCH RAIN EVENT (2-YEAR STORM EVENT IN CHARLESTON COUNTY ESTIMATED 4.6-INCH IN 24 HOUR)

APRIL 2017, ATLANTIC AVENUE & STATION 18 ST INTERSECTION DURING AN APPROXIMATE 4.0-INCH RAIN EVENT (2-YEAR STORM EVENT IN CHARLESTON COUNTY ESTIMATED 4.6-INCH IN 24 HOUR)



APRIL 2017, ATLANTIC AVENUE DURING AN APPROXIMATE 4.0-INCH RAIN EVENT (2-YEAR STORM EVENT IN CHARLESTON COUNTY ESTIMATED 4.6-INCH IN 24 HOUR)

1 Inch = 200 Feet
0 200 400 Feet

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TOWN OF SULLIVAN'S ISLAND

MULTI-BASIN DRAINAGE IMPROVEMENT

04/11/2018

☐ Parcels

PHOTO EXHIBIT
STATION 18 STREET/ATLANTIC AVENUE SOUTH BASIN

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ATTACHMENT 3

LiDAR and Proposed Stormwater Drainage System

South Basin Exhibit

Proposed Outfall Structure

Proposed Force Main

Proposed Force Main Manifold

Existing Force Main

Proposed Sta 18 Pump Station

Proposed Sta 18.5 Pump Station

Existing Dominion Energy Pump Station

BASIN AREA =12.0 AC

BASIN AREA = 9.9 AC

BASIN AREA = 8.2 AC

1 Inch = 300 Feet

0 300 600 Feet

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Town of Sullivan's Island

Multi-Basin Drainage Improvement

12/02/2021

- Pipes
- Culverts
- Inlets
- Junctions
- Outlets
- Proposed Pump Station
- Proposed Force Main
- Existing Force Main

Proposed Stormwater Drainage System - Force Main

Z:\27091\27091.0000\Engineering\Drawings\Exhibits\27091 DUAL PS Sta18 and 18.5 Location SOSC.dwg — Jun 22, 2021 — 1:55:16 PM

PROPOSED OUTFALL

PROPOSED STORMWATER FORCE MAIN

PROPOSED STORMWATER FORCE MAIN MANIFOLD

PROPOSED PUMP STATION STATION 18 AREA

EXISTING PROPERTY LINE

R/W

PROPOSED 36" STORM DRAINAGE PIPE

PROPOSED GRATE INLET (TYP)

PROPOSED GRATE INLET (TYP)

PROPOSED PUMP STATION 19 AREA

TMS # 529-09-00-083

TMS # 529-09-00-084
1807 ATLANTIC,
SULLIVANS ISLAND 29482

TMS # 529-09-00-113

TMS # 529-09-00-087

TMS # 529-09-00-112

Station 18 St

Station 19 St

Central Ave

Middle St

Station 20 St

Hag St

Sullivans Island

N
W
E
S

MULTI-BASIN DRAINAGE IMPROVEMENT
FEMA 4241-DR-SC
DUAL PUMP STATIONS

SULLIVAN'S ISLAND, SC

PREPARED FOR:

TOWN OF SULLIVAN'S ISLAND

PREPARED BY:

THOMAS & HUTTON

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JOB NO:	J-27091
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DATE:	06/21/2021
SCALE:	1" = 50'
SHEET:	1 OF 1

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DELIVERABLE 6:

Cost Estimate to Implement the Designed Project

This deliverable presents in the following pages an updated Engineer's opinion of probable cost for the final designed project.

This deliverable lists the latest opinion of probable cost. The cost estimate reflects current construction prices in the area for similar work and vendor provided price quotes.

Current costs have risen tremendously due to the market conditions, supply delivery issues, Covid-19 impacts, rise in fuel prices, and Contractor workloads.

Town of Sullivan's Island
DR-4241 Hazard Mitigation Grant
Sullivan's Island Multi-Basin Stormwater
Drainage Improvement Project
DUAL PUMP STATIONS @ STA 18 & STA 18.5
LOCATION :South Basin (Station 18 & 18.5 PS)
Sullivan's Island, South Carolina
ESTIMATOR : CGB/MFY

THOMAS & HUTTON

OPINION OF PROBABLE CONSTRUCTION COST

DATE PREPARED : 02/19/2019	REVISED: 12/15/2021

BASIS FOR ESTIMATE

	(No design completed-Conceptual)
	(Design Development)
X	(Preliminary Final design)

OPINION OF PROBABLE CONSTRUCTION COST

Since the Engineer has no control over the cost of labor, materials, equipment, over the Contractor's methods of determining prices, or over competitive bidding or market conditions, the Opinions of Probable Construction Costs provided for herein are made on the basis of his experience and qualifications. These opinions represent his best judgment as a design professional familiar with the construction industry. However, the Engineer cannot and does not guarantee that proposals, bids, or the construction cost will not vary from Opinions of Probable Construction Costs prepared by him.

	QUANTITY		COST	
DESCRIPTION	NUMBER OF UNITS	UNIT MEASURE	UNIT PRICE	TOTAL COST
IDENTIFICATION				
Inlets	18	each	$4,000	$72,000
Sediment Inlets (grate inlets)	2	each	$7,500	$15,000
Connect to existing Inlets	1	each	$2,500	$2,500
15-Inch Drainage pipes	50	lf	$75	$3,750
18-Inch Drainage pipes	535	lf	$80	$42,800
24-Inch Drainage pipes	320	lf	$90	$28,800
36-Inch Drainage pipes	220	lf	$130	$28,600
Stormwater Pump Station 18	1	Job	$750,000	$750,000
Stormwater Pump Station 18.5	1	Job	$700,000	$700,000
Stormwater Pump Station Installation	2	Job	$75,000	$150,000
Pump station Site Work & related	2	ea.	$30,000	$60,000
18" Force Main	1,000	lf	$100	$100,000
18" Force Main Fitting	1	job	$140,000	$140,000
20" Force Main	560	lf	$125	$70,000
20" Force Main fitting	1	job	$152,000	$152,000
30" Force Main	1,250	lf	$150	$187,500
30" Force Main Fitting	1	job	$200,000	$200,000
Water line Offset	8	ea.	$5,000	$40,000
Driveways	300	sy	$100	$30,000
Road cuts	10	ea.	$5,000	$50,000
Drainage swales	900	lf	$7	$6,300
SCDOT Road Restoration	3,000	lf	$100	$300,000
Site Restoration	2,000	lf	$12	$24,000
Station 18 St (Asphalt Overlay)	1	job	$30,000	$30,000
Atlantic Ave (Asphalt Overlay)	1	job	$25,000	$25,000
Subtotal				**$3,208,250**
MISCELLANEOUS ITEMS				
Mobilization	1	Job	$10,000	$10,000
Tree Protection/Perimeter Fencing (Orange Plastic)	1	Job	$3,500	$3,500
Silt Fence	1	Job	$20,000	$20,000
Traffic Control	15	days	$1,000	$15,000
Utility Conflicts	4	ea.	$20,000	$80,000
Erosion Control	1	Job	$7,500	$7,500
Bonding & Insurance	1.5	%		$48,124
Subtotal				**$184,124**
Total				**$3,392,374**
Generator	2	ea.	$ 100,000	$200,000

Town of Sullivan's Island
DR-4241 Hazard Mitigation Grant
Sullivan's Island Multi-Basin Stormwater
Drainage Improvement Project
DUAL PUMP STATIONS @ STA 18 & STA 18.5
LOCATION :South Basin (Station 18 & 18.5 PS)
Sullivan's Island, South Carolina
ESTIMATOR : CGB/MFY

THOMAS & HUTTON

OPINION OF PROBABLE CONSTRUCTION COST

DATE PREPARED : 02/19/2019	REVISED: 12/15/2021

BASIS FOR ESTIMATE

	(No design completed-Conceptual)
	(Design Development)
X	(Preliminary Final design)

OPINION OF PROBABLE CONSTRUCTION COST

Since the Engineer has no control over the cost of labor, materials, equipment, over the Contractor's methods of determining prices, or over competitive bidding or market conditions, the Opinions of Probable Construction Costs provided for herein are made on the basis of his experience and qualifications. These opinions represent his best judgment as a design professional familiar with the construction industry. However, the Engineer cannot and does not guarantee that proposals, bids, or the construction cost will not vary from Opinions of Probable Construction Costs prepared by him.

	QUANTITY		COST	
DESCRIPTION	**NUMBER OF UNITS**	**UNIT MEASURE**	**UNIT PRICE**	**TOTAL COST**
Electrical	2	ea.	$ 100,000	$200,000
GRAND TOTAL				**$3,792,374**
OPINION OF PROBALBE CONSTRUCTION COST				**$3,800,000**

Notes:

THOMAS & HUTTON

DELIVERABLE 7:

Benefit-Cost Analysis Required to Determine Cost Effectiveness Eligibility of the Proposed Project

This deliverable provides

A revised or updated benefit-cost analysis (BCA) to show cost effectiveness of the proposed project is included in the following pages.

DISASTER RECOVERY SOLUTIONS ROSTAN

TOWN OF SULLIVANS ISLAND BENEFIT-COST ANALYSIS

TECHNICAL MEMORANDUM

Documentation of Values and Description of Methodology

Town of Sullivan's Island, South Carolina
Stormwater Improvements – Phase 1 BCA
DR-4241-0049-SC HMGP
Total Project Benefits: $6,419,917
Total Annualized Project Costs: $3,981,397
Project Benefit-Cost Ratio ('BCR"): 1.61
August 15, 2022

Table of Contents

Tables and Figures

Rostan Solutions, LLC
4600 Goer Drive, Suite 200A
North Charleston, SC 29406
T: 813.333.7042 F: 813.333.733
www.rostan.com

1 Introduction

The Town of Sullivan's Island, South Carolina (hereinafter, the "Town,") is pleased to provide this memorandum and referenced exhibits in support of its Benefit-Cost Analysis ("BCA") in prepared for its Phase 1 Stormwater Improvements HMGP subgrant DR-4241-0049-SC. As described in the aforementioned agreement, the Town is proposing to install two (2) pump stations and perform additional internal stormwater conveyance upgrades to help address frequent, persistent stormwater flooding occurring within the project area [See Figure 1]. This document describes the steps taken and data utilized to develop the Phase 1 BCA required as a deliverable within the present subgrant application, included here as Exhibit A(1).[1]

Utilizing modeling output developed by the Town's Engineer of Record for this project, Thomas and Hutton ("T&H"), the Town has utilized an ArcGIS-based approach to estimate the impacts of flooding at existing and proposed conditions, quantifying the best available data to demonstrate this project's cost effectiveness. We have incorporated FEMA-accepted depth-damage functions ("DDFs") and standard values to arrive at a conservative analysis we believe meets or exceeds the required demonstration of cost-effectiveness required by the FEMA HMGP program.

Attached to this memorandum, we provide all BCA calculations in their native format for FEMA's review, recreation, and comment. Where assumptions were made in support of this analysis, they are clearly disclosed in this memorandum. The purpose of this memorandum is to clearly identify all values used in the present analysis, document their source and the basis for their use, and to provide a sufficient description of the methodology utilized to allow for SCEMD and/or FEMA recreate and validate the analysis performed.

[1] The .pdf export of the BCA is also included as Exhibit A(2).

Figure 1. Project Area

2 Theory of Cost Effectiveness

As introduced above, the existing stormwater drainage infrastructure within the project area is either insufficient or non-existent, and therefore fails to convey high frequency flood events within the Station 18 and Station 18.5 sub-basins. More specifically, the project area's topography presents as a large "bowl" or low-lying area where stormwater drains toward but has no way to natural flow out of the sub-basins. As a result, flooding conditions can persist for days, even up to a week or more, until evaporation and percolation/absorption remove most of flooding from the streets and over private property.

Persistent flooding conditions result in two (2) primary sources of damages as recognized by FEMA's Hazard Mitigation Assistance ("HMA") Programs, flood damages to structures and their contents, as well as disrupting the flow of traffic, otherwise known as the "loss of [function of]one-way trips. As flooding conditions can be expected at very frequent return periods, e.g., the 2-Year, 24-Hour Rainfall event, even relatively minor flooding conditions cause substantial negative impacts when viewed across a 20–30-year timeframe, consistent with the intended useful life of the proposed scope of work. By adding conveyance capacity through additional pipe sections, a combined improved outfall, and the positive pumping pressure generated though two (2) new stormwater pump stations, the proposed project will be able to quickly and decisively remove and discharge localized flooding conditions up to the 25-Year, 24-Hour rainfall event in both sub-basins. In doing so, the project will significantly reduce the negative impacts of both the flood impacts to structures and their contents,

as well as the loss of one-way trips due to the inundation of streets and driveways within the project area. Please see Exhibit B for T&H's Engineering Report serving as the basis for the present BCA and Memorandum.

Utilizing FEMA's Benefit-Cost Analysis Calculator [Version 6.0], specifically the Professional Expected Damages methodology, we can quantify and compare the anticipated damages at both existing and proposed conditions using the data, tools, and assumptions discussed below. We believe the analysis to be conservative, reasonable, and sufficient to support a favorable cost-effectiveness review.

3 Hazard Data

T&H has undertaken the required calculations and analyses sufficient to determine water surface elevations at the 2-, 10-, and 25-Year, 24-Hour Rainfall events for existing conditions.[2] Please see the following figure from T&H's ICPR Model estimating the anticipated water surface elevations at existing conditions.

Report Viewer

Name	Group	Simulation	Max Time Stage hrs	Max Stage ft
Combine	BASE	002 yr South	24.00	6.93
Combine	BASE	010 yr South	24.01	7.25
Combine	BASE	025 yr South	24.01	7.41
Dominion Energy	BASE	002 yr South	0.00	5.00
Dominion Energy	BASE	010 yr South	0.00	5.00
Dominion Energy	BASE	025 yr South	0.00	5.00

Figure 2 - Estimated Water Surface Elevations at Existing Conditions

These surface water elevations were interpreted to be consistent across the project area. For proposed conditions, T&H's modeling estimates that all three modeled events would be captured and contained within the proposed infrastructure as supported by the two pump stations, but no specific proposed conditions water surface elevations were provided for this analysis. As a result, an artificially derived surface water elevation of 2' NAVD88 was utilized for all events at proposed conditions to simulate the impacts of the proposed scope of work fully containing all three modeled events.[3]

The existing conditions model output was provided to the Town in an AutoCAD export file format as inundation areas/polygons, which were subsequently projected within an ArcGIS platform to allow for the creation of a two-dimensional project area. Later work, described in Sections 5 and 6 of this memorandum, added a third, vertical dimensional component, allowing for the application of the hazard data generated by T&H to the structures and streets located within the delineated project area.

[2] Please see Exhibit B.

[3] The proposed conditions assumptions were developed by the BCA analysts to simulate the flood events remaining in the stormwater conveyance system.

4 Sources of Benefits

4.1 Flood Damage to Structure(s) and Contents

The primary source of benefits for the present analysis were derived from the anticipated reduction of flooding impacts to structures and their contents, consistent with FEMA HMA programmatic guidelines. Through the utilization of USACE Generic Depth Damage Curves[4] ("DDFs") for a one-story, residential structure with no basement, each structure's interaction with the existing and proposed conditions surface water elevations. In addition to T&H's surface water elevations, grade elevation for each impacted structure was obtained via's NOAA's Digital Coast data set. First Floor Elevations ("FFE's") were estimated based on desktop surveys of existing/available street level imagery. This data set was further analyzed, and anticipated damages/reductions calculated through the geo-spatial review process described in Sections 5 and 6 of this memorandum. All native DDF calculations are provided in Exhibit C to this memorandum.

4.2 Traffic Benefits

One of the more important aspects of the proposed project is to reduce and/or eliminate the flooding of residential streets that prevent occupants, visitors, or commercial travelers and emergency equipment from accessing or exiting their structures by virtue of the inundation of those streets. At existing conditions, frequently recurring rainfall events serve to create long duration inundation of streets within the project area due to the lack of suitable drainage infrastructure. In terms of FEMA's HMA Programs and its BCA Software, the cognizable damages to be avoided or "benefits" generated by the proposed project are defined as the "Loss of One-Way Trips." To quantify the value of the loss of one-way trips, the following actions/assumptions were made:

- A manual count of structures with the ingress/egress completely blocked by the polygons projected onto the ArcGIS base map was performed. A structure was "counted" where there was no detour route identifiable from the combination of AutoCAD projection onto a buildings and streets base map.
- Based on the Institute of Transportation Engineers, "Trip Generation, 9th Edition", there are an average of 9.52 one-way trips per single family structure[5] that was "counted" for the purposes of this analysis.

Using the following formula, the Borough calculated the Number of One-Way trips for each scenario for the following equation:

- Number of Structures Impacted x 9.52 = Number of One-Way Trips

As stated above, the detour time was conservatively estimated at 360 minutes, which is appropriate where there is no detour route per FEMA HMA Guidance.[6] For "Days of Impact", the modeling performed by T&H did not provide existing conditions flooding duration specific to the number of days. Based on anecdotal data and information, the Town used a conservate estimate of one (1) day of impact per event analyzed to quantify these benefits without potentially exaggerating their impact without adequate supporting documentation.

[4] Separate DDFs for "Structure" and "Contents" damages were operationalized through a Microsoft Excel Workbook. Please see Section 4.1 and Exhibit C.
[5] Please see Exhibit D for an excerpt of this methodology.
[6] Please see Exhibit E for documentation of the appropriateness of this FEMA Standard Value.

5 ArcGIS Product Development

The GIS steps for this project required a combination of AutoCAD and ArcGIS Pro software. The following are a summary of the GIS steps taken to extract structure damage impacts and ultimately loss avoidance benefiting from the project.

1. **Data Collection**: The Applicant began by collecting the necessary data inputs for its analysis, which included three primary layers:

    a. Flood Elevation Layers: Flood elevation layers were extracted from the engineers .dwg file, which contained a single polygon feature representing the flood footprint for the modeled events.[7]

    b. Structures: Buildings were pulled from Charleston County's public GIS web service. This buildings layer provided a geospatial understanding of structures impacted by the flood elevation layers.

    c. Ground Elevation: A 2018 digital elevation model (DEM) was obtained from NOAA open sources, which provided a one-meter resolution raster layer of the impacted area.

2. **Structure Selection and Analysis**: The original structure layer dataset provided buildings outside the impacted area; therefore, a geospatial analysis was performed to select only those buildings falling within the impacted areas seen in the Flood Elevation Layers. Once selected, this revised Structures Layer was added to an ArcGIS Online layer for first flood elevation (FFE) analysis. Each structure was reviewed using Google Street view to determine estimated height above ground as well as classification of structure as building or commercial. This data was then joined back to the revised Structures Layer for further processing. A geometry calculation was then run on all structures to determine square footage of each feature (building).

3. **Zonal Statistics**: A Zonal Statistics as Table process was used to attach ground elevation to each structure. This tool provides a range of statistics on the values of all cells (one-meter resolution) intersecting each individual building (e.g., minimum, maximum, sum, mean, etc.). Applicant chose to use the maximum value as a matter of caution as this parameter would suggest the structures ground elevation exists at this uniform maximum height, which would minimize the difference between flood elevation and ground elevation.

4. **Table to Excel**: The attribute table for the revised Structure Layer was then extracted to an excel worksheet using a Table to Excel tool. This excel worksheet served as the raw data for the Applicant's Loss Avoidance worksheet.

6 Flood Impact Calculations / Depth-Damage Function Operation

With the structure data exported to excel, the DDF workbook was organized to allow for each structure to "run" through both the Structure and Contents DDFs through the three events discussed above. The Town utilized a combination of Microsoft Excel's Index and Match function, as described

[7] Per T&H, the surface water elevations for the 2-, 10-, and 25-Year, 24-Hour Events were so close in proximity that it would have been unnecessary to spatially depict all three (3) separately. The 25-Year, 24-Hour Flood Polygon is depicted in Figure 1, above.

below, to apply the DDFs to the various structures' building characteristics. The function used and the DDF tables are made available in their native form within Exhibit C.

All structures were analyzed through the DDF workbook for both "Building" and "Contents." Building square footage was developed through the ArcGIS application and was incorporated into the DDF workbook. A standard Building Replacement Value ("BRV") of $100 per square foot was calculated within the DDF Tool by multiplying building square footage by the BRV rate. Fifty percent of the BRV was used to establish the Contents Replacement Value ("CRV"). FFE was estimated by desktop visual surveys of open-source street view data, counting steps below the assumed first floor and adding this value to the grade elevation developed from the GIS application. Each step was presumed to count as 0.5 feet, with structures with no apparent steps [slab-on-grade] had 0.5 feet added to their assessed grade elevation.

The Index and Match Function(s) were then utilized to calculate percentages of damage for all structures and their contents at the interaction of each facility's FFEs and the corresponding depth of flooding at the 2, 10, and 25-Year flood heights at existing and proposed conditions as generated by T&H. The depth of flooding for each event for each structure was calculated relative to each structure's FFE. Next, the depth of flooding was indexed with a depth value the corresponding ["matched"] percentage of damage for both the structure and contents' DDFs. The various percentages obtained were then applied to the BRV and CRV to generate expected damage amounts for all modeled events for the before- and after-mitigation scenario. After-Mitigation damage scenarios are discussed in a later section of this report. The full set of calculations in their native format are contained within Exhibit C's "Damages Calcs" Tab. FEMA may view the summary of the Professional Expected Damages Before Mitigation below, as well as in Exhibit A(2).

Professional Expected Damages Before Mitigation

Damages Before Mitigation:

Add Row

		ROADS AND BRIDGES	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
SELECT	RECURRENCE INTERVAL (YEARS)	IMPACT (DAYS)	Category 1 ($)	Category 2 ($)	Category 3 ($)	NUMBER OF VOLUNTEERS	NUMBER OF DAYS	DAMAGES ($)
☐	2	1	598,637	299,319	0	0	0	957,327
☐	10	1	677,044	338,522	0	0	0	1,074,937
☐	25	1	718,961	359,480	0	0	0	1,137,812

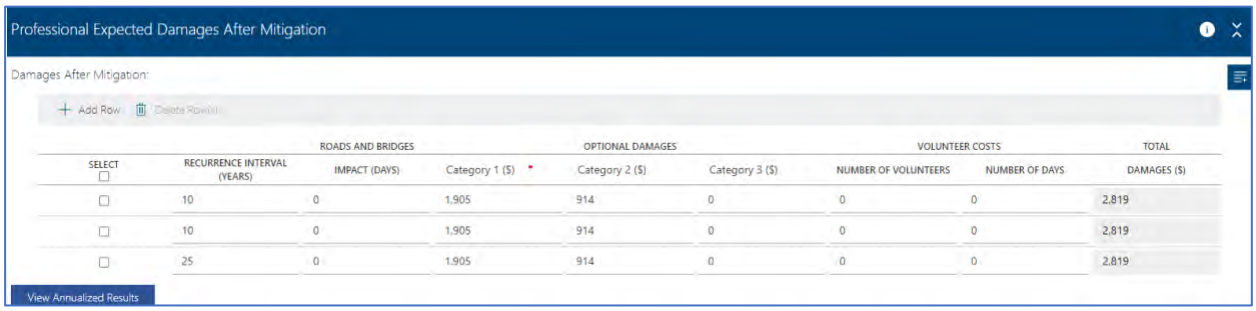
View Annualized Results

Table 1. Professional Expected Damages Before Mitigation

7 After Mitigation Damages

As reflected in Exhibit B, the project scope of work was modeled and designed to absorb and drain the 25-Year, 24-Hour rainfall event from the project area. More specifically, the proposed project is designed to keep all flooding events up to the 25-Year, 24-Hour rainfall ["design"] event within [or removed by] the proposed improved stormwater conveyance system. As a result, artificial surface water elevations far below the majority of existing grade elevations in the project area[8] were utilized to demonstrate the proposed conditions. However, one structure demonstrated a sufficiently low FFE that minor damages were noted at the 2' NAVD88 surface water elevation. Those damages remain in the analysis and are summarized below:

[8] A consistent value of 2' NAVD88 was used for proposed condition surface water elevations at all three recurrence intervals modeled.


Professional Expected Damages After Mitigation

Damages After Mitigation:

Add Row | Delete Row(s)

SELECT	RECURRENCE INTERVAL (YEARS)	ROADS AND BRIDGES IMPACT (DAYS)	ROADS AND BRIDGES Category 1 ($) *	OPTIONAL DAMAGES Category 2 ($)	OPTIONAL DAMAGES Category 3 ($)	VOLUNTEER COSTS NUMBER OF VOLUNTEERS	VOLUNTEER COSTS NUMBER OF DAYS	TOTAL DAMAGES ($)
☐	10	0	1,905	914	0	0	0	2,819
☐	10	0	1,905	914	0	0	0	2,819
☐	25	0	1,905	914	0	0	0	2,819

View Annualized Results

Table 2. Professional Expected Damages After Mitigation

8 Additional Data Inputs and Supporting Documentation

In addition to the data summarized above, the following values complete all remaining inputs into the analysis to allow SCEMD or FEMA to recreate and test any aspect of this analysis. Supporting documentation for these values are identified and referenced in Exhibits or to citations to appropriate sources:

- **Property Structure Type** – Roads and Bridges
  - Basis – Selection allowed for a use of traffic benefits
- **Hazard Type** – Riverine Flood
  - Basis – Most applicable hazard type to study area
- **Mitigation Type** – Drainage Improvements
  - Basis – Closest match with project scope
- **Project Useful Life** – 30 Years
  - Source – FEMA BCA Reference Guide Appendix D
- **Project Cost** – $3,950,374.00
  - Source – Engineer's Opinion of Probable Construction Cost. Please see Exhibit F, T&H's Opinion of Probable Construction Cost.
- **Annual Maintenance Costs** - $2,500.00
  - Source – Provided by BCA Analyst and anecdotal data.
- **Total Mitigation Project Cost** – $3,981,397.00
  - Basis – Generated by BCA calculator based on inputs
- **Professional Expected Damages Before Mitigation**
  - Recurrence Intervals – Engineer's H&H Study and Report. Please see "**Hazard Data**" section above, as supported by Exhibit B.
  - Calculation of Structure and Contents Damages – Please see Exhibit C, DDF Calculations
- **Profession Expected Damages After Mitigation**
  - See "After Mitigation Damages" section above.

9 Benefits Not Utilized

Though available to the Town, other sources of "benefits" were not utilized within this analysis. This was done, in large part, to reduce the number of assumptions required to justify the overall analysis. These include:

- [Residential] Displacement – Available for residential structures where sufficient flooding is experienced to generate anticipated days of required absence from a structure by its residents, "displacement" days and associated costs were not calculated for this analysis due to the minor flood depths above estimated FFE. If required to further

support this analysis, several structures could be analyzed for displacement costs. To preserve the conservative posture of this analysis, displacement days/damages have not been calculated for this analysis, though the Town seeks to reserve the right to do so in the future if needed.

- "Social" Benefits – Where residential structures directly benefit from mitigation projects that reduce or eliminate flooding, the residents of those structures are able to generate the benefits through the reduction of "mental stress/anxiety" and the "loss of productivity," calculated according to the number of residents and how many of those residents work full-time. While up to fifteen structures within the project area potentially qualified for social benefits based upon the DDF estimates of damage, these benefits have been withheld from the analysis until such time as they are needed to help support the Phase 2 scope of work's cost effectiveness.

10 Schedule of Exhibits

- Exhibit A – Benefit-Cost Analysis
  - A(1) – Native BCA Calculator File (Excel + Add-In)
  - A(2) – Printed BCA Export Report
- Exhibit B – T&H Engineering Report
- Exhibit C – Depth Damage Function (DDF) Native Calculations
- Exhibit D – Institute of Transportation Engineers, "Trip Generation", V.9. Excerpt
- Exhibit E – Justification for Detour Duration (time) with No Detour Available from FEMA BCA Software 5.3.0
- Exhibit F – T&H Opinion of Probable Construction Cost

11 Summary and Conclusion

On behalf of Town of Sullivan's Island, SC we trust that the above report, when considered with the referenced BCA and supporting Exhibits, meets or exceeds all SCEMD and/or FEMA HMGP program eligibility requirements as they pertain to cost- and mitigation-effectiveness. Should either or FEMA have any questions or concerns regarding this analysis, please do not hesitate to contact the following contracted third parties for the Town:

- Adam T. Ferguson – Senior BCA Analyst
  - aferguson@rostan.com / 910.200.4735
- Scotty McLeay – BCA Analyst
  - smcleay@rostan.com / 402.315.8646

FEMA Benefit-Cost Calculator

V.6.0 (Build 20220729.1959 | Release Notes)

Benefit-Cost Analysis

Project Name: Sullivan's Island Multi-Basin Stormwater Drainage Improvements

Map Marker ▲	Mitigation Title	Property Type	Hazard	Benefits (B)	Costs (C)	BCR (B/C)
1	Drainage Improvement @ Ion Ave, Sullivans Island, South Carolina, 29482		DFA - Riverine Flood	$ 6,419,917	$ 3,981,397	1.61
TOTAL (SELECTED)				**$ 6,419,917**	**$ 3,981,397**	**1.61**
TOTAL				**$ 6,419,917**	**$ 3,981,397**	**1.61**

Property Configuration

Property Title:	Drainage Improvement @ Ion Ave, Sullivans Island, South Carolina, 29482
Property Location:	29482, Charleston, South Carolina
Property Coordinates:	32.75771502999482, -79.84858989242863
Hazard Type:	Riverine Flood
Mitigation Action Type:	Drainage Improvement
Property Type:	Roads & Bridges
Analysis Method Type:	Professional Expected Damages

Cost Estimation

Drainage Improvement @ Ion Ave, Sullivans Island, South Carolina, 29482

Project Useful Life (years):	30
Project Cost:	$3,950,374
Number of Maintenance Years:	30 Use Default:Yes
Annual Maintenance Cost:	$2,500

Comments

-

Project Useful Life:

FEMA Standard Value for Infrastructure Projects, per FEMA BCA Reference Guide, Appendix D.

-

Mitigation Project Cost:

Please see engineer's estimate of probable construction cost, plus $158,000.00 in Phase 1 Design Costs

-

Annual Maintenance Cost:

Analyst estimated value for pipe inspection and pump station maintenance.

Damage Analysis Parameters - Damage Frequency Assessment

Drainage Improvement @ Ion Ave, Sullivans Island, South Carolina, 29482

Year of Analysis was Conducted:	2022
Year Property was Built:	0
Analysis Duration:	10 Use Default:Yes

Comments

Analysis Year:
Current Year

Year Built:
N/A for Professional Expected Damages Approach

Roads and Bridges Properties
Drainage Improvement @ Ion Ave, Sullivans Island, South Carolina, 29482

Estimated Number of One-Way Traffic Detour Trips per Day:	285
Additional Time per One-Way Detour Trip (minutes):	360
Number of Additional Miles:	0
Federal Rate ($):	0.655 Use Default:Yes
Economic Loss Per Day of Loss of Function ($):	59,371.2

Comments

Number of Trips:
Please see BCA Technical Memorandum. International Institute of Transportation, Trip Generation Methodology used, assume 30 houses at 9.56 one-way trips per day for 285 trips per structure in the inundation area.

Time per Trip:
Please see BCA Technical Memorandum. There is no detour for the 30 structures that are flooded by persistent, non-draining street flooding. Maximum of 12 hours/360 minutes utilized.

Number of Miles:
No detour available.

Professional Expected Damages Before Mitigation

Drainage Improvement @ Ion Ave, Sullivans Island, South Carolina, 29482

	ROADS AND BRIDGES	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Impact (days)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
2	1	598,637	299,319	0	0	0	957,327
10	1	677,044	338,522	0	0	0	1,074,937
25	1	718,961	359,480	0	0	0	1,137,812

Comments

-

Damages Before Mitigation:

Please see BCA Technical Memorandum. The Town utilized an excel-based version of FEMA/USACE Generic One-Story No Basement Depth-Damage Function (DDF) for structure and contents damages before and after mitigation. All native data calculations are provided as exhibits to the BCA Technical Memorandum.

Annualized Damages Before Mitigation

Drainage Improvement @ Ion Ave, Sullivans Island, South Carolina, 29482

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
2	957,327	405,772
10	1,074,937	66,356
25	1,137,812	45,512
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	3,170,077	517,640

Professional Expected Damages After Mitigation

Drainage Improvement @ Ion Ave, Sullivans Island, South Carolina, 29482

	ROADS AND BRIDGES	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Impact (days)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
10	0	1,905	914	0	0	0	2,819
10	0	1,905	914	0	0	0	2,819
25	0	1,905	914	0	0	0	2,819

Comments

-

Damages After Mitigation:

Please see BCA Technical Memorandum. The Town utilized an excel-based version of FEMA/USACE Generic One-Story No Basement Depth-Damage Function (DDF) for structure and contents damages before and after mitigation. After Mitigation Damages are based on the 25-Year event remaining within the stormwater conveyance systems, below all but one structure analyzed through the DDF analysis process. All native data calculations are provided as exhibits to the BCA Technical Memorandum.

Annualized Damages After Mitigation

Drainage Improvement @ Ion Ave, Sullivans Island, South Carolina, 29482

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
10	2,819	169
25	2,819	113
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	5,638	282

Standard Benefits - Ecosystem Services

Drainage Improvement @ Ion Ave, Sullivans Island, South Carolina, 29482

Total Project Area (acres):	0
Percentage of Urban Green Open Space:	0.00%
Percentage of Rural Green Open Space:	0.00%
Percentage of Riparian:	0.00%
Percentage of Coastal Wetlands:	0.00%
Percentage of Inland Wetlands:	0.00%
Percentage of Forests:	0.00%
Percentage of Coral Reefs:	0.00%
Percentage of Shellfish Reefs:	0.00%
Percentage of Beaches and Dunes:	0.00%
Expected Annual Ecosystem Services Benefits:	$0

Comments

-

Total Project Area:

N/A for this analysis.

Benefits-Costs Summary

Drainage Improvement @ Ion Ave, Sullivans Island, South Carolina, 29482

Total Standard Mitigation Benefits:	$6,419,917
Total Social Benefits:	$0
Total Mitigation Project Benefits:	$6,419,917
Total Mitigation Project Cost:	$3,981,397
Benefit Cost Ratio - Standard:	1.61
Benefit Cost Ratio - Standard + Social:	1.61

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HYDROLOGIC AND HYDRAULIC REPORT

Sullivan's Island Multi-Basin Stormwater Drainage Improvement
Phase 1
FEMA DR-4241-SC at
Sullivan's Island, SC

Prepared for:
Town of Sullivan's Island

J – 27091.0000

November 2021

thomasandhutton.com

TABLE OF CONTENTS

FIGURES

APPENDICES

EXHIBITS

1.0 INTRODUCTION

Sullivan's Island is a 2,200-acre barrier island between the Atlantic Ocean and the intracoastal waterway in eastern Charleston County, South Carolina. The island was incorporated as a town in the early 1800's and is located approximately four miles southeast of Charleston, South Carolina. The Island was once an active military establishment with remnants throughout the Island. Today, the Island inhabits approximately 2,000 residents.

Because of its position on the coast, low elevations, and lack of drainage infrastructure, Sullivan's Island endures frequent flooding and wind damage from coastal and inland storms. In October 2015, a catastrophic storm event caused major damage statewide, surpassing 24-hour historic rainfall records. This storm was called the "thousand-year" event. During such storm events, flooding problems on Sullivan's Island are highlighted. Low-laying areas which are depressed and have no outfall are affected the most. The past several years, certain areas in Sullivan's Island have encountered recurring flood damage from rainstorm events and are more problematic when rain happens at the same time of exceptionally high tides. Flooding problems are compounded by the fact that many parts of the Island have no drainage system.

Thomas & Hutton (T&H) has prepared this report to provide the necessary engineering calculations to demonstrate that the proposed drainage improvements will meet regulatory requirements and minimum standards of an associated FEMA HGMP grant. The Town of Sullivan's Island proposes to construct drainage improvements in two priority sub-basins:

- Station 18 Street/Atlantic Avenue Watershed Basin (Sta. 18)
- Station 18.5 Street/Flag Street (Sta. 18.5)

The drainage improvements are intended to provide drainage and alleviate flooding including reoccurring structural flooding with the basins. The improvements will include installing new pipes, inlets, swales, stormwater pump stations, and structures while re-establishing existing open channels and swales where possible.

The design report primarily focuses on the supporting design considerations for the drainage improvements.

2.0 PURPOSE

The purpose of this study is to:

- Examine two watershed sub- basins, Station 18 Street/Atlantic Avenue Basin (Sta. 18 Basin) and the Station 18.5 Street/Flag Street Basin (Sta. 18.5 Basin), both which experience continuous flooding resulting in repetitive property damage.
- Determine potential aids to improve the existing stormwater drainage system to minimize flood associated losses.

- Document compliance with regulatory requirements of the Town of Sullivan's Island, Charleston County, South Carolina Department of Health and Environmental Control, and FEMA grant requirements.

2.1 Station 18 Street/Atlantic Avenue Watershed Basin (Sta. 18)

This watershed basin consists of two sub-basins and totals approximately 9.9 acres that includes portions of I 'On Avenue, Atlantic Avenue, and south portions of Station 18 Street. Much of the basin has residential coverage. The basin's soils are Made *Land* (map unit symbol – Ma), and *Coastal beaches and dune land* (map unit symbol – Co). The hydrologic group rating for *Made Land* is B and the Coastal beaches and dune land is D. Existing drainage is non-existent and there is no outfall for runoff.

There is an operating existing stormwater pump station which serves a single private parcel, owned by Dominion Energy (formerly the South Carolina Electric and Gas Company - SCE&G). This existing pump station cannot serve the entire basin. It is proposed that the existing Dominion Energy pump station continue to serve its sub-basin. This existing pump station has a single existing 10-inch force main that outfalls to the north end of the island into the marshes of the intracoastal waterway. The existing force main cannot handle any additional flow.

Due to low elevations and extensive conflicts to reach a suitable outfall, a new stormwater pump station is the most feasible option to serve the project area.

2.2 Station 18.5/Flag Street Watershed Basin (Sta. 18.5)

This watershed basin is approximately 16.5 acres that includes portions of I 'On Avenue, Thee Street, Flag Street, and Station 19 Street. The basin is residential properties. The basin's soils are Made *Land* (map unit symbol – Ma), and *Coastal beaches and dune land* (map unit symbol – Co). Existing swales serve this basin, but there is no outlet for stormwater runoff. During any storm event, the lack of a drainage system allows the runoff to pond in the low laying areas which are in most cases, in the streets, adjacent rights-of-way, and spread to adjacent properties. This area's existing drainage system does not provide positive drainage outlets. Areas within the basin flood even during minor storm events with the ponding that affects emergency service response.

3.0 HYDROLOGY

The drainage basins are entirely developed, so it is not anticipated that stormwater runoff will increase in the future.

Two hydrologic conditions are considered in the design of the proposed improvements to adhere to regulatory and FEMA grant requirements. The following hydrologic parameters were used:

1. The Rational method is used to size the peak flow to the pump stations.
2. The rainfall intensity for each storm event was obtained from the *NOAA Atlas 14 Sullivan's Island Station ID 38-8405*. NOAA Atlas 14 Point Precipitation Frequency Estimates for Sullivan's Island, SC, see Appendix D.
   a. 2-year, 24-hour duration - 4.33 inches
   b. 10-year, 24-hour duration - 6.62 inches
   c. 25-year, 24-hour duration - 8.06 inches
   d. 50-year, 24-hour duration - 9.24 inches
   e. 100-year, 24-hour duration - 10.5 inches
   f. 100-year, 5-day duration - 13.1 inches

   A FEMA HGMP grant secured by the Town of Sullivan's Island requires the infrastructure to provide a level of protection to the 100-year, 5-day precipitation event which is 13.1 inches from NOAA records.
   The base design storm is for a 10-year, 24-hour event.
3. The time of concentration for each basin was calculated according to the procedures set forth in *Urban Hydrology for Small Watersheds (TR-55)* (USDA-NRCS, 1986). A minimum time of concentration of 5 minutes was used, per accepted hydrology practices.
4. Per the FEMA grant requirements, the project will provide a level of protection to the 100-year, 5-day precipitation event which is like what Sullivan's Island experienced during an October 2015 storm event.

4.0 BASE DATA/ASSUMPTIONS

The following base data was compiled, and assumptions were made to complete the study:

- Existing utilities for water and sewer were obtained from GIS plans - Town of Sullivan's Island.
- Property claims damage records for flood locations – Town of Sullivan's Island.
- Existing drainage system and flooding photos show problem locations – Town of Sullivan's Island.
- Existing Dominion Energy (formerly SCE&G) pump station design documents – Town of Sullivan's Island and Dominion Energy.
- Hydrologic soil data and group rating – Natural Resources Conservation Service Web Soil Survey from National Cooperative Soil Survey.
- Existing stormwater drainage system inventory/GIS data – Rostan Solution LLC/Charleston County Public Works.
- Additional data was collected from Thomas & Hutton GIS reference library - topography was LiDAR-derived, aerial photography, parcels, and soils.

- Allowable ponding during the design storm event at peak tide elevation is 0.5-feet for the 100-year, 5-day event.
- Design storm for culvert under roadway. Jasper Boulevard shall be designed using the 50-year storm event per SCDOT standard requirements.

5.0 NPDES CONSIDERATIONS

The proposed drainage improvements will outfall to the marshes behind the Island and the intracoastal waterway.

This project is not related to land development or the increase in any impervious surfaces. Thus, no post-construction, permanent water quality control is required.

The proposed land disturbance consists of existing drainage channels that will be disturbed as part of the drainage system installation and localized grading between structures and in existing road rights-of-way for the installation of the storm drain system. Once the drainage system has been installed and grading activities completed, all disturbed areas will be returned to the pre-construction condition. This will ensure that the post-construction runoff from the site will remain unchanged and will not have a significant impact on the downstream water quality.

In addition, construction BMPs have been selected for the project and their performances evaluated such that the construction site's stormwater discharges will not cause, have the reasonable potential to cause, or contribute to an excursion above any state water quality standard.

6.0 SUMMARY AND CONCLUSIONS

This analysis modeled the peak design storm to the pump stations, sized collection pipes, and modelled a manifold force main for the two new stations. Note, we recommend that the system continue to be cleaned and inspected at regular intervals. The Town should clean existing swales and ditches, as necessary. The watershed basins were delineated into sub-basins to determine the peak runoff and the needed capacity for each collection culvert. The proposed culverts and pump station wet well will serve detention storage. Pipe capacity calculations were performed using the Darcy-Weisbach Method drainage computation. Since the project areas are lacking a stormwater pond or basin, the hydraulic grade line elevation was set at the maximum water elevation in the pump station wet well.

6.1 Station 18 Street/Atlantic Avenue Watershed Basin (Sta. 18 Basin)

Much of this basin has permeable soils and has some ability to absorb the stormwater runoff during small storm events. However, the existing conditions within this basin is unable to transport runoff to an outfall without flooding. Stormwater collects in an extremely low-lying area near the beach between Station 18 and Station 18.5 as the slope falls toward the ocean. This topography retains the runoff at the lowest area of the watershed basin without an outfall, which is near the intersection of Atlantic Avenue and Station 18 Street. As mentioned earlier, the existing stormwater pump stations on the (Dominion Energy property (or SCE&G PS), will continue to operate under a standalone basis since it only serves one parcel.

6.2 Station 18.5/Flag Street Watershed Basin (Sta. 18.5)

This basin has areas prone to frequent flooding even during small events due to the lack of an outfall. The area does not have any infrastructure to convey runoff to an outfall, so runoff collects and ponds for days during any rainfall event.

This basin needs new drainage lines, inlets, and a stormwater pump station to convey runoff to the receiving body outfall.

7.0 RECOMMENDATIONS

7.1 Existing Stormwater Drainage System

We recommend the addition of new storm lines and an upgrade in capacity for the undersizesd lines. Recommended improvements are shown in the attached exhibits. We suggest two (2) stormwater pump stations be installed to move runoff out of the pockets. An outfall structure will ibe provided which is set above extreme tide levels to minimize any backflow, and to prevent sunny day flooding due to tidal influence. The backflow prevention preserves the storage volume in the system and prevents saltwater from entering and deteriorating the system.

7.2 New Station 18 Pump Station

We recommend a new stormwater Pump Station at Station 18 be installed to handle the 10-year, 24-hour storm event for the basin and to function independently from the Dominion Energy (formerly SCE&G) pump station.

The new Station 18 stormwater pump station should be designed with redundancy in case of a pump failure, and will include provisions for standby power (generator) to run the station in the event of power loss.

7.3 New Station 18.5 Pump Station

Due to impossibilities of obtaining easements and the alternative need to route large diameter storm pipes up hill (excessive depth and expensive construction/restoration costs) a second stormwater pump station will serve the Sta. 18.5 area.

7.4 Force Main

A common force main to serve both new pump stations 18 and 18.5 will be used to reduce cost. After evaluation of the proposed pump stations in a computer model, we recommend that The Town of Sullivan's Island construct two (2) triplex pump stations (3 pumps per station). We also propose that the force mains be sized as follows:

- From Pump Station 18: 18-inch PVC Force Main
- From Pump Station 18.5: 20-inch PVC Force Main
- Force main conveying combined flows: 30-inch PVC Force Main

The proposed conditions will limit ponding in the pump station basins during extreme rainfall events beyond the base design storm by utilizing two of the three pumps at once and will be able to manage moderate rainfall events through the

cycling of pumps, with one pump in operation at a time. By using the force main sizes listed above (18-inch, 20-inch and 30-inch) excessive velocities in the force mains shall be avoided. During a 10-year, 24-hour rainfall event, the resulting velocities are as follows:

- Force main from PS 18: 7.44 fps (PVC) and 6.57 fps (DIP)
- Force main from PS 18.5: 7.32 fps (PVC) and 6.20 fps (DIP)
- Force main conveying combined flow: 6.11 fps (PVC) and 5.12 fps (DIP)

During a 100-year, 5-day rainfall event, when all three pumps are in operation at each of the pump stations. The resulting velocities in the model are as follows (see Technical Memorandum, Appendix D):

- Force main from PS 18: 10.9 fps
- Force main from PS 18.5: 11.2 fps
- Force main conveying combined flow: 9.2 fps

The utilization of these force main sizes allows for the use of smaller horsepower pumps in the pump stations (35 hp for pump station 18 and 25 hp for pump station 18.5), while maintaining velocities around 10 fps in the force mains under 100-year storm conditions. It also allows velocities in the force mains during the 10-year design storm to be less than 8 fps.

The Stormwater Design Considerations for the pump stations and force mains are included in Appendix B. A technical memorandum discussing PS 18 and 18.5 is included in Appendix D.

8.0 REFERENCES

The following references were used for this study:

Hydraulic Engineering Circular No. 14 (HEC-14) *Hydraulic Design of Energy Dissipators for Culverts and Channels*, (FHWA-HIF-06-086), July 2002, Third Edition.

South Carolina Department of Transportation Access & Roadside Management Standards (ARMS Manual), 2008 Edition, Revision Date: Sept. 26, 2012.

South Carolina Department of Transportation Requirements for Hydraulic Design Studies, May 26, 2009.

United States Department of Agriculture – Natural Resources Conservation Service (NRCS), Urban Hydrology for Small Watersheds, Technical Release 55, June 1986.

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HYDROLOGIC AND HYDRAULIC REPORT

Sullivan's Island Multi-Basin Stormwater Drainage Improvement
Phase 1

FEMA DR-4241-SC at

Sullivan's Island, SC

FIGURES

J – 27091.0000

December 2021

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TOWN OF SULLIVAN'S ISLAND

MULTI-BASIN STORMWATER DRAINAGE IMPROVEMENTS
DRAINAGE IMPROVEMENTS

CLIENT:

TOWN OF SULLIVAN'S ISLAND, SC

LOCATION: CHARLESTON COUNTY
DATE: 03/2018; Rev 12/2021 DRAWN BY: CGB SHEET: LOCATION
JOB NUMBER: J-W:MARK REVIEWED BY: MFY SCALE: 1" = 2000'

THOMAS & HUTTON

682 Johnnie Dodds Blvd. • Suite 100
Mt. Pleasant, SC 29464 • 843.849.0200

www.thomasandhutton.com

Soil Map—Charleston County Area, South Carolina
(South Sullivan's Island Multi-Basin Stormwater Drainage Improvement)

Map Scale: 1:4,460 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 50 100 200 300

Feet: 0 200 400 800 1200

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 17N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Charleston County Area, South Carolina
Survey Area Data: Version 14, Oct 11, 2017

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Feb 9, 2017—Mar 19, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
Co	Coastal beaches and dune land	21.2	41.8%
Ma	Made land	29.6	58.2%
Totals for Area of Interest		**50.8**	**100.0%**

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HYDROLOGIC AND HYDRAULIC REPORT

Sullivan's Island Multi-Basin Stormwater Drainage Improvement Phase 1

FEMA DR-4241-SC at

Sullivan's Island, SC

APPENDIX A

SOUTH BASIN - EXISTING CONDITIONS RATIONAL METHOD CALCUATIONS

J – 27091.0000

December 2021

STORMWATER DESIGN CONSIDERATIONS

PROJECT: MULTI-BASIN DRAINAGE IMPROVEMENT

PREPARED FOR: TOWN OF SULLIVAN'S ISLAND

Job: J-27091

Date: 6/1/21

By: MFY/CGB

THOMAS & HUTTON

Rational Method used to calculate flow rate for drainage basin/area: **Q = CiA**

Station 18 Basin

C =	0.28	SFR	
Tc =	30	min.	
i =	4.33	in/hr	SCDOT Rainfall Intensity values
A =	9.9	ac.	
Q =	**12.0**	**cfs**	

Station 18.5 Basin

C =	0.28	SFR	
Tc =	30	min.	
i =	4.33	in/hr	SCDOT Rainfall Intensity values
A =	12	ac.	
Q =	**14.5**	**cfs**	

Total combined Q :	**26.6**	**cfs**

Rainfall Intensity Values
Utilized by South Carolina Department of Transportation

Rainfall intensity values utilized by the South Carolina Department of Transportation are computed by the following formula:

$$i = \frac{a}{(b+Tc)^c}$$

where: i = rainfall intensity in inches per hour,
Tc = time of concentration in minutes,
and a, b, and c are coefficients.

The coefficients for the 2-, 5-, 10-, 25-, 50-, and 100-year rainfall events are given in the table below for each county in South Carolina. The intensity values for time of concentration of 5, 10, 15, 30, and 60 minutes are also listed in the table for the same frequencies. To use these values compute the time of concentration for the drainage area using the velocity method in the NRCS TR-55 manual. Pick the appropriate county in the tables below to determine the appropriate coefficients. Then apply the equation to obtain the intensity value.

CHARLESTON

Frequency (years)	Rational Coefficients			Rainfall Intensity ("/hr) for Time of Concentration (T_c)				
	a	b	c	T_c = 5	T_c = 10	T_c = 15	T_c = 30	T_c = 60
2	72.6900	11.39	0.8390	6.96	5.56	4.67	3.20	2.02
5	61.1600	9.8460	0.7573	7.93	6.36	5.37	3.75	2.45
10	55.1300	8.4120	0.6972	9.02	7.23	6.12	4.33	2.90
25	45.5300	6.2570	0.6179	10.20	8.13	6.89	4.95	3.41
50	42.6800	5.2800	0.5741	11.20	8.92	7.58	5.52	3.88
100	39.5300	4.2970	0.5309	12.10	9.63	8.21	6.05	4.33

Table 4: Runoff Factors for Rational Method

RUNOFF FACTORS FOR RATIONAL METHOD			
	Flat	**Rolling**	**Hilly**
	0% - 2%	**2% - 10%**	**Over 10%**
Pavements & Roofs	0.90	0.90	0.90
Earth shoulders	0.50	0.50	0.50
Drives & Walks	0.75	0.80	0.85
Gravel Pavements	0.50	0.55	0.60
City Business Areas	0.80	0.85	0.85
Unpaved Road, Sandy Soils	0.34	0.45	0.59
Unpaved Road, Silty Soils	0.35	0.47	0.61
Unpaved Road, Clay Soils	0.40	0.53	0.69
Apartment Dwelling Areas	0.50	0.60	0.70
Suburban, Normal Residential	0.45	0.50	0.55
Dense Residential Sections	0.60	0.65	0.70
Lawns, Sandy Soils	0.10	0.15	0.20
Lawns, Heavy Soils	0.17	0.22	0.35
Grass Shoulders	0.25	0.25	0.25
Side Slopes, Earth	0.60	0.60	0.60
Side Slopes, Turf	0.30	0.30	0.30
Median Areas, Turf	0.25	0.30	0.30
Cultivated Land, Clay & Loam	0.50	0.55	0.60
Cultivated Land, Sand & Gravel	0.25	0.30	0.35
Industrial Areas, Light	0.50	0.70	0.80
Industrial Areas, Heavy	0.60	0.80	0.90
Parks & Cemeteries	0.10	0.15	0.25
Playgrounds	0.20	0.25	0.30
Woodland & Forest	0.10	0.15	0.20
Meadows & Pasture Land	0.25	0.30	0.35
Unimproved Areas	0.10	0.20	0.30
Rail Yards	0.25	0.30	NA
Expressways & Freeways *	0.60*	0.70*	0.75*

* The designer can also calculate weighted 'C' values for expressways and freeways using the values in the table for pavement, side slopes and planted medians.

Revised 3/16/09

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HYDROLOGIC AND HYDRAULIC REPORT

Sullivan's Island Multi-Basin Stormwater Drainage Improvement
Phase 1

FEMA DR-4241-SC at

Sullivan's Island, SC

APPENDIX B

SOUTH BASIN – PUMP STATION STORMWATER DESIGN CONSIDERATIONS

J – 27091.0000

December 2021

STATION 18 PUMP STATION
STORMWATER DESIGN CONSIDERATIONS

Project: Sullivan's Island Multi-Basin Stormwater Drainage Job: 27091.0000
Proposed Pump Station 18 Evaluation **Individual FM To Outfall** Date: 2/2/19
Thomas & Hutton Engineering Co. Revised: **10/29/21**
Stormwater Design Considerations By: CGB/MFY

THOMAS & HUTTON

DESIGN FLOW - 10 Year Storm Event

Description	10 yr Flow Rate		
Station 18 PS Basin	12 cfs	=	5,390 gpm

Proposed Force main size of:	15.35"	16"	nominal PVC	9.34	Velocity (fps)	To high
Proposed Force main size of:	16.41"	16"	nominal DIP	8.17	Velocity (fps)	To high
Proposed Force main size of:	17.20"	18"	nominal PVC	7.44	Velocity (fps)	Use 18"
Proposed Force main size of:	18.31"	18"	nominal DIP	6.57	Velocity (fps)	Use 18"

EQUIVALENT LENGTH OF FORCE MAIN TO STA. 18 to Manifold

Description	Quantity	Unit Equiv. Length of Straight Pipe	Equivalent Length of Force Main
Force Main	2200 l.f.	1 l.f.	2200 l.f.
45° Bend	20 ea.	21 l.f.	420 l.f.
90° Bend	2 ea.	46 l.f.	92 l.f.
Check Valve	1 ea.	165 l.f.	165 l.f.
Wye	1 ea.	200 l.f.	200 l.f.
Tee (Branch)	0 ea.	100 l.f.	0 l.f.
Tee (Thru)	0 ea.	85 l.f.	0 l.f.
Plug Valve	0.5 ea.	25 l.f.	12.5 l.f.
		Total Equivalent Length of Force Main	3,090 l.f.

TOTAL DYNAMIC HEAD (TDH)

Total Dynamic Head (TDH) = Static Head + Friction Head

Static Head

Static Head = Force Main Discharge Elevation (high point on FM) – L.W.L.

Static Head - At Build Out:

FM Discharge El. = 6.50 feet
Pumps Off: = -2.00 feet
= 8.50 feet

Friction Head

Equiv. Length of FM = 3,090 ft
C-factor = 130

The force main will be constructed of **DIP *or* PVC** pipe. A Hazen-Williams coefficient of C = ***130*** will be used to calculate friction head. The force main velocity will be designed for a range of 3.5 to 10 ft/sec.

Calculate Friction Head (Hf) Associated with Force main
Hf = Friction Head (Feet) (Based on Hazen-Williams Formula, Hf = 10.44 x EQ x GPM^1.85 / (D^4.8655 x C^1.85)
(See Reference Note 1) where: EQ = Equivalent Length of Discharge Line, including fittings, in feet
GPM = Discharge Rate, in Gallons Per Minute
D = Inside Diameter of Discharge Line, in inches
C = Hazen-Williams Coefficient

GPM	EQ	D	C	Hf	
5390	3090	17.20	130	30.9	PVC
5390	3090	18.31	130	22.8	DIP

	PVC	DIP
Total Friction Head =	**30.9 Feet**	**22.8**
Head Loss through Pump Station =	**2.0 Feet**	**2.0**
Total Static Head =	**8.5 Feet**	**8.5**
Condition 1 - Friction Head in FM line (Manifold to Outfall) =	**1.4 Feet (Condtion 1 PS 18 only)**	**1.0**
Condition 2 - Friction Head in FM line (Manifold to Outfall) =	**6.2 Feet (Condtion 2 PS 18 & PS 19)**	**4.0**
Total Dynamic Head (TDH) Condition 1 =	**42.8 Feet**	**34.3**
Total Dynamic Head (TDH) Condition 2 =	**47.6 Feet**	**37.3**

STATION 18.5 PUMP STATION
STORMWATER DESIGN CONSIDERATIONS

DESIGN FLOW - 10 Year Storm Event

Description	10 yr Flow Rate		
Station 18.5 PS Basin	**14.5** cfs	=	6,510 gpm

Proposed Force main size of: **19.06"** **20"** **nominal PVC** | 7.32 | Velocity (fps) **Acceptable**
Proposed Force main size of: **20.70"** **20"** **nominal DIP** | 6.20 | Velocity (fps) **Acceptable**

EQUIVALENT LENGTH OF FORCE MAIN TO STA. 19 to Manifold

Description	Quantity	Unit Equiv. Length of Straight Pipe	Equivalent Length of Force Main
Force Main	1720 l.f.	1 l.f.	1720 l.f.
45° Bend	12 ea.	26 l.f.	312 l.f.
90° Bend	2 ea.	50 l.f.	100 l.f.
Check Valve	1 ea.	150 l.f.	150 l.f.
Wye	0 ea.	235 l.f.	0 l.f.
Tee (Branch)	0 ea.	100 l.f.	0 l.f.
Tee (Thru)	0 ea.	78 l.f.	0 l.f.
Plug Valve	0.5 ea.	30 l.f.	15 l.f.
		Total Equivalent Length of Force Main	2,297 l.f.

TOTAL DYNAMIC HEAD (TDH)

Total Dynamic Head (TDH) = Static Head + Friction Head

Static Head

Static Head = Force Main Discharge Elevation (high point on FM) – L.W.L.

Static Head - At Build Out:

FM Discharge El. = 6.50 feet
Pumps Off: = -2.00 feet
= 8.50 feet

Friction Head

Equiv. Length of FM = 2,297 ft
C-factor = 130

The force main will be constructed of **DIP *or* *PVC*** ipe. A Hazen-Williams coefficient of C = ***130*** will be used to calculate friction head. The force main velocity will be designed for a range of 3.5 to 10 ft/sec.

Calculate Friction Head (Hf) Associated with Force main
Hf = Friction Head (Feet) (Based on Hazen-Williams Formula, Hf = 10.44 x EQ x GPM^1.85 / (D^4.8655 x C^1.85)
(See Reference Note 1) where: EQ = Equivalent Length of Discharge Line, including fittings, in feet
GPM = Discharge Rate, in Gallons Per Minute
D = Inside Diameter of Discharge Line, in inches
C = Hazen-Williams Coefficient

GPM	EQ	D	C	Hf	
6510	2297	19.06	130	19.8	PVC
6510	2297	20.70	130	13.2	DIP

	PVC	DIP
Total Friction Head =	**19.8 Feet**	**13.2**
Head Loss through Pump Station =	**2.0 Feet**	**2.0**
Total Static Head =	**8.5 Feet**	**8.5**
Condition 1 - Friction Head in 24" line (Manifold to Outfall) =	**2.0 Feet (Condtion 1 PS 18.5 only)**	**1.3**
Condition 2 - Friction Head in 24" line (Manifold to Outfall) =	**6.2 Feet (Condtion 2 PS 18 & PS 18.5)**	**4.0**
Total Dynamic Head (TDH) Condition 1 =	**32.3 Feet**	**25.0**
Total Dynamic Head (TDH) Condition 2 =	**36.4 Feet**	**27.7**

COMBINED PUMP STATIONS
STORMWATER DESIGN CONSIDERATIONS

Project: Sullivan's Island Multi-Basin Stormwater Drainage Job: 27091.0000
Proposed Pump Station Evaluation - @ Combined Manifold Date: 2/2/19
Thomas & Hutton Engineering Co. Revised: 6/16/21
Stormwater Design Considerations By: CGB/MFY

THOMAS & HUTTON

DESIGN FLOW

Description	10 yr Flow Rate				
Station 18 PS Basin	**12.0**	cfs	=	5,390	gpm
Station 18.5 PS Basin	**14.5**	cfs	=	6,510	gpm
Combined	**26.5**	cfs		11,900	gpm

11,900 gpm **Combined**

Proposed Force main size of:	**22.76"**	**24"**	**nominal PVC**	**9.38**	Velocity (fps)	**To high**
Proposed Force main size of:	**24.67"**	**24"**	**nominal DIP**	**7.99**	Velocity (fps)	**To high**
Proposed Force main size of:	**28.21"**	**30"**	**nominal PVC**	**6.11**	Velocity (fps)	**Acceptable**
Proposed Force main size of:	**30.81"**	**30"**	**nominal DIP**	**5.12**	Velocity (fps)	**Acceptable**

6510 gpm **Station 18.5 PS Basin**

5.13	Velocity (fps)
4.37	Velocity (fps)

5390 gpm **Station 18 PS Basin**

4.25	Velocity (fps)
3.62	Velocity (fps)

EQUIVALENT LENGTH OF PROPOSED FORCE MAIN MANIFOLD TO OUTFALL

Description	Quantity	Unit Equiv. Length of Straight Pipe	Equivalent Length of Force Main
Force Main	1250 l.f.	1 l.f.	1250 l.f.
45° Bend	8 ea.	30 l.f.	240 l.f.
90° Bend	0 ea.	79 l.f.	0 l.f.
Check Valve	1 ea.	95 l.f.	95 l.f.
Tee (Branch)	0 ea.	140 l.f.	0 l.f.
Tee (Thru)	0 ea.	115 l.f.	0 l.f.
Plug Valve	0 ea.	30 l.f.	0 l.f.
Total Equivalent Length of Force Main			1,585 l.f.

TOTAL DYNAMIC HEAD (TDH)

Total Dynamic Head (TDH) = Static Head + Friction Head

Static Head

Static Head = Force Main Discharge Elevation (high point on FM) – L.W.L.

Friction Head

Equiv. Length of FM = 1,585 ft
C-factor = 130

The force main will be constructed of **DIP *or* PVC** pipe. A Hazen-Williams coefficient of C = ***130*** will be used to calculate friction head. The force main velocity will be designed for a range of 3.5 to 10 ft/sec.

Calculate Friction Head (Hf) Associated with Force main
Hf = Friction Head (Feet) (Based on Hazen-Williams Formula, Hf = 10.44 x EQ x GPM^1.85 / (D^4.8655 x C^1.85)
(See Reference Note 1) where: EQ = Equivalent Length of Discharge Line, including fittings, in feet
GPM = Discharge Rate, in Gallons Per Minute
D = Inside Diameter of Discharge Line, in inches
C = Hazen-Williams Coefficient

GPM	EQ	D	C	Hf	
5390	1585	28.21	130	1.4	PVC
5700	1585	30.81	130	1.0	DIP

CONDITION 1 PS 18 only Friction Head = 1.4 Feet PVC
1.0 Feet DIP

GPM	EQ	D	C	Hf	
6510	1585	28.21	130	2.0	PVC
6510	1585	30.81	130	1.3	DIP

CONDITION 1 PS 19 only Friction Head = 2.0 Feet PVC

1.3 Feet **DIP**

GPM	EQ	D	C	Hf	
11900	1585	28.21	130	6.2	PVC
11900	1585	30.81	130	4.0	DIP

CONDITION 2 PS 18 & PS 19 Combined Friction Head = **6.2 Feet** **PVC**
4.0 Feet **DIP**

THOMAS & HUTTON

HYDROLOGIC AND HYDRAULIC REPORT

Sullivan's Island Multi-Basin Stormwater Drainage Improvement
Phase 1

FEMA DR-4241-SC at

Sullivan's Island, SC

APPENDIX C

DRAINAGE COMPUTATION TABLE

J – 27091.0000

December 2021

thomasandhutton.com

Sullivan's Island Multi-Basin Stormwater Drainage Improvement
Drainage Computations
Rational Method used to generate Q
Darcy-Weisbach Method used to determine friction losses

THOMAS & HUTTON

By: CGB
Date: 12/07/21
Job No.: 27091
Design Storm: 10 Year
Sta 18 PS El: **3.50**
Sta 18.5 PS El: **3.50**
Revised:

DRAINAGE COMPUTATION TABLE

From	To	Area Incr. (ac)	Area Total (ac)	C	Time of Flow Inlet (min)	Time of Flow Pipe (min)	Tc (min)	I (in/hr)	Q (cfs)	Line Size (in)	Line Length (ft)	Reynold's Number	D-W f	Friction Loss (ft)	HGL Upper (ft)	HGL Lower (ft)	TOP
GI-4	GI-3	3.18	3.18	0.25	**10**	0.0	10	6.6	5.24	**24**	**62**	2.7E+05	0.024	0.03	3.59	3.56	5.50
GI-3	GI-2	1.91	5.09	0.25		0.6	11	6.5	8.25	**24**	**16**	4.3E+05	0.024	0.02	3.56	3.54	4.75
GI-2	GI-1	0.95	6.04	0.25		0.1	11	6.5	9.77	**36**	**153**	3.4E+05	0.022	0.03	3.54	3.50	5.00
GI-1	**Sta 18 PS**	0.46	6.50	0.25		1.8	13	6.2	10.05	**36**	**17**	3.5E+05	0.022	0.00	3.50	3.50	5.00
																	0.05
GI-21	GI-18	1.26	1.26	0.25	**10**	0.0	10	6.6	2.08	**18**	**29**	1.4E+05	0.027	0.01	3.58	3.57	5.50
GI-18	GI-15	0.54	1.80	0.25		0.4	10	6.5	2.93	**24**	**79**	1.5E+05	0.025	0.01	3.57	3.55	5.50
GI-15	GI-14	0.10	1.90	0.25		1.4	12	6.3	2.99	**24**	**30**	1.6E+05	0.025	0.01	3.55	3.55	5.70
GI-14	GI-13	0.24	2.14	0.25		0.5	12	6.2	3.33	**24**	**80**	1.7E+05	0.025	0.02	3.55	3.53	6.00
GI-13	GI-12	0.10	2.24	0.25		1.3	14	6.0	3.38	**24**	**59**	1.8E+05	0.025	0.01	3.53	3.52	5.93
GI-12	GI-11	0.08	2.32	0.25		0.9	15	5.9	3.43	**24**	**73**	1.8E+05	0.025	0.02	3.52	3.50	5.40
GI-11	GI-5	0.15	2.47	0.25		1.1	16	5.8	3.56	**36**	**42**	1.2E+05	0.023	0.00	3.50	3.50	5.30
GI-5	JB-24	0.18	2.65	0.25		1.4	17	5.6	3.70	**36**	**37**	1.3E+05	0.023	0.00	3.50	3.50	5.75
JB-24	**Sta 18.5 PS**	0.42	3.07	0.25		1.2	18	5.4	4.18	**36**	**13**	1.5E+05	0.023	0.00	3.50	3.50	5.50
GI-10	GI-9	0.32	0.32	0.25	**10**	0.0	10	6.6	0.53	**24**	**33**	2.8E+04	0.029	0.00	3.51	3.51	5.00
GI-9	GI-7	0.45	0.77	0.25		3.3	13	6.1	1.17	**24**	**98**	6.1E+04	0.026	0.00	3.51	3.50	5.00
GI-7	GI-6	0.36	1.13	0.25		4.4	18	5.5	1.56	**24**	**72**	8.1E+04	0.026	0.00	3.50	3.50	5.00
GI-6	GI-5	0.26	1.39	0.25		2.4	20	5.2	1.82	**36**	**72**	6.3E+04	0.024	0.00	3.50	3.50	5.00
GI-5	JB-24	0.18	1.57	0.25		4.7	25	4.8	1.88	**36**	**37**	6.5E+04	0.024	0.00	3.50	3.50	5.00
JB-24	**Sta 18.5 PS**	0.42	1.99	0.25		2.3	27	4.6	2.28	**36**	**13**	8.0E+04	0.024	0.00	3.50	3.50	5.00

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HYDROLOGIC AND HYDRAULIC REPORT

Sullivan's Island Multi-Basin Stormwater Drainage Improvement Phase 1

FEMA DR-4241-SC at

Sullivan's Island, SC

APPENDIX D

TECHNICAL MEMORANDUM

EVALUATION OF PUMP STATION 18 & 18.5

J – 27091.0000

December 2021

ESTD 1946
75H
THOMAS & HUTTON

682 JOHNNIE DODDS BOULEVARD, SUITE 100 | POST OFFICE BOX 1522
MT. PLEASANT, SC 29464 | 843.849.0200
THOMASANDHUTTON.COM

TECHNICAL MEMORANDUM

BY: **Robert Hickey, P.E., Mark Yodice, P.E.**

DATE: **August 25, 2021**

SUBJECT: **Evaluation of Pump Station 18 and 18.5 and other stormwater improvements for Sullivan's Island**

JOB NO.: **27091.0000**

Purpose

The purpose of this memorandum is to provide information related to an evaluation of proposed storm water Pump Stations at Station (Sta) 18 and Sta 18.5 located on Sullivan's Island, South Carolina. These proposed storm water pumping systems are needed to provide storm water drainage in an area lacking any outlet on Sullivan's Island to mitigate flooding during rainfall events. The specific goal is to look at conditions during the 100-year, 5-day storm event. The pumps are sized for the design event of the 10-year, 24-hour storm.

This evaluation includes the review of three scenarios; one in which the pump stations designed and operated as a duplex station and two in which the pump stations are designed and operated as a triplex station. Pumps used to model the duplex scenario were provided to Thomas and Hutton by Peter Carlson of Flygt on 7/13/2021 and 7/20/2021. The pumps used to model one triplex scenario were provided to Thomas and Hutton in a report by Romtec Utilities on 8/4/2021, while pumps used to model the second triplex scenario were selected by the engineer as an alternate during the model evaluation.

The hydrograph used in the stormwater model for the project was provided by Mark Yodice on 8/10/2021 and consists of historical rainfall data from Hurricane Joaquin which affected the Charleston metro area from October 1-5, 2015. This is to model a 100-yr, 5-day storm event to determine how the proposed pumps handle this larger event. Appendix A for information regarding the storm hydrograph. All pumps were designed for the base condition of the 10-year, 24-hour event.

Hydraulic Model Update

A hydraulic model was created using Bentley SewerCAD to evaluate pumping capacity of each of the proposed scenarios, as shown below. Please note that pump curves for each of the three scenarios are provided in Appendix C.

- Duplex station using pump curves provided by Flygt
- Triplex station using pump curves provided by Romtec Utilities
- Triplex station using duty points alternate

In each of the scenarios, the Hurricane Joaquin hydrograph (to simulate a 100-year, 5-day storm event) was used in conjunction with the rational method to create hourly stormwater inflow for each of the storm water basis. These flows were input at the modeled catch basins located upstream of the respective pump stations to evaluate flow through the system drainage pipes as well as pump station and manifolded force main network.

An extended period study was run for 120 hours, with increments of 0.1 hours to monitor modeled flow rate into the wet well, as well as pumping rates out of the wet well. Wet well profiles and elevations in the model were provided by Romtec and edited by Mark Yodice on 8/12/2021. The following is a summary of the results found by running the extended period survey.

Summary of Results

Duplex Station: For the proposed conditions of the pump station evaluation, neither Pump Station 18 nor 18.5 was overloaded during the 120-hour storm event. The pumps in each pump station were able to convey storm water out of the respective pump station at a rate equal to or faster than the inflow into the respective pump station. Thus, minimal flooding is expected under the duplex scenario. For most of the modeled storm event, the flow was conveyed by only the lead pump. **Table 1** below shows flows conveyed by the pump stations under two conditions: lead pump only and lead/lag pump running simultaneously. Also shown in the table are the rainfall intensities which result in the noted flow rate for the respective stormwater basins.

	Pump Station 18		Pump Station 18.5	
	Flow Rate (cfs)	Intensity (in/hr.)	Flow Rate (cfs)	Intensity (in/hr.)
Lead Pump On	15.84	2.04	20.2	1.68
Lag Pump On	18.16	2.34	26.7	2.23

Table 1: Flow Rates Under Duplex Conditions

Triplex Station with Romtec Pumps: For the proposed conditions of the pump station evaluation, both Pump Station 18 and 18.5 were overloaded during the 120-hour storm event. The pumps in each pump station were not able to convey storm water out of the respective pump station at an equal rate to the inflow into the respective pump station. Thus, nuisance flooding is expected under this triplex scenario under the 100-year, 5-day condition. See EX. 1 in Appendix B for estimated flooding extents during the modeled storm event. Assuming that flood water can be directed back to the pump station from all low points, the model indicates that flood waters could be drained and conveyed thru the pump station within approximately one to two hours after the peak of the storm event. This is based upon an hourly intensity of over 2 in/hr.

For most of the modeled storm event, the flow was conveyed by only the lead pump. **Table 2** below shows flows conveyed by the pump stations under conditions in which one pump, two pumps and three pumps are running. Also shown in the table are the rainfall intensities which result in the noted flow rate for the respective stormwater basins.

	Pump Station 18		Pump Station 18.5	
	Flow Rate (cfs)	Intensity (in/hr.)	Flow Rate (cfs)	Intensity (in/hr.)
Single Pump	10.44	1.35	10.98	0.92
Double Pump	11.26	1.45	16.32	1.36
Triple Pump	13.05	1.68	22.26	1.86

Table 2: Flow Rates Under Triplex Conditions with Romtec Provided Pumps

Triplex Station with Alternate Pumps: For the proposed conditions of the pump station evaluation, neither Pump Station 18 nor 18.5 was overloaded during the 120-hour storm event. The pumps in each pump station were able to convey storm water out of the respective pump station at a rate equal to or faster than the inflow into the respective pump station. Thus, flooding is not expected under this triplex scenario during the 100-year, 5-day event. For most of the modeled storm event, the flow was conveyed by only the lead pump. **Table 3** below shows flows conveyed by the pump stations under conditions in which one pump, two pumps and three pumps are running. Also shown in the table are the rainfall intensities which result in the noted flow rate for the respective stormwater basins.

	Pump Station 18		Pump Station 18.5	
	Flow Rate (cfs)	Intensity (in/hr.)	Flow Rate (cfs)	Intensity (in/hr.)
One Pump	11.21	1.44	11.71	0.98
Two Pumps	15.04	1.94	19	1.58
Three Pumps	16.05	2.07	24.56	2.05

Table 3: Flow Rates Under Triplex Conditions with alternate Selected Pumps

Discussion

The FEMA grant, which the Town of Sullivan's Island received, as written, requires the product to handle flood volumes and flow rates of the 10-year storm, 24-hour event as the design level of protection with "the intent of the proposed project is to provide a level of protection to the 100-year, 5-day precipitation event…". The amount of rain for each event is:

- 10-year 24-hour storm event (handle) 6.6 inches
- 100-year, 5-day prescription (provide protection against) 13.1 inches

To address these goals, three options for pump set up were reviewed. Attached is a simple comparison of the three options. The attached also comments to the force main sizes (velocities are a bit high during the peak of the storms). With the three-pump option using the smaller horsepower pumps and the increased force main sizes, the system would be able to handle 2.2 in/hr. (PS Sta 18) and 2.5 in/hr. (PS Sta 18.5). The peak intensity of the 100-year, 5-day storm event (which is basically the Joaquin Storm, Joaquin dropped 15.84 inches over 5 days so a bit more than the NOAA rain amount of 13.1 inches is 2.06 in/hr. Therefore, any nuisance flooding may not occur since the model uses an event with rainfall excessing the NOAA specified 100-year, 5-day storm for the local.

The Joaquin Storm graph is the guide for the 100-year, 5-day event and an estimate of the shallow ponding limits with the option of the smaller horsepower pumps follows. We estimate the ponding would last a bit less than an hour of course (based upon more rain than the 100-year, 5-day event) before the pumps draw the water down without the addition of a jockey pump.

Since the design storm is the 10-year, 24-hour event, the three-pump scenario Option 2 will handle the smaller intensity storms, like the 2-year event, better because of the varying flows from different storms. Scenario 2 offers a much smaller horsepower setup so the ongoing operating costs will be more affordable and a bit easier for operators to maintain. A smaller jockey pump to assist during the 100-year, 5-day event may be warranted but is not the base design. A jockey pump would also address the possible groundwater fluctuations getting into the system. Therefore, based upon these matters above, the 2nd scenario was selected by the Town.

Basically, any event over 2 in/hr. causes stormwater to start backing up (assuming all rainwater from the basin is being routed through the pump station, a.k.a. ignoring ground infiltration under any scenario).

Below are some of the quick results looking at the worst-case scenario when all pumps are running during the 100-year, 5-day event using pumps in Option 2.

Pipe	Size (inches)	Velocity (fps)	Flow Rate (cfs)	Intensity (in/hr.)
18	18	10.9	17.6	2.2
18.5	20	11.2	22.2	2.5
Combined	30	9.2	39.8	

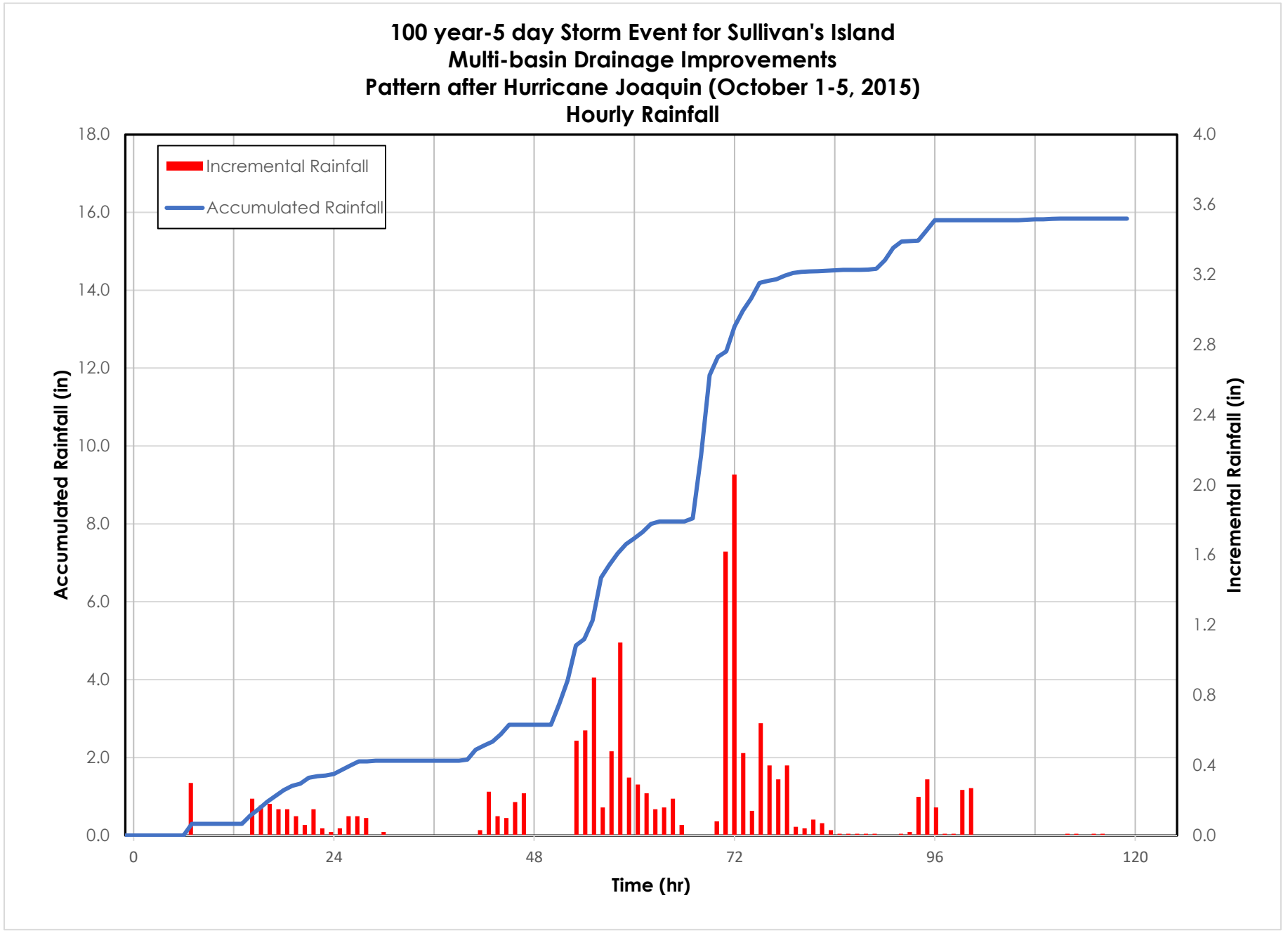
This scenario can serve the pump stations with the smaller (25 and 35 hp) pumps.

Keep in mind, these velocities are for the worst-case scenario, when all three pumps in both pump stations are running. Under "normal" circumstances when single pumps are running, the velocities will be more in the 3-6 fps range across the system.

For force main sizes less than the above fluid velocities are in the 10.1 to 15.1 fps range which is too high for this application.

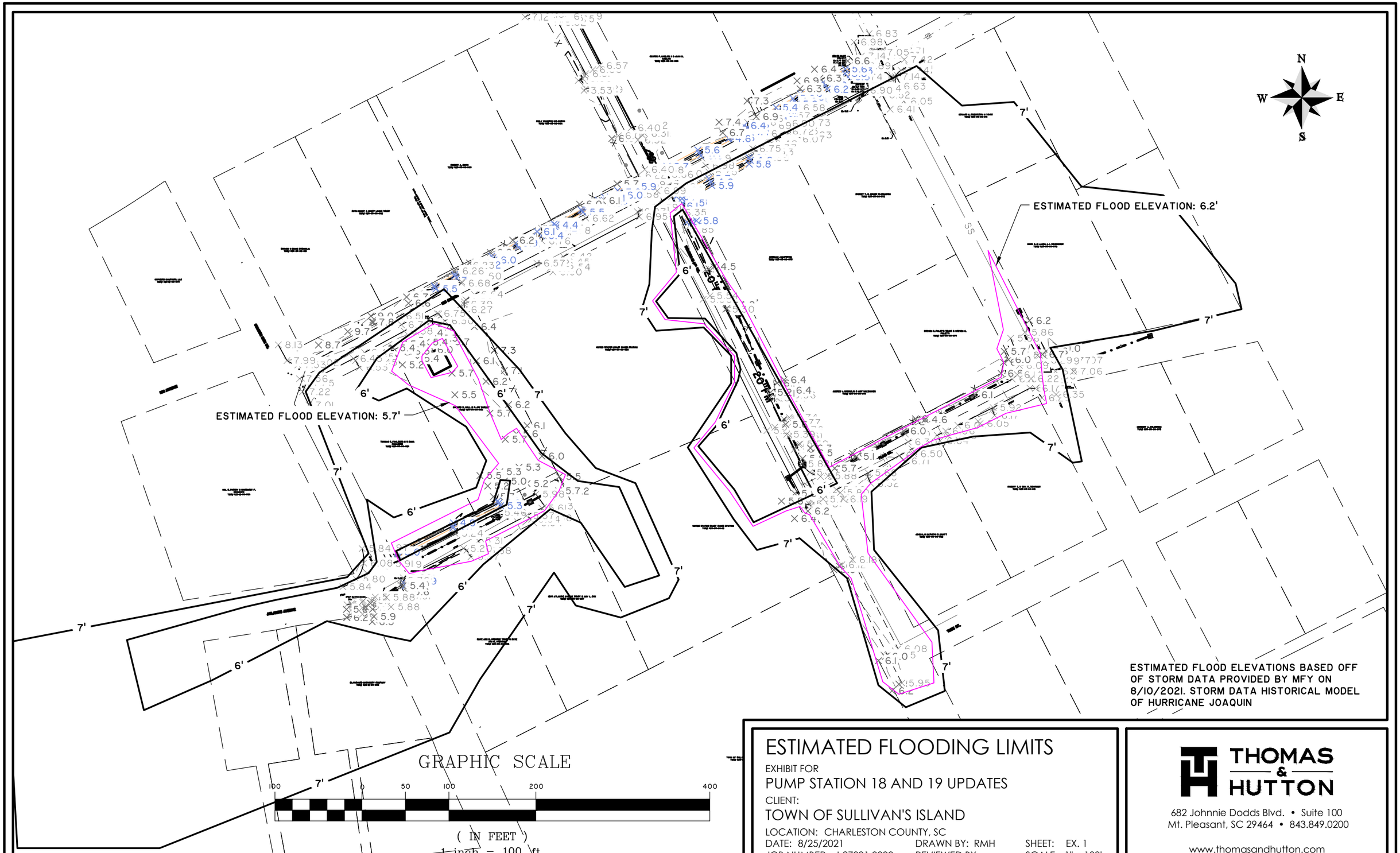
APPENDIX A

HYDROGRAPH – HURRICANE JOAQUIN


100 year-5 day Storm Event for Sullivan's Island
Multi-basin Drainage Improvements
Pattern after Hurricane Joaquin (October 1-5, 2015)
Hourly Rainfall
Incremental Rainfall
Accumulated Rainfall
Accumulated Rainfall (in)
Incremental Rainfall (in)
Time (hr)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
0.0
0.4
0.8
1.2
1.6
2.0
2.4
2.8
3.2
3.6
4.0
0
24
48
72
96
120

APPENDIX B

EXHIBITS



ESTIMATED FLOOD ELEVATIONS BASED OFF OF STORM DATA PROVIDED BY MFY ON 8/10/2021. STORM DATA HISTORICAL MODEL OF HURRICANE JOAQUIN

GRAPHIC SCALE

100 0 50 100 200 400

(IN FEET)

1 inch = 100 ft.

ESTIMATED FLOODING LIMITS

EXHIBIT FOR

PUMP STATION 18 AND 19 UPDATES

CLIENT:

TOWN OF SULLIVAN'S ISLAND

LOCATION: CHARLESTON COUNTY, SC

DATE: 8/25/2021 DRAWN BY: RMH SHEET: EX. 1

JOB NUMBER: J-27091.0000 REVIEWED BY: SCALE: 1" = 100'

THOMAS & HUTTON

682 Johnnie Dodds Blvd. • Suite 100
Mt. Pleasant, SC 29464 • 843.849.0200

www.thomasandhutton.com

APPENDIX C

PUMP CURVES

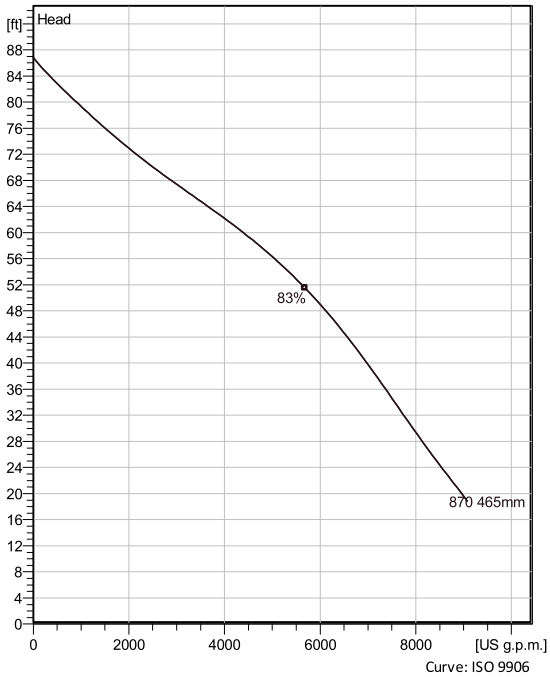
DUPLEX PUMP STATION

NP 3356/665 3~ 870

Patented self cleaning semi-open channel impeller, ideal for pumping in waste water applications. Modular based design with high adaptation grade.

Technical specification

Curves according to: Water, pure ,39.2 °F,62.42 lb/ft³,1.6891E-5 ft²/s



Curve: ISO 9906

Configuration

Motor number
N0665.000 35-45-8AA-W 100hp

Installation type
P - Semi permanent, Wet

Impeller diameter
465 mm

Discharge diameter
9/16 inch

Pump information

Impeller diameter
465 mm

Discharge diameter
9/16 inch

Inlet diameter
350 mm

Maximum operating speed
880 rpm

Number of blades
3

Max. fluid temperature
40 °C

Materials

Impeller
Hard-Iron ™

Project		**Created by**	PETER CARLSON
Block		**Created on**	7/13/2021 **Last update** 7/13/2021

NP 3356/665 3~ 870

Technical specification

Motor - General

Motor number N0665.000 35-45-8AA-W 100hp	**Phases** 3~	**Rated speed** 880 rpm	**Rated power** 100 hp
ATEX approved No	**Number of poles** 8	**Rated current** 128 A	**Stator variant** 1
Frequency 60 Hz	**Rated voltage** 460 V	**Insulation class** H	**Type of Duty**
Version code 000			

Motor - Technical

Power factor - 1/1 Load 0.80	**Motor efficiency - 1/1 Load** 91.0 %	**Total moment of inertia** 55.5 lb ft²	**Starts per hour max.** 0
Power factor - 3/4 Load 0.77	**Motor efficiency - 3/4 Load** 92.0 %	**Starting current, direct starting** 660 A	
Power factor - 1/2 Load 0.68	**Motor efficiency - 1/2 Load** 92.0 %	**Starting current, star-delta** 220 A	

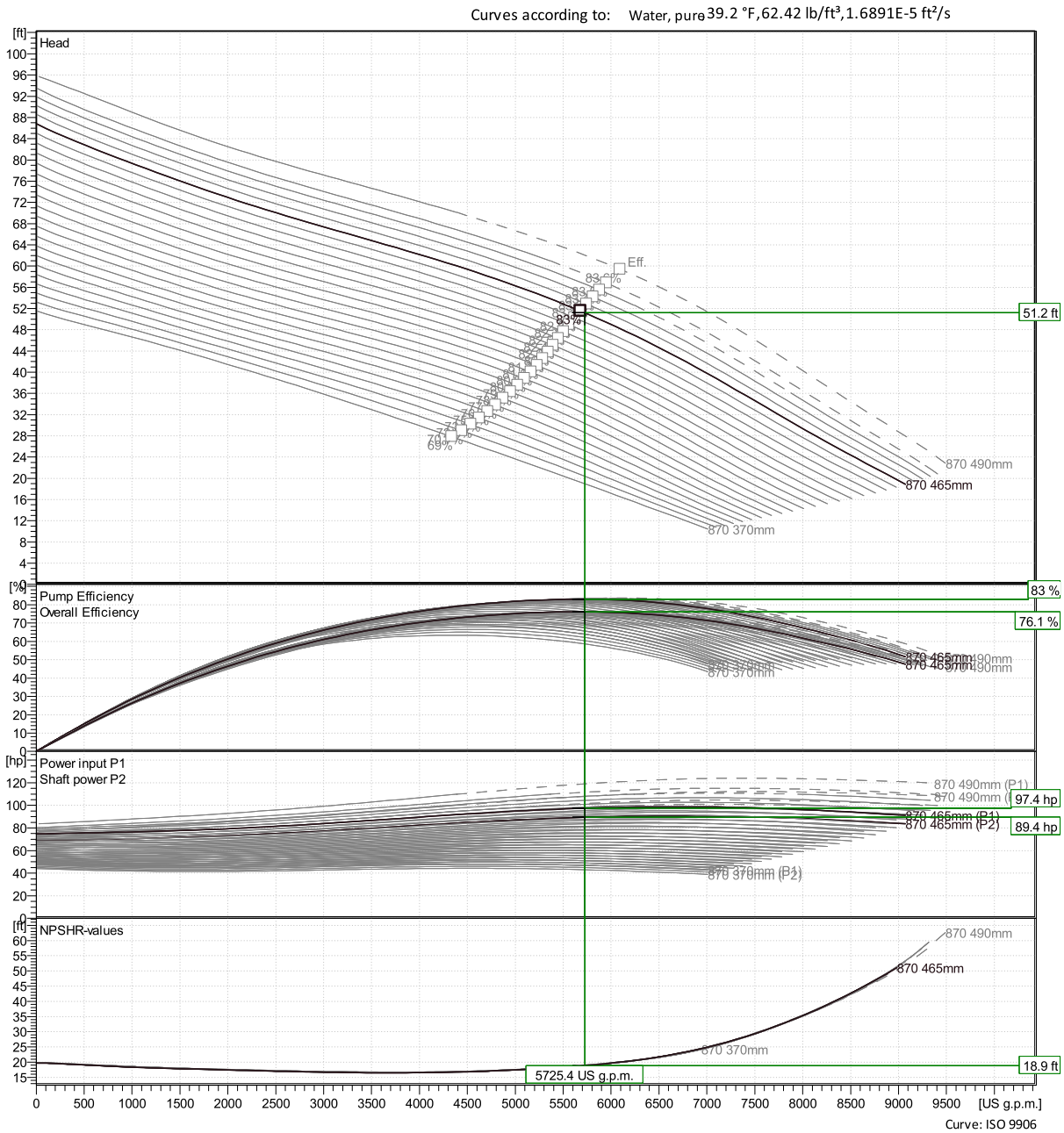
Project	**Created by**	PETER CARLSON	
Block	**Created on**	7/13/2021	**Last update** 7/13/2021

NP 3356/665 3~ 870

Performance curve

Duty point

Flow	Head
5730 US g.p.m.	51.2 ft

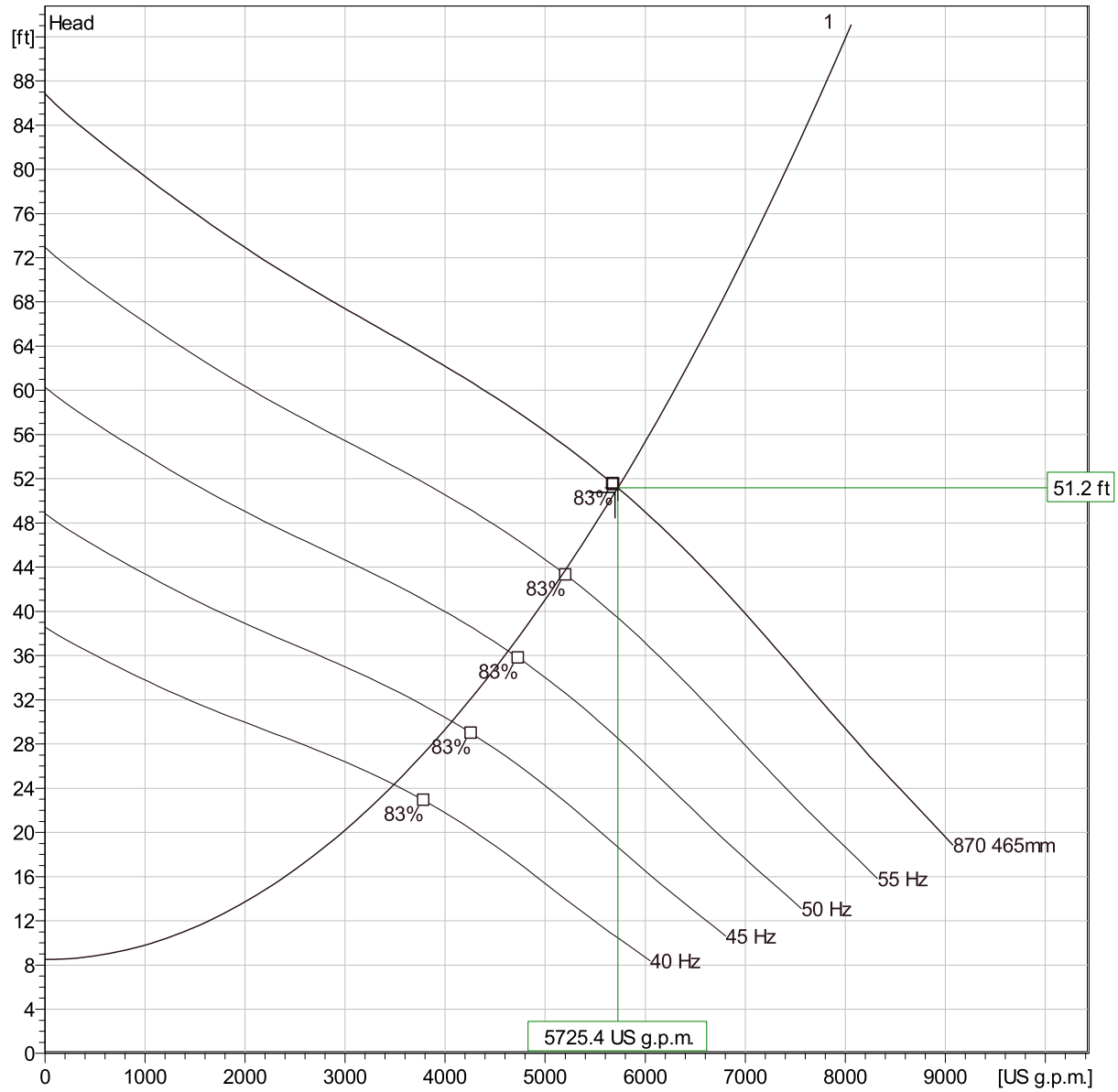


Project	**Created by**	PETER CARLSON	
Block	**Created on**	7/13/2021	**Last update** 7/13/2021

NP 3356/665 3~ 870

Duty Analysis

Curves according to: Water, pure ,39.2 °F,62.42 lb/ft³,1.6891E-5 ft²/s



Operating characteristics

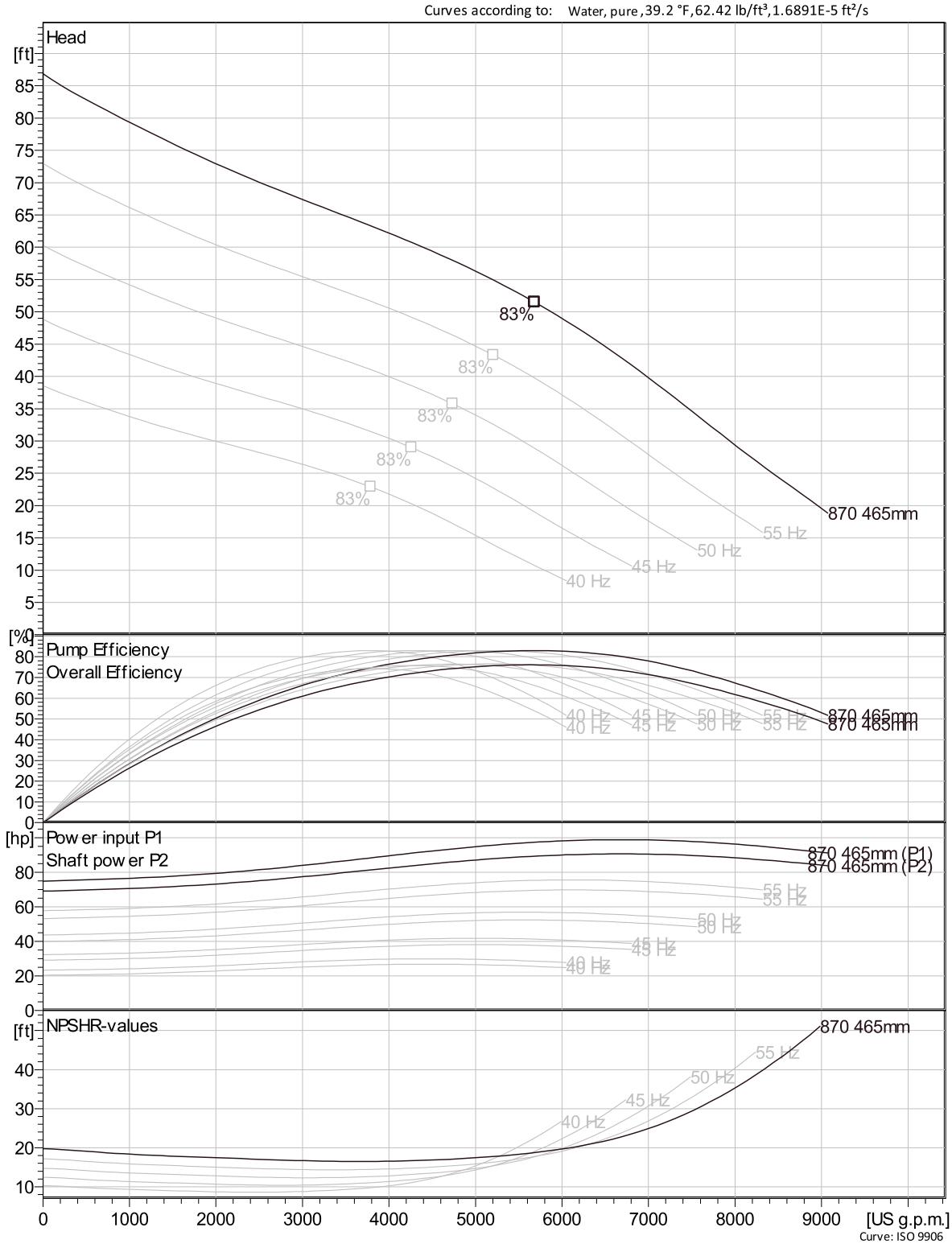
Pumps / Systems	Flow	Head	Shaft power	Flow	Head	Shaft power	Hydr.eff.	Specific Energy	NPSHre
1	5730 US g.p.m	51.2 ft	89.4 hp	5730 US g.p.m	51.2 ft	89.4 hp	83 %	212 kWh/US M	18.9 ft

Project		**Created by**	PETER CARLSON		
Block		**Created on**	7/13/2021	**Last update**	7/13/2021

NP 3356/665 3~ 870

VFD Curve

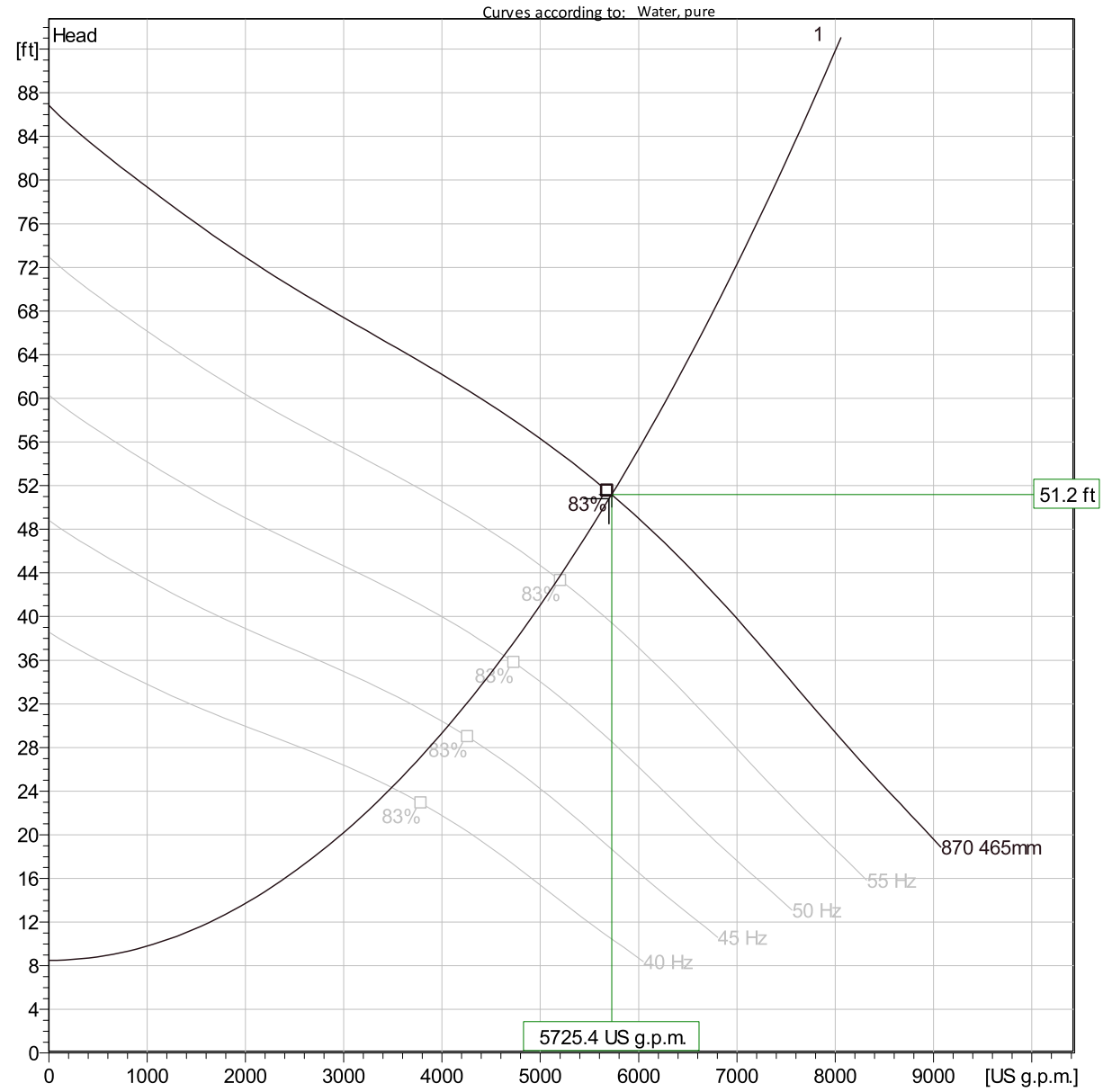
Curves according to: Water, pure ,39.2 °F,62.42 lb/ft³,1.6891E-5 ft²/s



Project	**Created by**	PETER CARLSON	
Block	**Created on**	7/13/2021	**Last update** 7/13/2021

NP 3356/665 3~ 870

VFD Analysis



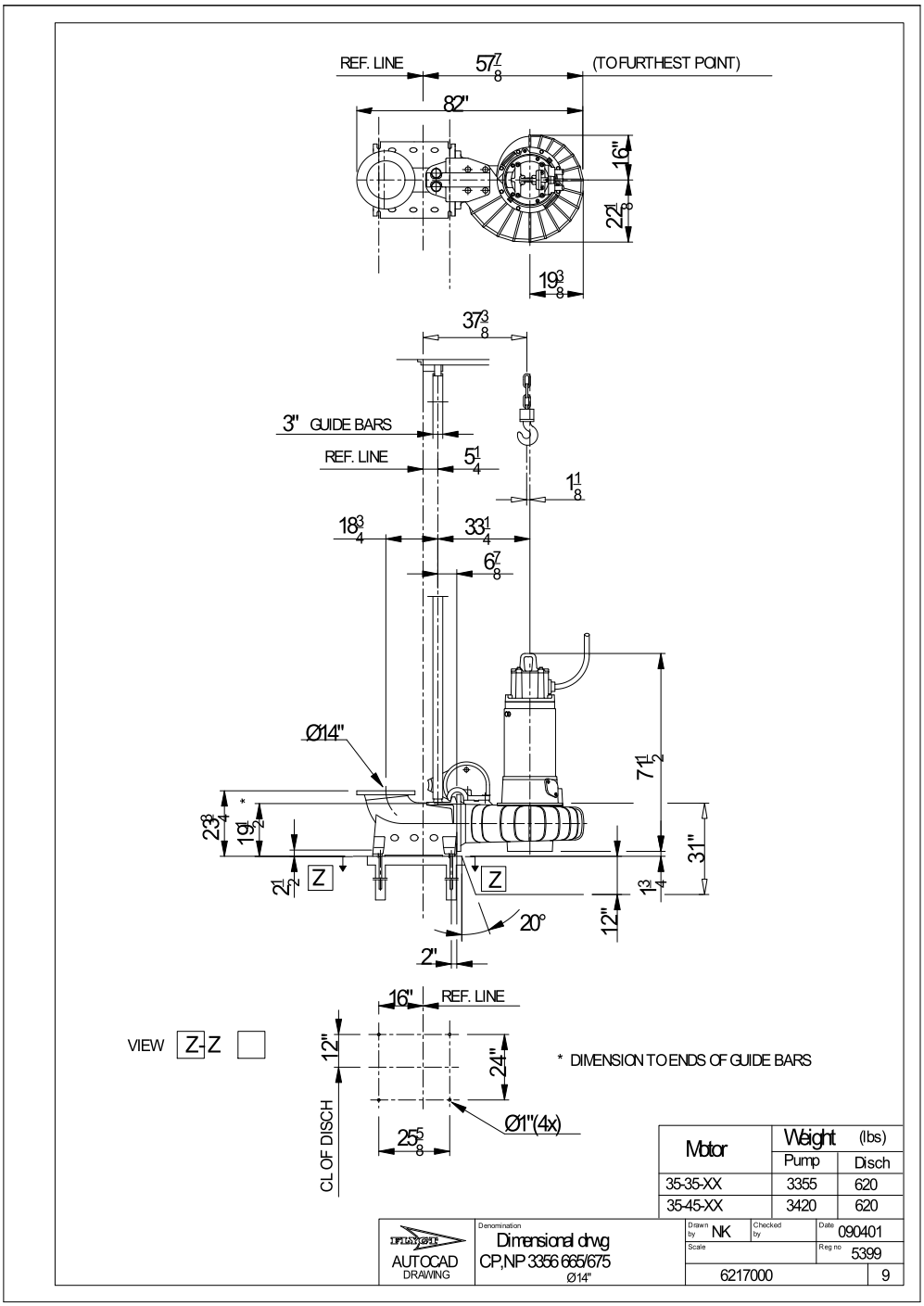
Operating characteristics

Pumps / Systems	Frequency	Flow	Head	Shaft power	Flow	Head	Shaft power	Hydr.eff.	Specific Energy	NPSHre
1	60 Hz	5730 US g.p.m	51.2 ft	89.4 hp	5730 US g.p.m	51.2 ft	89.4 hp	83 %	212 kWh/US M	18.9 ft
1	55 Hz	5210 US g.p.m	43.9 ft	69.7 hp	5210 US g.p.m	43.9 ft	69.7 hp	83 %	180 kWh/US M	16.4 ft
1	50 Hz	4660 US g.p.m	36.8 ft	52.2 hp	4660 US g.p.m	36.8 ft	52.2 hp	82.9 %	151 kWh/US M	13.9 ft
1	45 Hz	4090 US g.p.m	30.3 ft	37.9 hp	4090 US g.p.m	30.3 ft	37.9 hp	82.8 %	126 kWh/US M	11.6 ft
1	40 Hz	3510 US g.p.m	24.5 ft	26.4 hp	3510 US g.p.m	24.5 ft	26.4 hp	82.5 %	105 kWh/US M	9.39 ft

Project	**Created by**	PETER CARLSON	
Block	**Created on**	7/13/2021	**Last update** 7/13/2021

NP 3356/665 3~ 870

Dimensional drawing



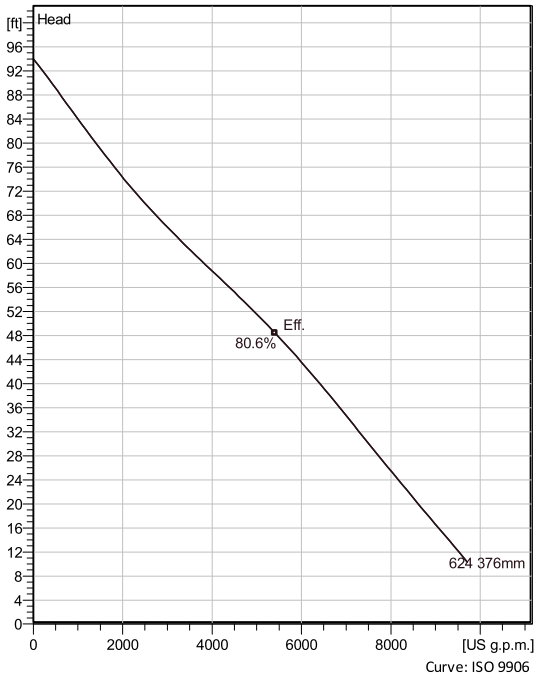
Project		**Created by**	PETER CARLSON
Block		**Created on**	7/13/2021 **Last update** 7/13/2021

NP 3301 LT 3~ 624

Patented self cleaning semi-open channel impeller, ideal for pumping in waste water applications. Modular based design with high adaptation grade.

Technical specification

Curves according to: Water, pure ,39.2 °F,62.42 lb/ft³,1.6891E-5 ft²/s



Curve: ISO 9906

Configuration

Motor number
N3301.185 35-29-6AA-W 85hp

Installation type
P - Semi permanent, Wet

Impeller diameter
376 mm

Discharge diameter
1/2 inch

Pump information

Impeller diameter
376 mm

Discharge diameter
1/2 inch

Inlet diameter
350 mm

Maximum operating speed
1185 rpm

Number of blades
2

Max. fluid temperature
40 °C

Materials

Impeller
Hard-Iron ™

Project		**Created by**	PETER CARLSON
Block		**Created on**	7/20/2021 **Last update** 7/20/2021

NP 3301 LT 3~ 624

Technical specification

Motor - General

Motor number N3301.185 35-29-6AA-W 85hp	**Phases** 3~	**Rated speed** 1185 rpm	**Rated power** 85 hp
ATEX approved No	**Number of poles** 6	**Rated current** 109 A	**Stator variant** 1
Frequency 60 Hz	**Rated voltage** 460 V	**Insulation class** H	**Type of Duty** S1
Version code 185			

Motor - Technical

Power factor - 1/1 Load 0.80	**Motor efficiency - 1/1 Load** 91.0 %	**Total moment of inertia** 28.7 lb ft²	**Starts per hour max.** 30
Power factor - 3/4 Load 0.75	**Motor efficiency - 3/4 Load** 91.5 %	**Starting current, direct starting** 685 A	
Power factor - 1/2 Load 0.64	**Motor efficiency - 1/2 Load** 90.5 %	**Starting current, star-delta** 228 A	

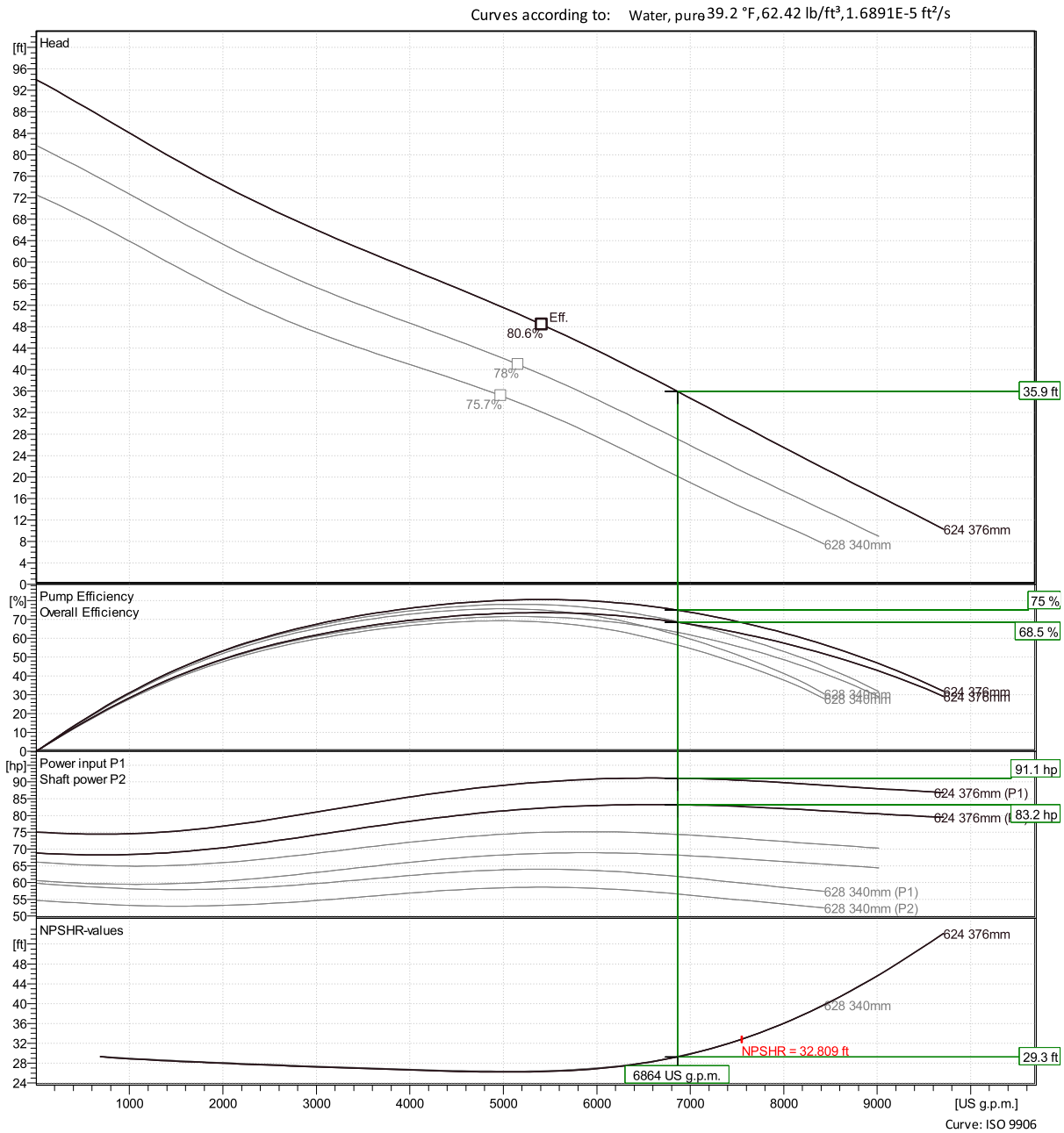
Project	**Created by**	PETER CARLSON	
Block	**Created on**	7/20/2021	**Last update** 7/20/2021

NP 3301 LT 3~ 624

Performance curve

Duty point

Flow	Head
6860 US g.p.m.	35.9 ft

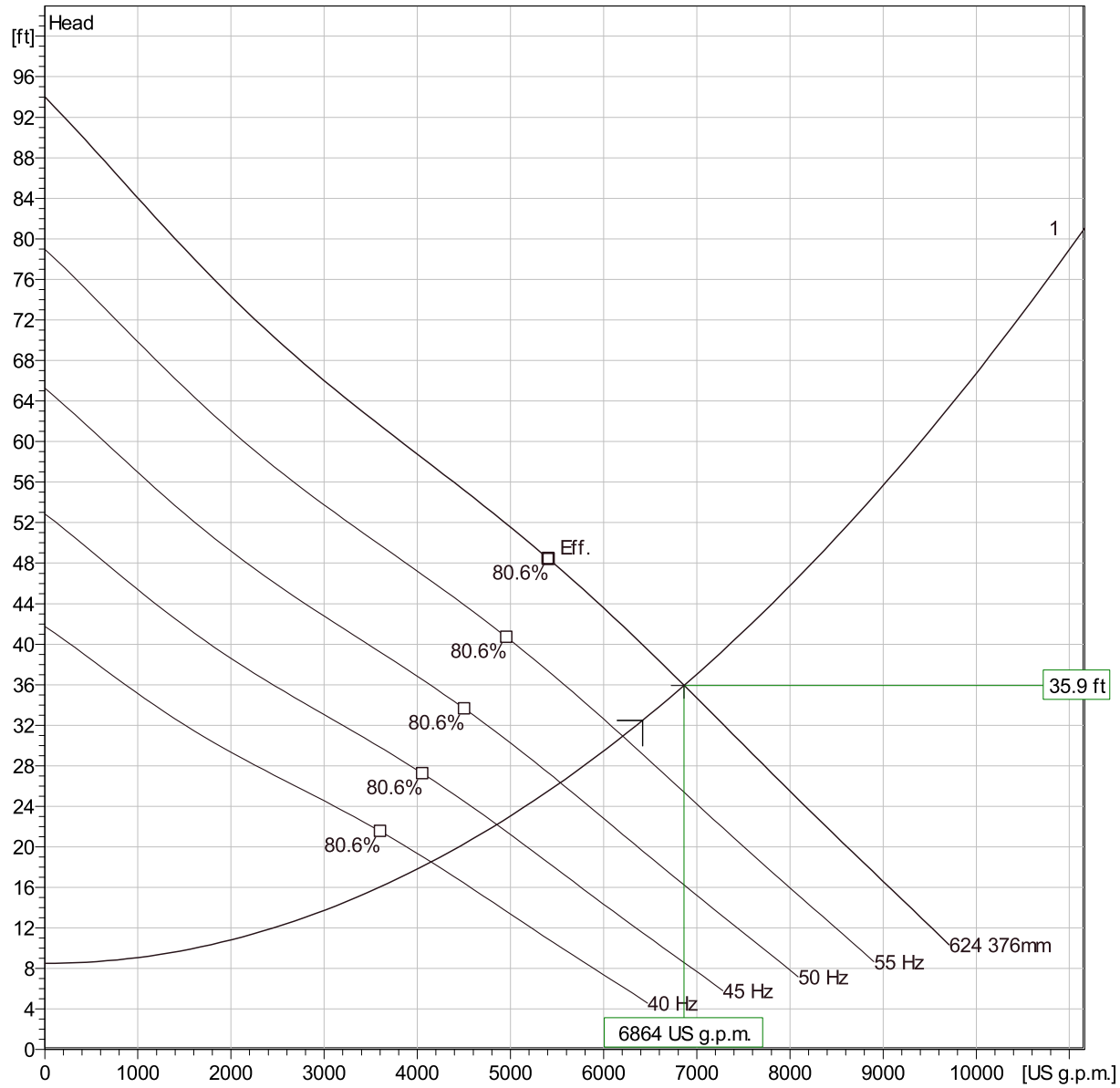


Project	**Created by**	PETER CARLSON	
Block	**Created on**	7/20/2021	**Last update** 7/20/2021

NP 3301 LT 3~ 624

Duty Analysis

Curves according to: Water, pure ,39.2 °F,62.42 lb/ft³,1.6891E-5 ft²/s



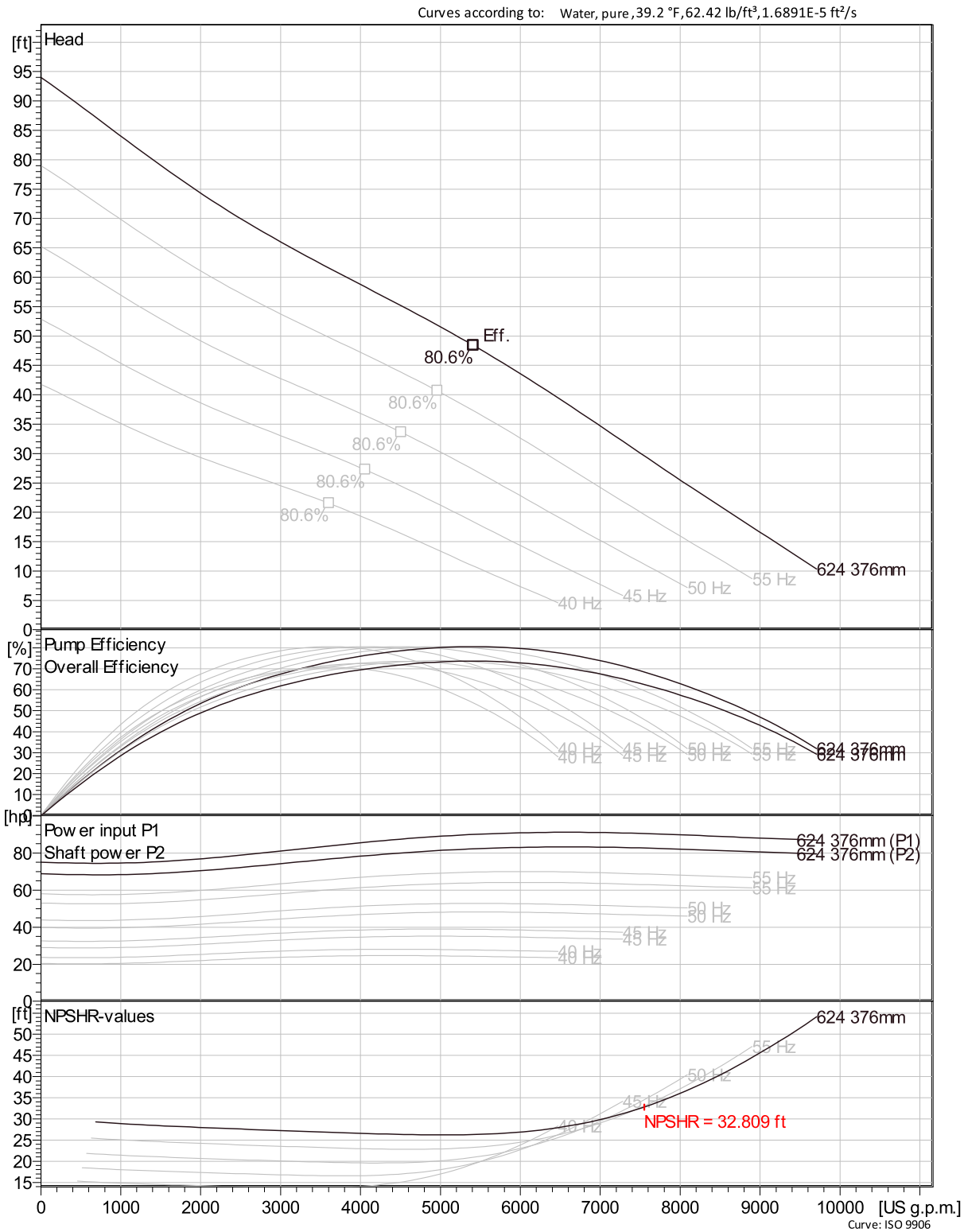
Operating characteristics

Pumps / Systems	Flow	Head	Shaft power	Flow	Head	Shaft power	Hydr.eff.	Specific Energy	NPSHre
1	6860 US g.p.m	35.9 ft	83.2 hp	6860 US g.p.m	35.9 ft	83.2 hp	75 %	165 kWh/US M	29.3 ft

Project		**Created by**	PETER CARLSON		
Block		**Created on**	7/20/2021	**Last update**	7/20/2021

NP 3301 LT 3~ 624

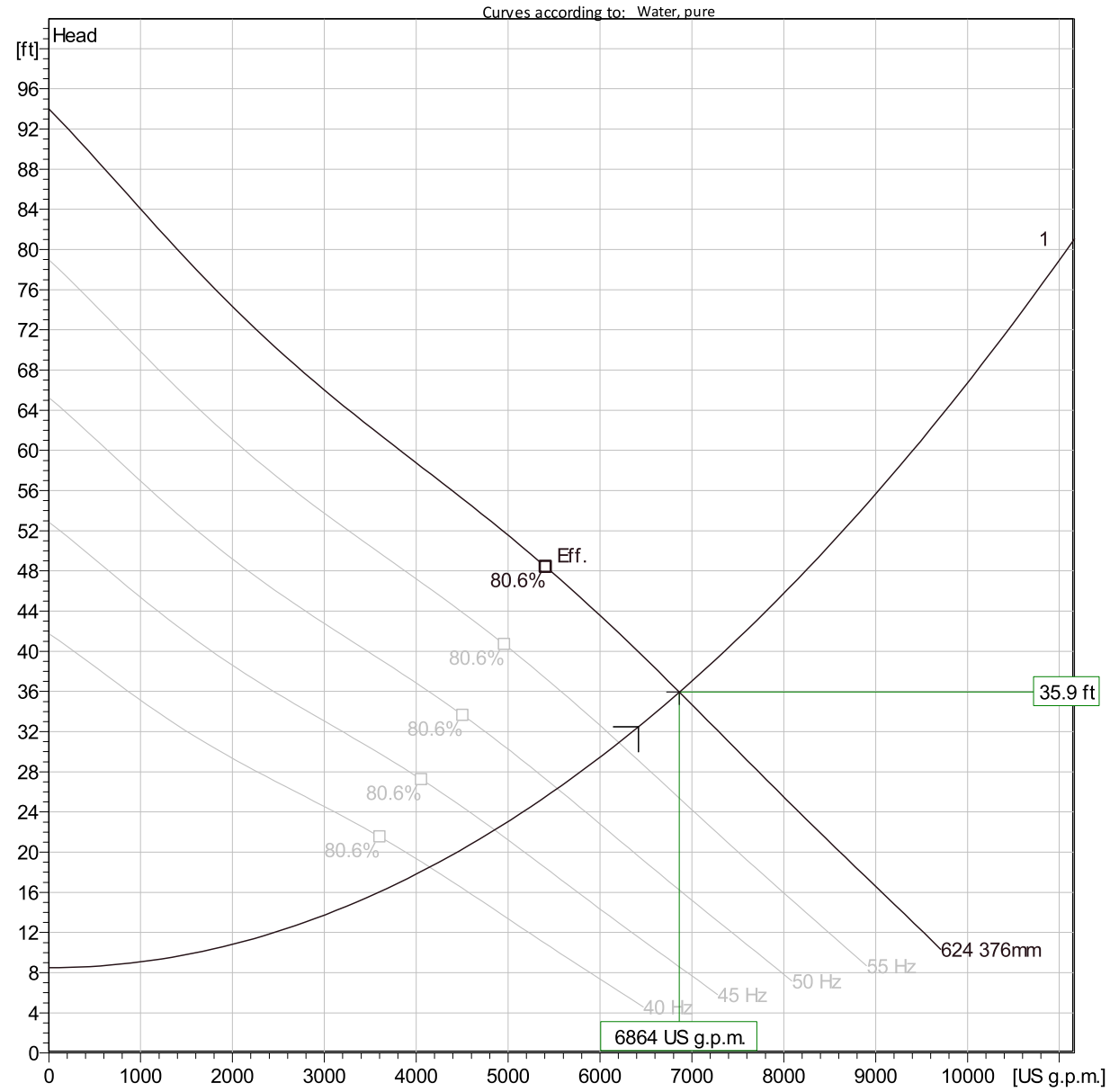
VFD Curve



Project	**Created by**	PETER CARLSON	
Block	**Created on**	7/20/2021	**Last update** 7/20/2021

NP 3301 LT 3~ 624

VFD Analysis



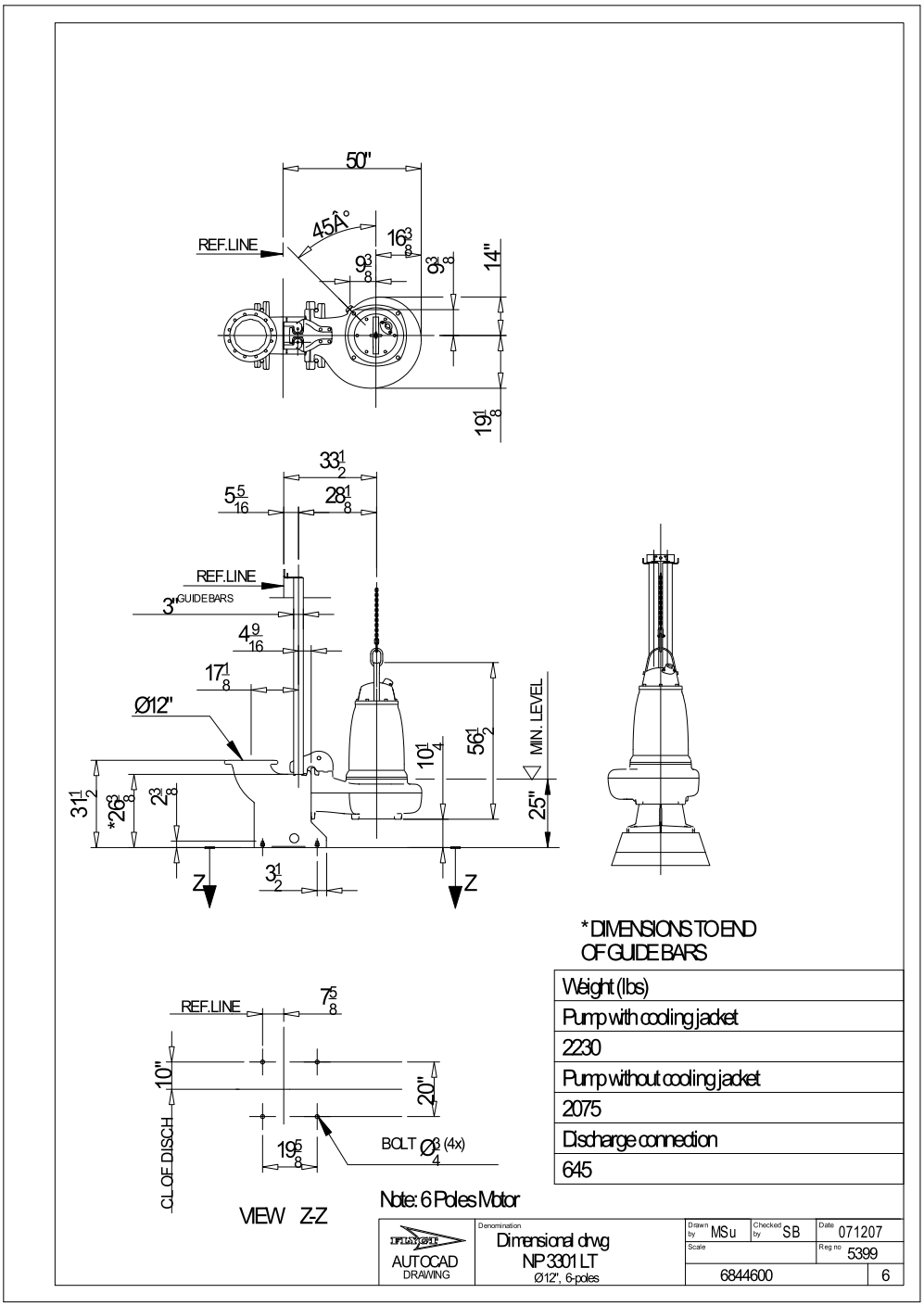
Operating characteristics

Pumps / Systems	Frequency	Flow	Head	Shaft power	Flow	Head	Shaft power	Hydr.eff.	Specific Energy	NPSHre
1	60 Hz	6860 US g.p.m	35.9 ft	83.2 hp	6860 US g.p.m	35.9 ft	83.2 hp	75 %	165 kWh/US M	29.3 ft
1	55 Hz	6210 US g.p.m	30.9 ft	64.1 hp	6210 US g.p.m	30.9 ft	64.1 hp	75.7 %	140 kWh/US M	25.1 ft
1	50 Hz	5540 US g.p.m	26.3 ft	48.2 hp	5540 US g.p.m	26.3 ft	48.2 hp	76.6 %	119 kWh/US M	21.3 ft
1	45 Hz	4850 US g.p.m	22.2 ft	35.1 hp	4850 US g.p.m	22.2 ft	35.1 hp	77.6 %	99.8 kWh/US M	17.6 ft
1	40 Hz	4150 US g.p.m	18.5 ft	24.6 hp	4150 US g.p.m	18.5 ft	24.6 hp	78.9 %	84.1 kWh/US M	14.3 ft

Project	**Created by**	PETER CARLSON	
Block	**Created on**	7/20/2021	**Last update** 7/20/2021

NP 3301 LT 3~ 624

Dimensional drawing



Project		**Created by**	PETER CARLSON
Block		**Created on**	7/20/2021 **Last update** 7/20/2021

TRIPLEX PUMP STATION

ROMTEC SELECTION

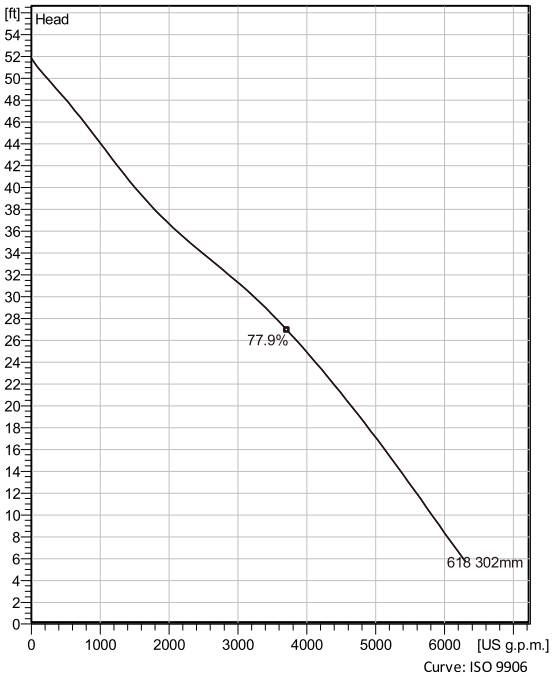
PUMP STATION 18

NP 3202 LT 3~ 618

Patented self cleaning semi-open channel impeller, ideal for pumping in waste water applications. Modular based design with high adaptation grade.

Technical specification

Curves according to: Water, pure ,39.2 °F,62.42 lb/ft³,1.6891E-5 ft²/s



Curve: ISO 9906

Configuration

Motor number
N3202.185 30-18-6AA-W 35hp

Installation type
P - Semi permanent, Wet

Impeller diameter
302 mm

Discharge diameter
1/2 inch

Pump information

Impeller diameter
302 mm

Discharge diameter
1/2 inch

Inlet diameter
300 mm

Maximum operating speed
1165 rpm

Number of blades
2

Max. fluid temperature
40 °C

Materials

Impeller
Hard-Iron ™

Project		**Created by**	Ryan Palmer
Block		**Created on**	7/29/2021 **Last update** 7/29/2021

NP 3202 LT 3~ 618

Technical specification

Motor - General

Motor number N3202.185 30-18-6AA-W 35hp	**Phases** 3~	**Rated speed** 1165 rpm	**Rated power** 35 hp
ATEX approved No	**Number of poles** 6	**Rated current** 42 A	**Stator variant** 4
Frequency 60 Hz	**Rated voltage** 460 V	**Insulation class** H	**Type of Duty** S1
Version code 185			

Motor - Technical

Power factor - 1/1 Load 0.88	**Motor efficiency - 1/1 Load** 89.0 %	**Total moment of inertia** 10.8 lb ft²	**Starts per hour max.** 30
Power factor - 3/4 Load 0.85	**Motor efficiency - 3/4 Load** 90.0 %	**Starting current, direct starting** 225 A	
Power factor - 1/2 Load 0.79	**Motor efficiency - 1/2 Load** 90.5 %	**Starting current, star-delta** 75 A	

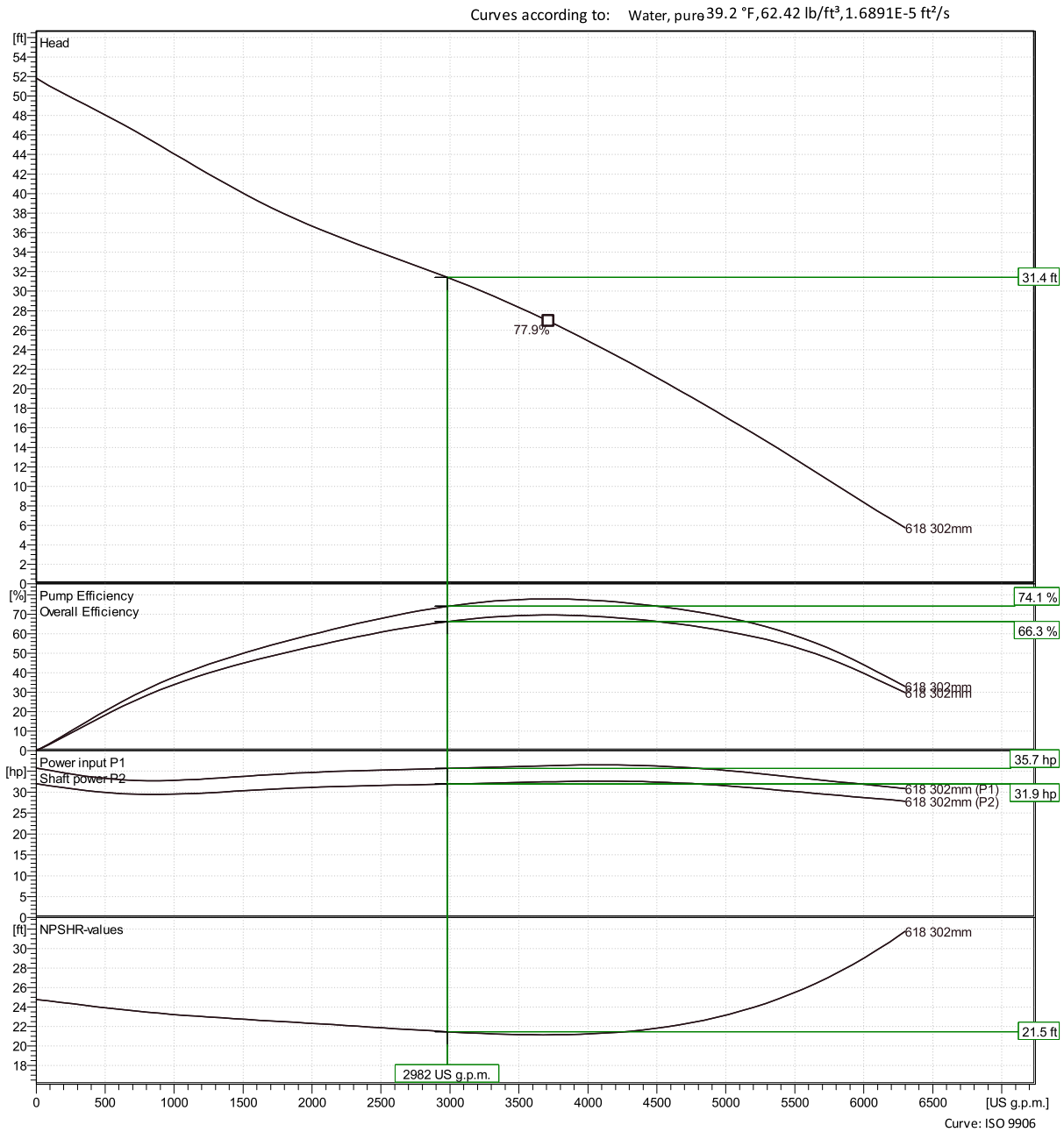
Project	**Created by**	Ryan Palmer	
Block	**Created on**	7/29/2021	**Last update** 7/29/2021

NP 3202 LT 3~ 618

Performance curve

Duty point

Flow	Head
2980 US g.p.m.	31.4 ft



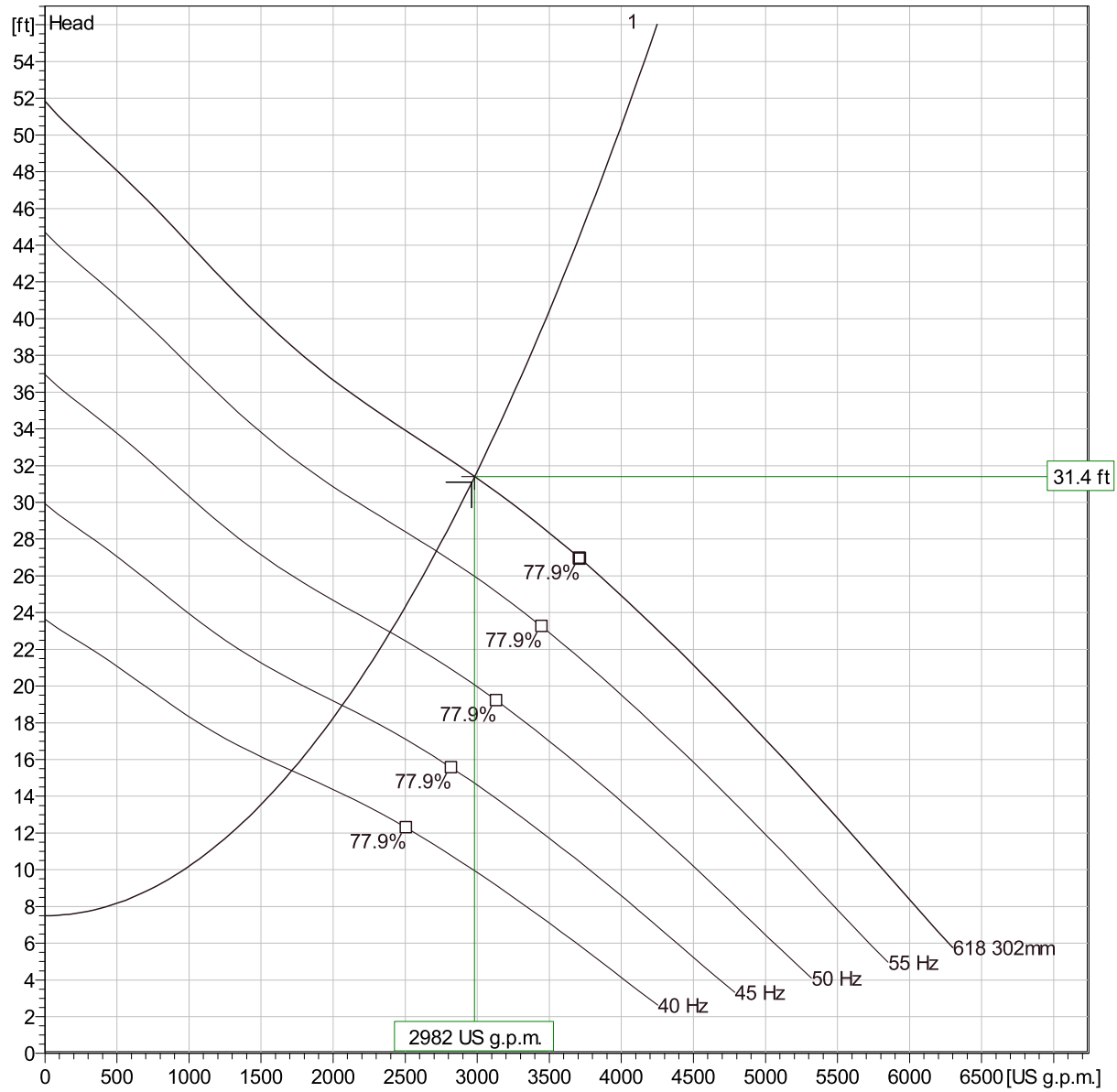
Curve: ISO 9906

Project		**Created by**	Ryan Palmer		
Block		**Created on**	7/29/2021	**Last update**	7/29/2021

NP 3202 LT 3~ 618

Duty Analysis

Curves according to: Water, pure ,39.2 °F,62.42 lb/ft³,1.6891E-5 ft²/s



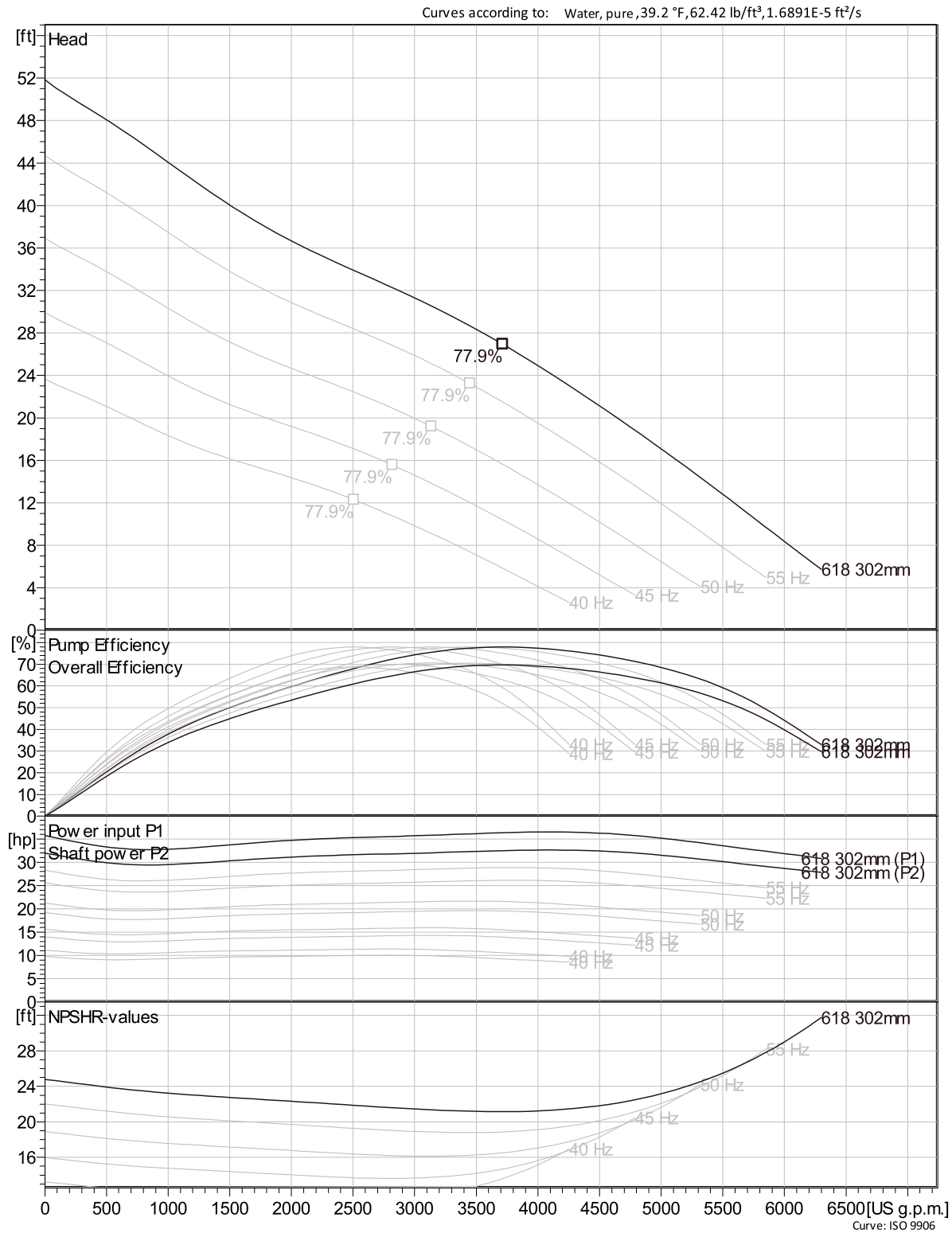
Operating characteristics

Pumps / Systems	Flow	Head	Shaft power	Flow	Head	Shaft power	Hydr.eff.	Specific Energy	NPSHre
1	2980 US g.p.m	31.4 ft	31.9 hp	2980 US g.p.m	31.4 ft	31.9 hp	74.1 %	149 kWh/US M	21.5 ft

Project		**Created by**	Ryan Palmer		
Block		**Created on**	7/29/2021	**Last update**	7/29/2021

NP 3202 LT 3~ 618

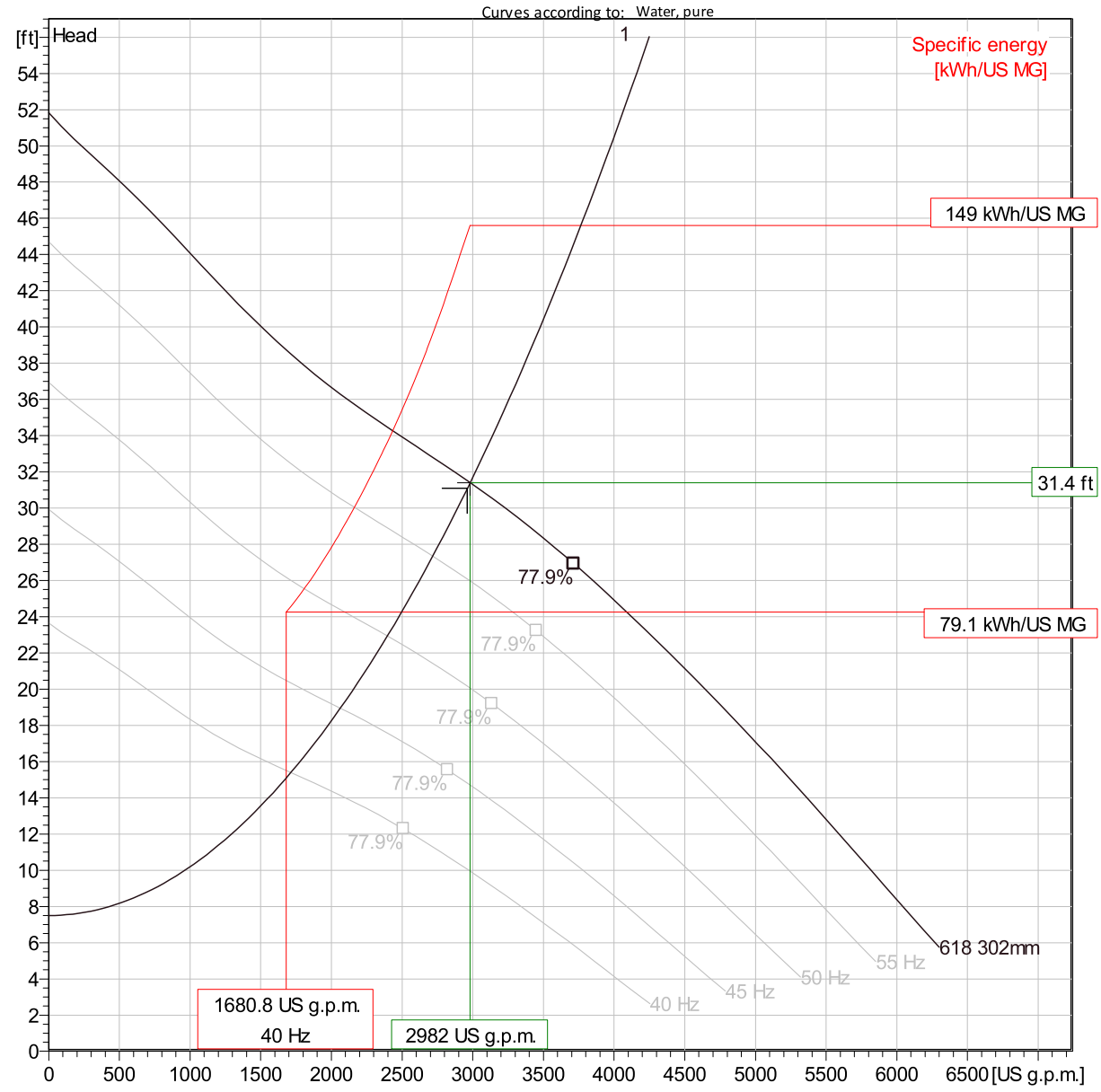
VFD Curve



Project		**Created by**	Ryan Palmer		
Block		**Created on**	7/29/2021	**Last update**	7/29/2021

NP 3202 LT 3~ 618

VFD Analysis



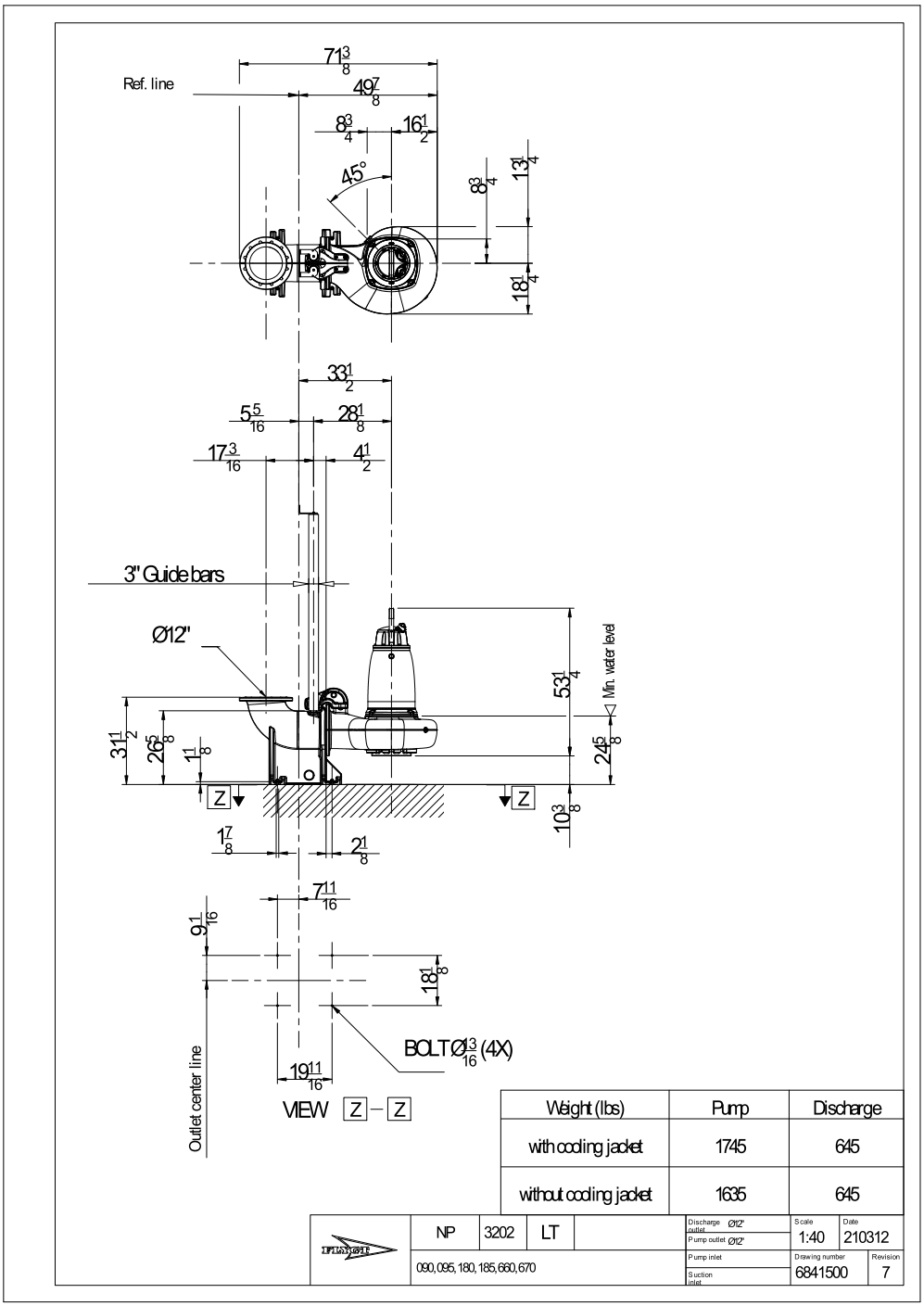
Operating characteristics

Pumps / Systems	Frequency	Flow	Head	Shaft power	Flow	Head	Shaft power	Hydr.eff.	Specific Energy	NPSHre
1	60 Hz	2980 US g.p.m	31.4 ft	31.9 hp	2980 US g.p.m	31.4 ft	31.9 hp	74.1 %	149 kWh/US M	21.5 ft
1	55 Hz	2680 US g.p.m	26.8 ft	24.7 hp	2680 US g.p.m	26.8 ft	24.7 hp	73.4 %	127 kWh/US M	18.8 ft
1	50 Hz	2360 US g.p.m	22.5 ft	18.5 hp	2360 US g.p.m	22.5 ft	18.5 hp	72.4 %	108 kWh/US M	16.2 ft
1	45 Hz	2030 US g.p.m	18.6 ft	13.5 hp	2030 US g.p.m	18.6 ft	13.5 hp	70.8 %	92 kWh/US M	13.7 ft
1	40 Hz	1680 US g.p.m	15.1 ft	9.42 hp	1680 US g.p.m	15.1 ft	9.42 hp	68.2 %	79.1 kWh/US M	11.5 ft

Project	**Created by**	Ryan Palmer	
Block	**Created on**	7/29/2021	**Last update** 7/29/2021

NP 3202 LT 3~ 618

Dimensional drawing



Weight (lbs)	Pump	Discharge
with cooling jacket	1745	645
without cooling jacket	1635	645

NP	3202	LT		Discharge outlet Ø12"	Scale 1:40	Date 210312
090, 095, 180, 185, 660, 670				Pump outlet Ø12"		
				Pump inlet	Drawing number 6841500	Revision 7
				Suction inlet		

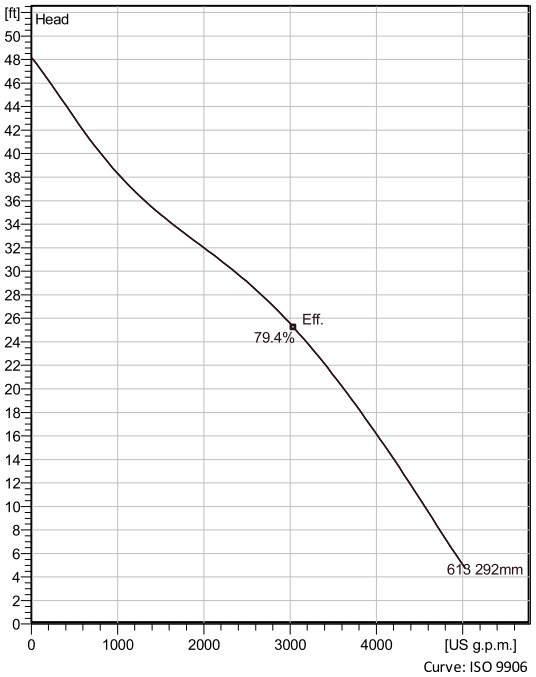
Project		**Created by**	Ryan Palmer
Block		**Created on**	7/29/2021 **Last update** 7/29/2021

PUMP STATION 19
NP 3171 LT 3~ 613

Patented self cleaning semi-open channel impeller, ideal for pumping in waste water applications. Modular based design with high adaptation grade.

Technical specification

Curves according to: Water, pure ,39.2 °F,62.42 lb/ft³,1.6891E-5 ft²/s



Curve: ISO 9906

Configuration

Motor number
N3171.185 25-18-6BB-W 25hp

Installation type
P - Semi permanent, Wet

Impeller diameter
292 mm

Discharge diameter
3/8 inch

Pump information

Impeller diameter
292 mm

Discharge diameter
3/8 inch

Inlet diameter
250 mm

Maximum operating speed
1160 rpm

Number of blades
2

Max. fluid temperature
40 °C

Materials

Impeller
Hard-Iron ™

Project		**Created by**	Ryan Palmer
Block		**Created on**	7/29/2021 **Last update** 7/29/2021

NP 3171 LT 3~ 613

Technical specification

Motor - General

Motor number N3171.185 25-18-6BB-W 25hp	**Phases** 3~	**Rated speed** 1160 rpm	**Rated power** 25 hp
ATEX approved No	**Number of poles** 6	**Rated current** 32 A	**Stator variant** 7
Frequency 60 Hz	**Rated voltage** 460 V	**Insulation class** H	**Type of Duty** S1
Version code 185			

Motor - Technical

Power factor - 1/1 Load 0.85	**Motor efficiency - 1/1 Load** 86.0 %	**Total moment of inertia** 6.34 lb ft²	**Starts per hour max.** 30
Power factor - 3/4 Load 0.80	**Motor efficiency - 3/4 Load** 87.5 %	**Starting current, direct starting** 177 A	
Power factor - 1/2 Load 0.70	**Motor efficiency - 1/2 Load** 87.5 %	**Starting current, star-delta** 59 A	

Project	**Created by**	Ryan Palmer	
Block	**Created on**	7/29/2021	**Last update** 7/29/2021

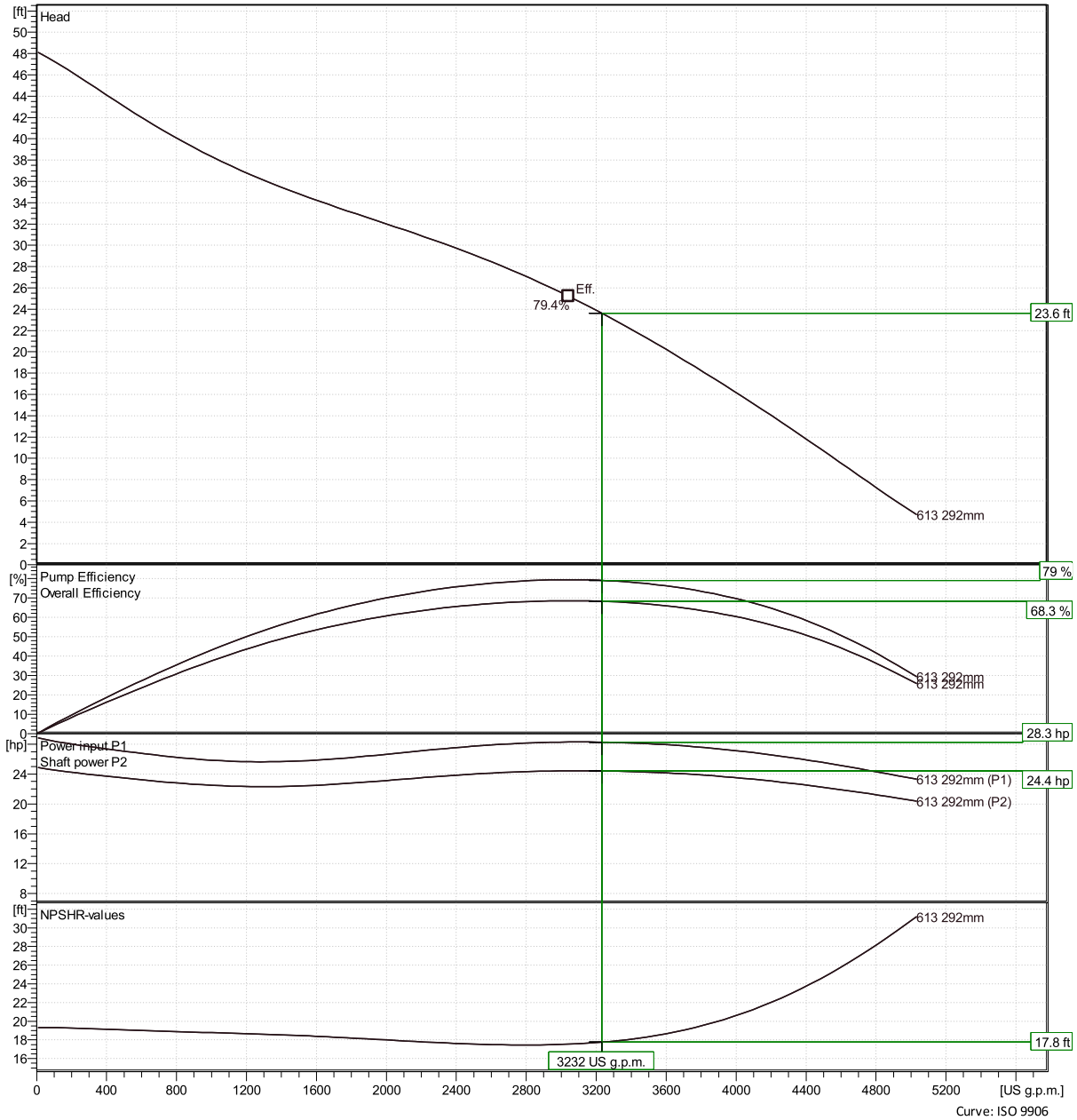
NP 3171 LT 3~ 613

Performance curve

Duty point

Flow	Head
3230 US g.p.m.	23.6 ft

Curves according to: Water, pure 39.2 °F, 62.42 lb/ft³, 1.6891E-5 ft²/s



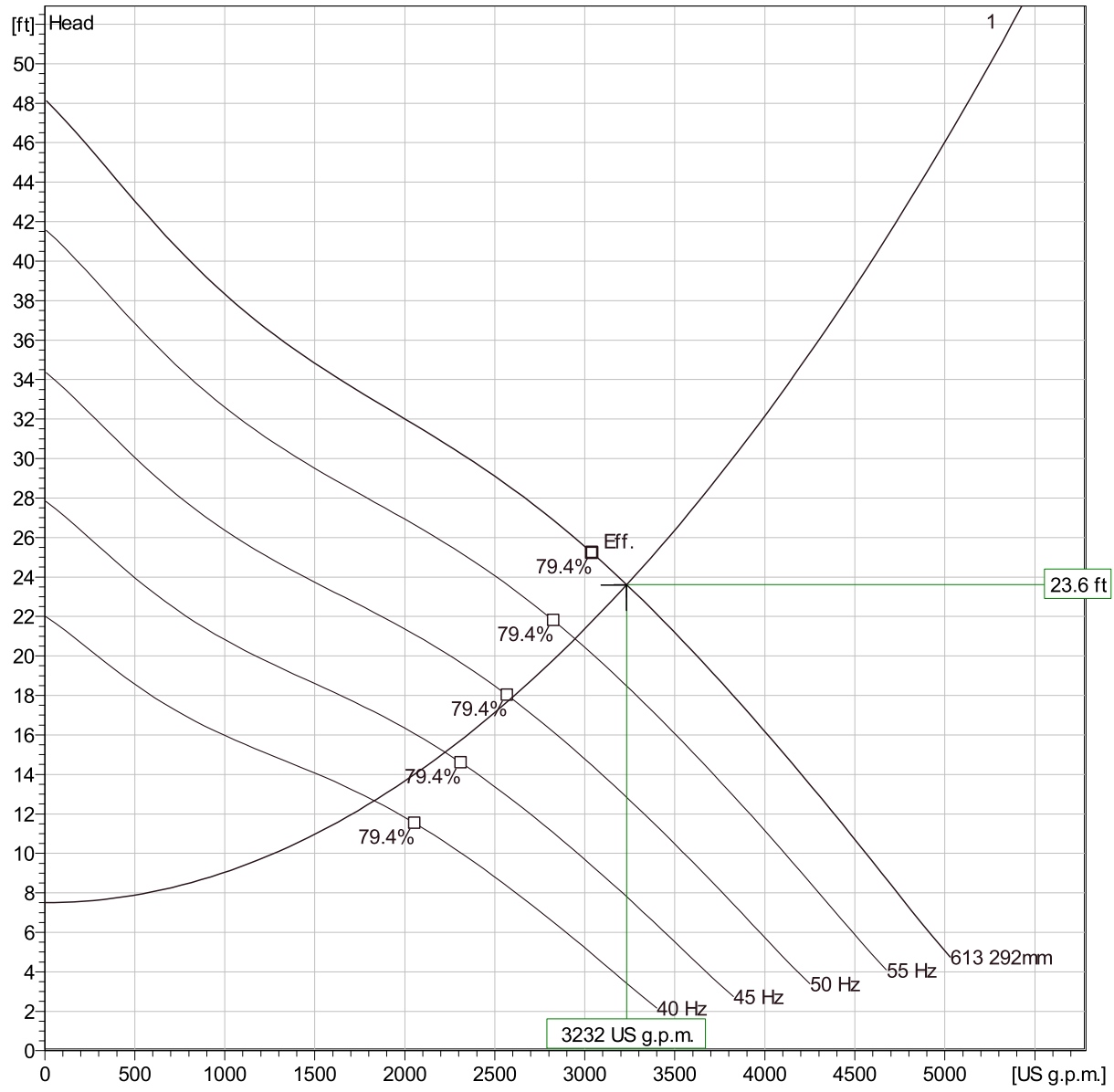
Curve: ISO 9906

Project		**Created by**	Ryan Palmer		
Block		**Created on**	7/29/2021	**Last update**	7/29/2021

NP 3171 LT 3~ 613

Duty Analysis

Curves according to: Water, pure ,39.2 °F,62.42 lb/ft³,1.6891E-5 ft²/s



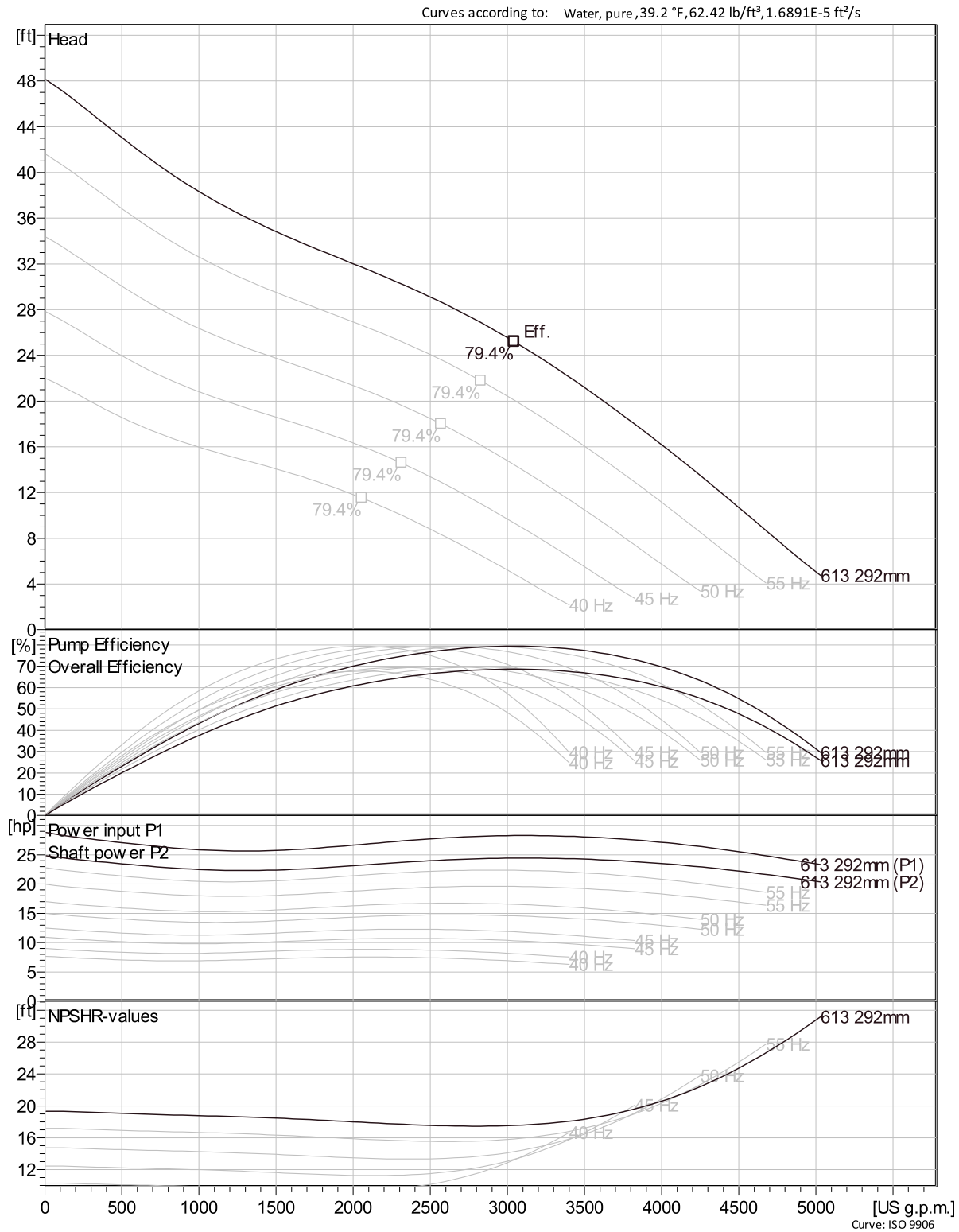
Operating characteristics

Pumps / Systems	Flow	Head	Shaft power	Flow	Head	Shaft power	Hydr.eff.	Specific Energy	NPSHre
1	3230 US g.p.m	23.6 ft	24.4 hp	3230 US g.p.m	23.6 ft	24.4 hp	79 %	109 kWh/US M	17.8 ft

Project		**Created by**	Ryan Palmer		
Block		**Created on**	7/29/2021	**Last update**	7/29/2021

NP 3171 LT 3~ 613

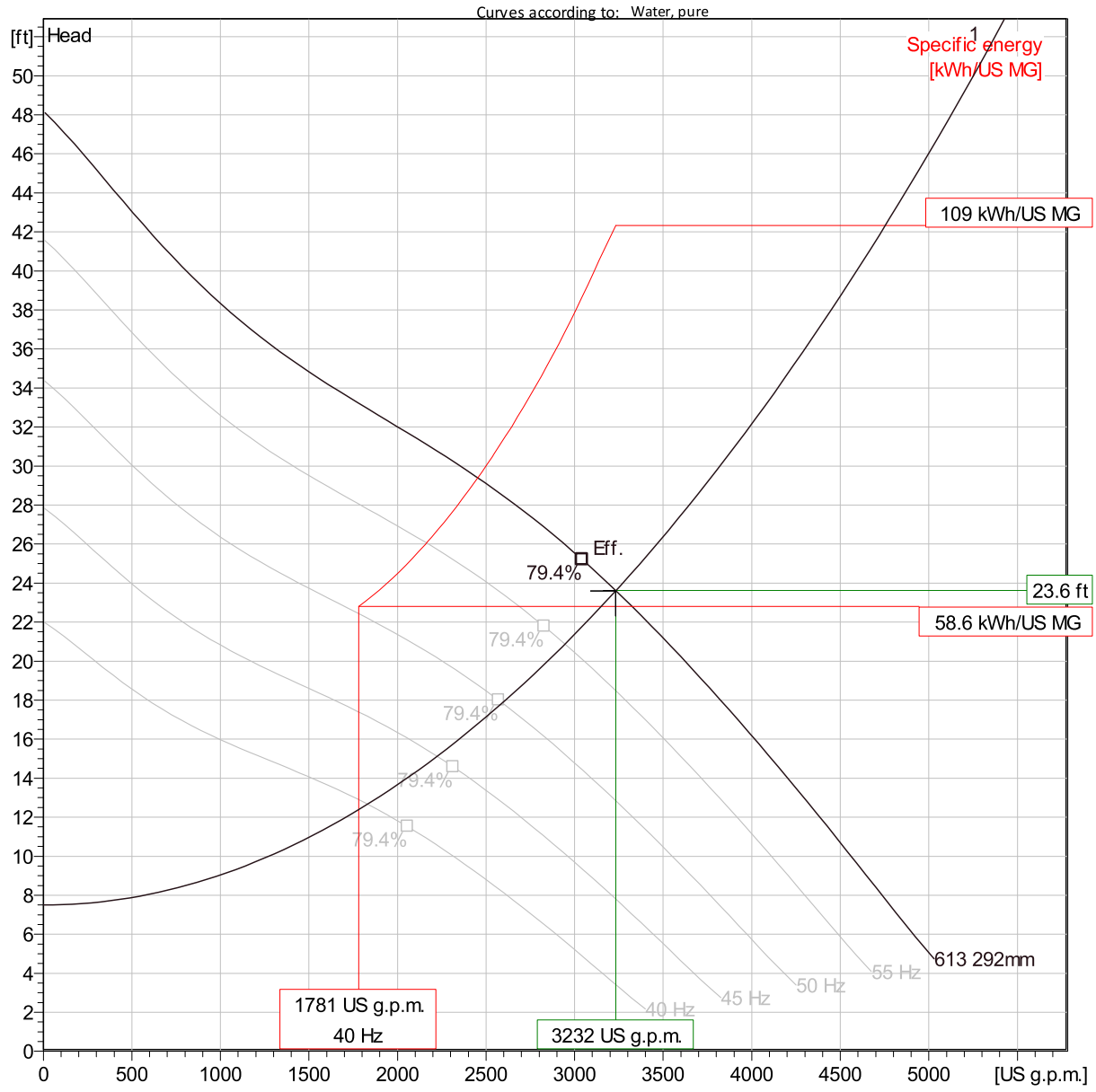
VFD Curve



Project	**Created by**	Ryan Palmer	
Block	**Created on**	7/29/2021	**Last update** 7/29/2021

NP 3171 LT 3~ 613

VFD Analysis



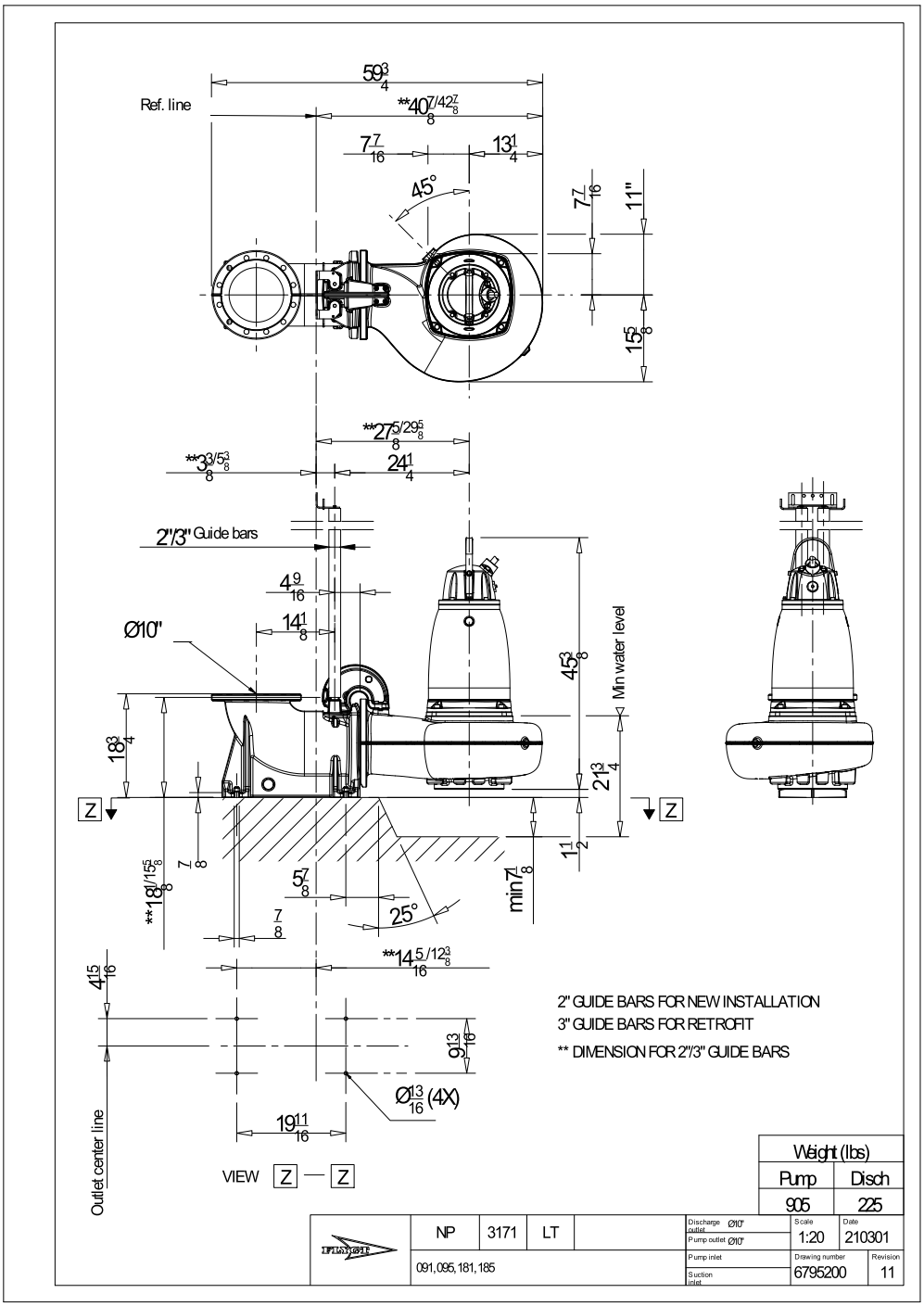
Operating characteristics

Pumps / Systems	Frequency	Flow	Head	Shaft power	Flow	Head	Shaft power	Hydr.eff.	Specific Energy	NPSHre
1	60 Hz	3230 US g.p.m	23.6 ft	24.4 hp	3230 US g.p.m	23.6 ft	24.4 hp	79 %	109 kWh/US M	17.8 ft
1	55 Hz	2890 US g.p.m	20.3 ft	18.7 hp	2890 US g.p.m	20.3 ft	18.7 hp	79.3 %	92.1 kWh/US M	15.3 ft
1	50 Hz	2540 US g.p.m	17.4 ft	14.1 hp	2540 US g.p.m	17.4 ft	14.1 hp	79.4 %	78.3 kWh/US M	13.1 ft
1	45 Hz	2170 US g.p.m	14.8 ft	10.2 hp	2170 US g.p.m	14.8 ft	10.2 hp	79.2 %	67.1 kWh/US M	11 ft
1	40 Hz	1780 US g.p.m	12.4 ft	7.15 hp	1780 US g.p.m	12.4 ft	7.15 hp	78.1 %	58.6 kWh/US M	9.11 ft

Project	**Created by**	Ryan Palmer	
Block	**Created on**	7/29/2021	**Last update** 7/29/2021

NP 3171 LT 3~ 613

Dimensional drawing



Project		**Created by**	Ryan Palmer
Block		**Created on**	7/29/2021 **Last update** 7/29/2021

TRIPLEX PUMP STATION

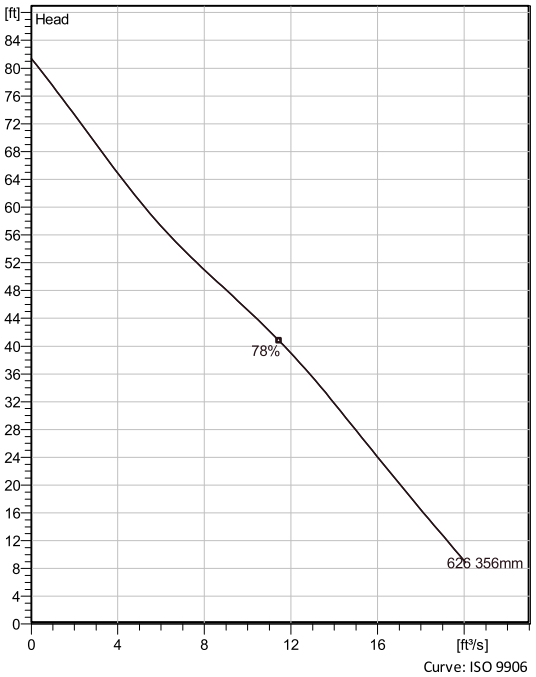
ENGINEER SELECTION

NP 3301 LT 3~ 626

Patented self cleaning semi-open channel impeller, ideal for pumping in waste water applications. Modular based design with high adaptation grade.

Technical specification

Curves according to: Water, pure ,39.2 °F,62.428 lb/ft³,1.6889E-5 ft²/s



Curve: ISO 9906

Configuration

Motor number
N3301.185 35-25-6AA-W 70hp

Installation type
P - Semi permanent, Wet

Impeller diameter
356 mm

Discharge diameter
1/2 inch

Pump information

Impeller diameter
356 mm

Discharge diameter
1/2 inch

Inlet diameter
350 mm

Maximum operating speed
1185 rpm

Number of blades
2

Max. fluid temperature
40 °C

Materials

Impeller
Hard-Iron ™

Project		**Created by**	
Block	0	**Created on**	8/27/2021 **Last update** 8/27/2021

NP 3301 LT 3~ 626

Technical specification

Motor - General

Motor number N3301.185 35-25-6AA-W 70hp	**Phases** 3~	**Rated speed** 1185 rpm	**Rated power** 70 hp
ATEX approved No	**Number of poles** 6	**Rated current** 107 A	**Stator variant** 6
Frequency 60 Hz	**Rated voltage** 380 V	**Insulation class** H	**Type of Duty** S1
Version code 185			

Motor - Technical

Power factor - 1/1 Load 0.81	**Motor efficiency - 1/1 Load** 91.0 %	**Total moment of inertia** 25 lb ft²	**Starts per hour max.** 30
Power factor - 3/4 Load 0.77	**Motor efficiency - 3/4 Load** 92.0 %	**Starting current, direct starting** 655 A	
Power factor - 1/2 Load 0.67	**Motor efficiency - 1/2 Load** 91.5 %	**Starting current, star-delta** 218 A	

Project		**Created by**			
Block	0	**Created on**	8/27/2021	**Last update**	8/27/2021

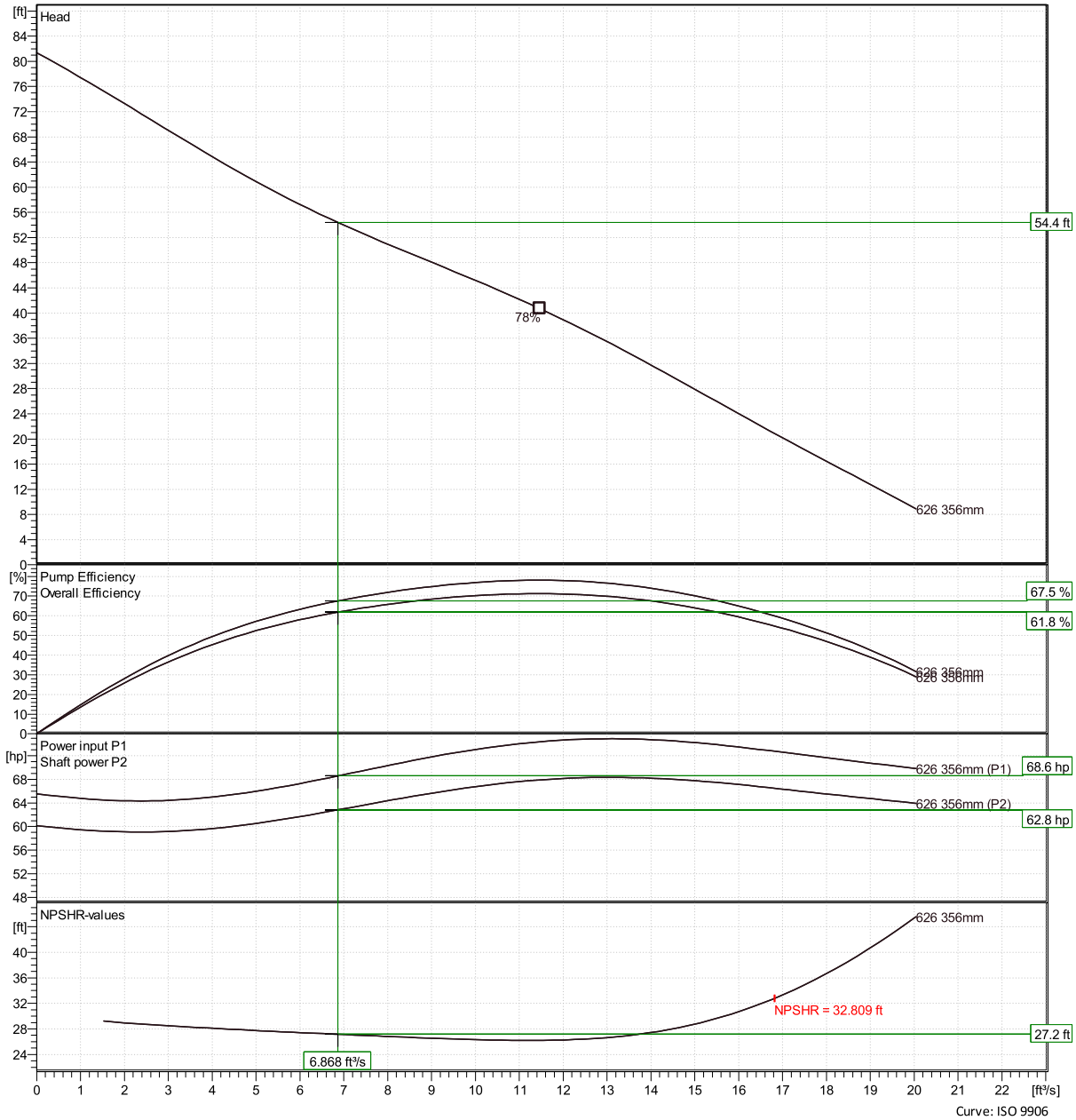
NP 3301 LT 3~ 626

Performance curve

Duty point

Flow	Head
6.87 ft³/s	54.4 ft

Curves according to: Water, pure 39.2 °F, 62.428 lb/ft³, 1.6889E-5 ft²/s



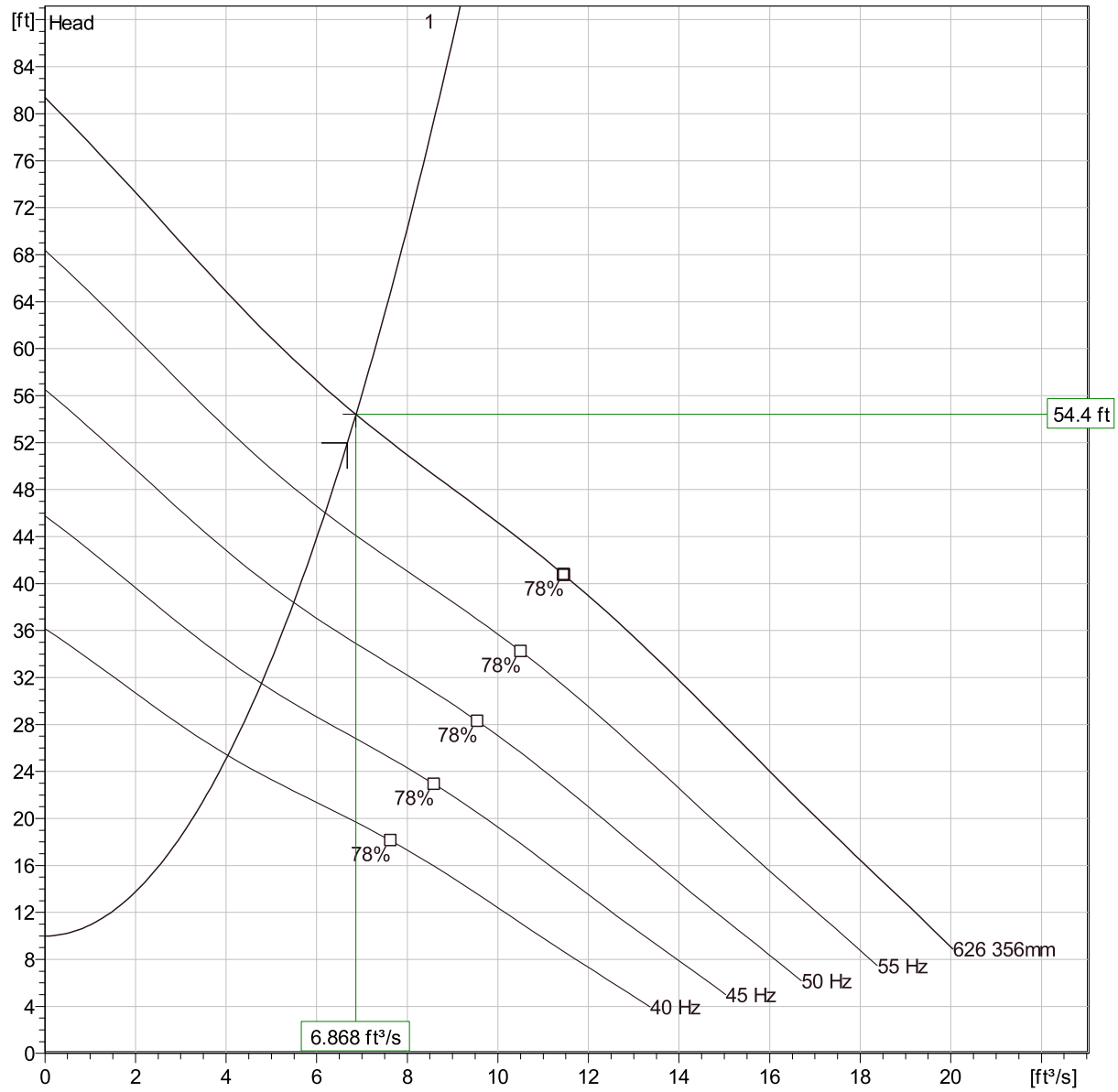
Curve: ISO 9906

Project		**Created by**			
Block	0	**Created on**	8/27/2021	**Last update**	8/27/2021

NP 3301 LT 3~ 626

Duty Analysis

Curves according to: Water, pure ,39.2 °F,62.428 lb/ft³,1.6889E-5 ft²/s



Operating characteristics

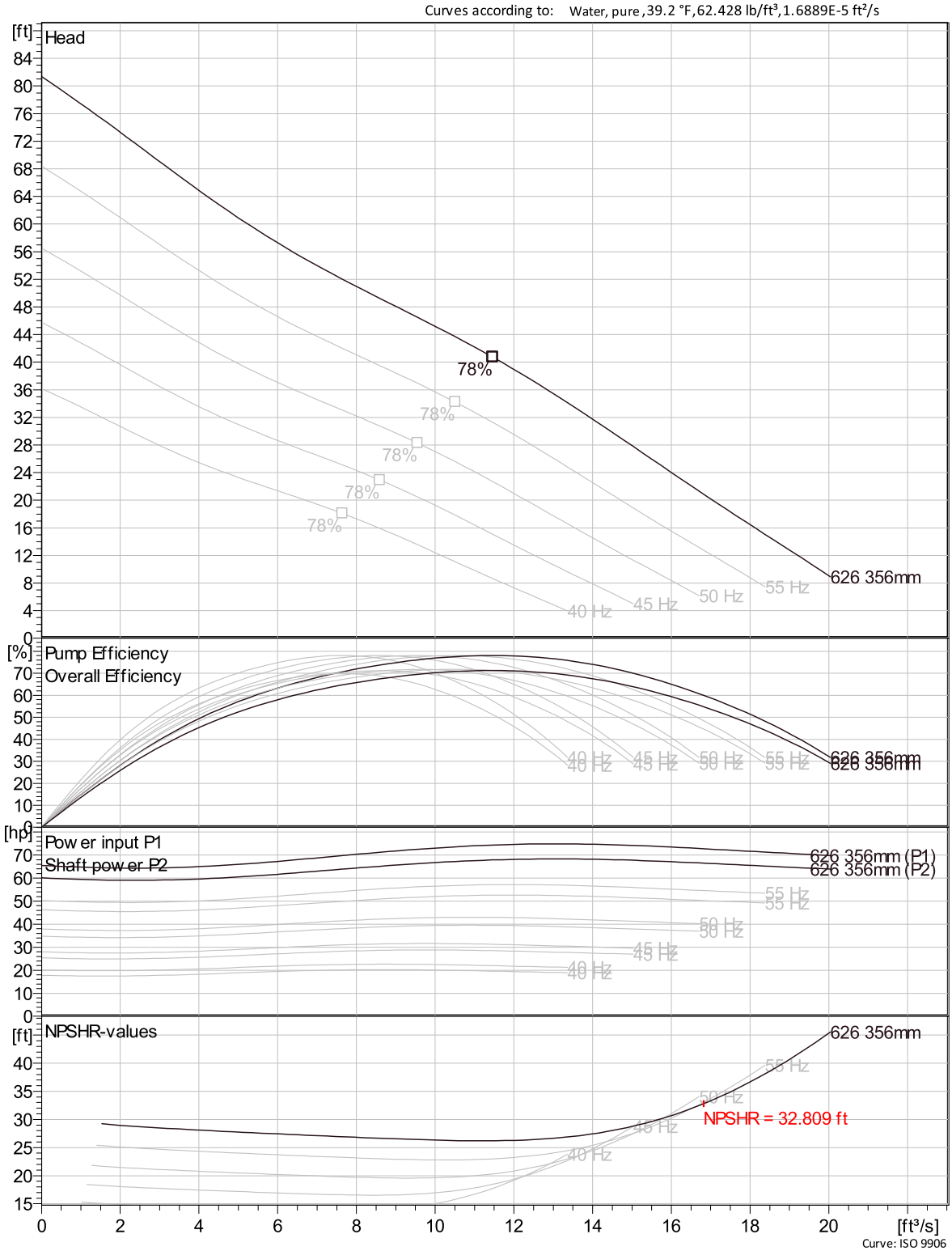
Pumps / Systems	Flow	Head	Shaft power	Flow	Head	Shaft power	Hydr.eff.	Specific Energy	NPSHre
1	6.87 ft³/s	54.4 ft	62.8 hp	6.87 ft³/s	54.4 ft	62.8 hp	67.5 %	277 kWh/US M	27.2 ft

Project		**Created by**			
Block	0	**Created on**	8/27/2021	**Last update**	8/27/2021

NP 3301 LT 3~ 626

VFD Curve

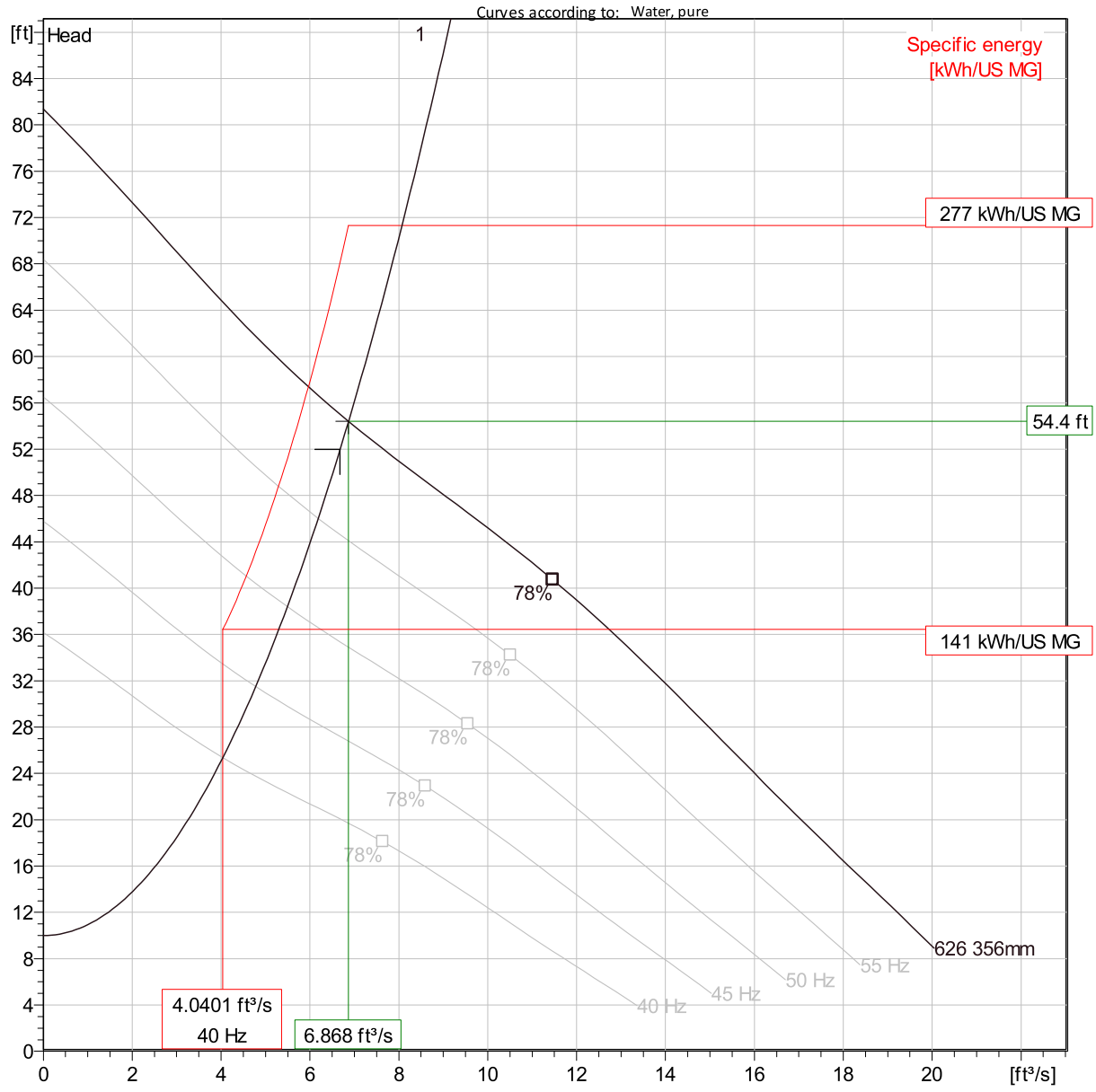
Curves according to: Water, pure ,39.2 °F,62.428 lb/ft³,1.6889E-5 ft²/s



Project		**Created by**			
Block	0	**Created on**	8/27/2021	**Last update**	8/27/2021

NP 3301 LT 3~ 626

VFD Analysis



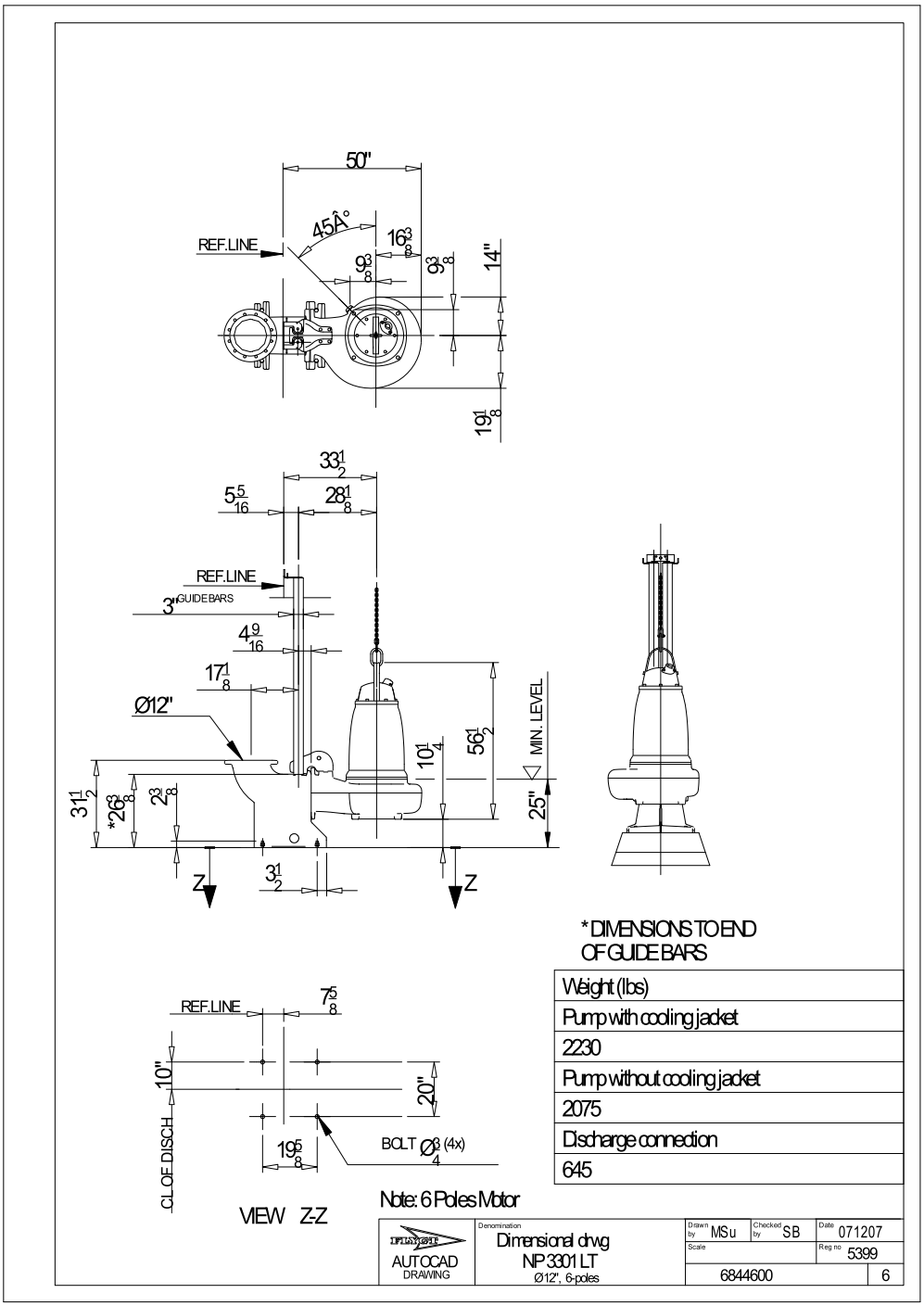
Operating characteristics

Pumps / Systems	Frequency	Flow	Head	Shaft power	Flow	Head	Shaft power	Hydr.eff.	Specific Energy	NPSHre
1	60 Hz	6.87 ft³/s	54.4 ft	62.8 hp	6.87 ft³/s	54.4 ft	62.8 hp	67.5 %	277 kWh/US M	27.2 ft
1	55 Hz	6.19 ft³/s	46 ft	48.3 hp	6.19 ft³/s	46 ft	48.3 hp	67 %	235 kWh/US M	23.7 ft
1	50 Hz	5.49 ft³/s	38.4 ft	36.1 hp	5.49 ft³/s	38.4 ft	36.1 hp	66.2 %	199 kWh/US M	20.4 ft
1	45 Hz	4.78 ft³/s	31.5 ft	26.2 hp	4.78 ft³/s	31.5 ft	26.2 hp	65.2 %	167 kWh/US M	17.2 ft
1	40 Hz	4.04 ft³/s	25.4 ft	18.3 hp	4.04 ft³/s	25.4 ft	18.3 hp	63.6 %	141 kWh/US M	14.3 ft

Project		**Created by**			
Block	0	**Created on**	8/27/2021	**Last update**	8/27/2021

NP 3301 LT 3~ 626

Dimensional drawing



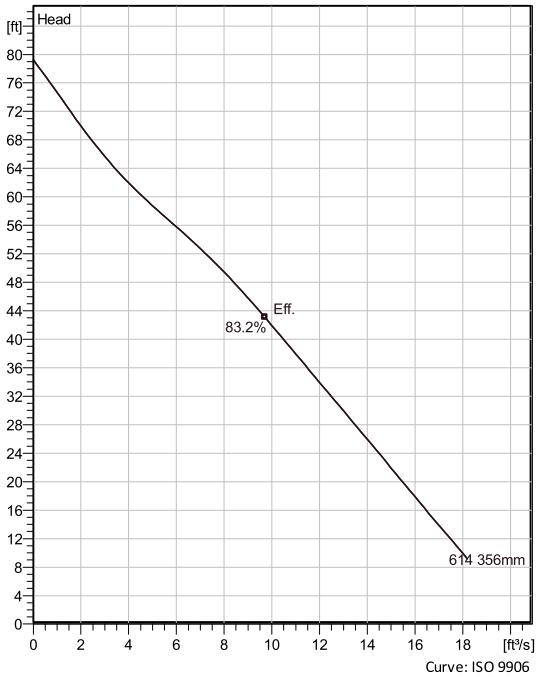
Project		**Created by**	
Block	0	**Created on**	8/27/2021 **Last update** 8/27/2021

NP 3202 LT 3~ 614

Patented self cleaning semi-open channel impeller, ideal for pumping in waste water applications. Modular based design with high adaptation grade.

Technical specification

Curves according to: Water, pure ,39.2 °F,62.428 lb/ft³,1.6889E-5 ft²/s



Curve: ISO 9906

Configuration

Motor number
N3202.185 30-29-6AA-W 60hp

Installation type
P - Semi permanent, Wet

Impeller diameter
356 mm

Discharge diameter
1/2 inch

Pump information

Impeller diameter
356 mm

Discharge diameter
1/2 inch

Inlet diameter
300 mm

Maximum operating speed
1170 rpm

Number of blades
2

Max. fluid temperature
40 °C

Materials

Impeller
Hard-Iron ™

Project		**Created by**	
Block	0	**Created on**	8/27/2021 **Last update** 8/27/2021

NP 3202 LT 3~ 614

Technical specification

Motor - General

Motor number N3202.185 30-29-6AA-W 60hp	**Phases** 3~	**Rated speed** 1170 rpm	**Rated power** 60 hp
ATEX approved No	**Number of poles** 6	**Rated current** 88 A	**Stator variant** 7
Frequency 60 Hz	**Rated voltage** 380 V	**Insulation class** H	**Type of Duty** S1
Version code 185			

Motor - Technical

Power factor - 1/1 Load 0.85	**Motor efficiency - 1/1 Load** 90.5 %	**Total moment of inertia** 15.5 lb ft²	**Starts per hour max.** 30
Power factor - 3/4 Load 0.81	**Motor efficiency - 3/4 Load** 91.0 %	**Starting current, direct starting** 545 A	
Power factor - 1/2 Load 0.72	**Motor efficiency - 1/2 Load** 90.5 %	**Starting current, star-delta** 182 A	

Project		**Created by**			
Block	0	**Created on**	8/27/2021	**Last update**	8/27/2021

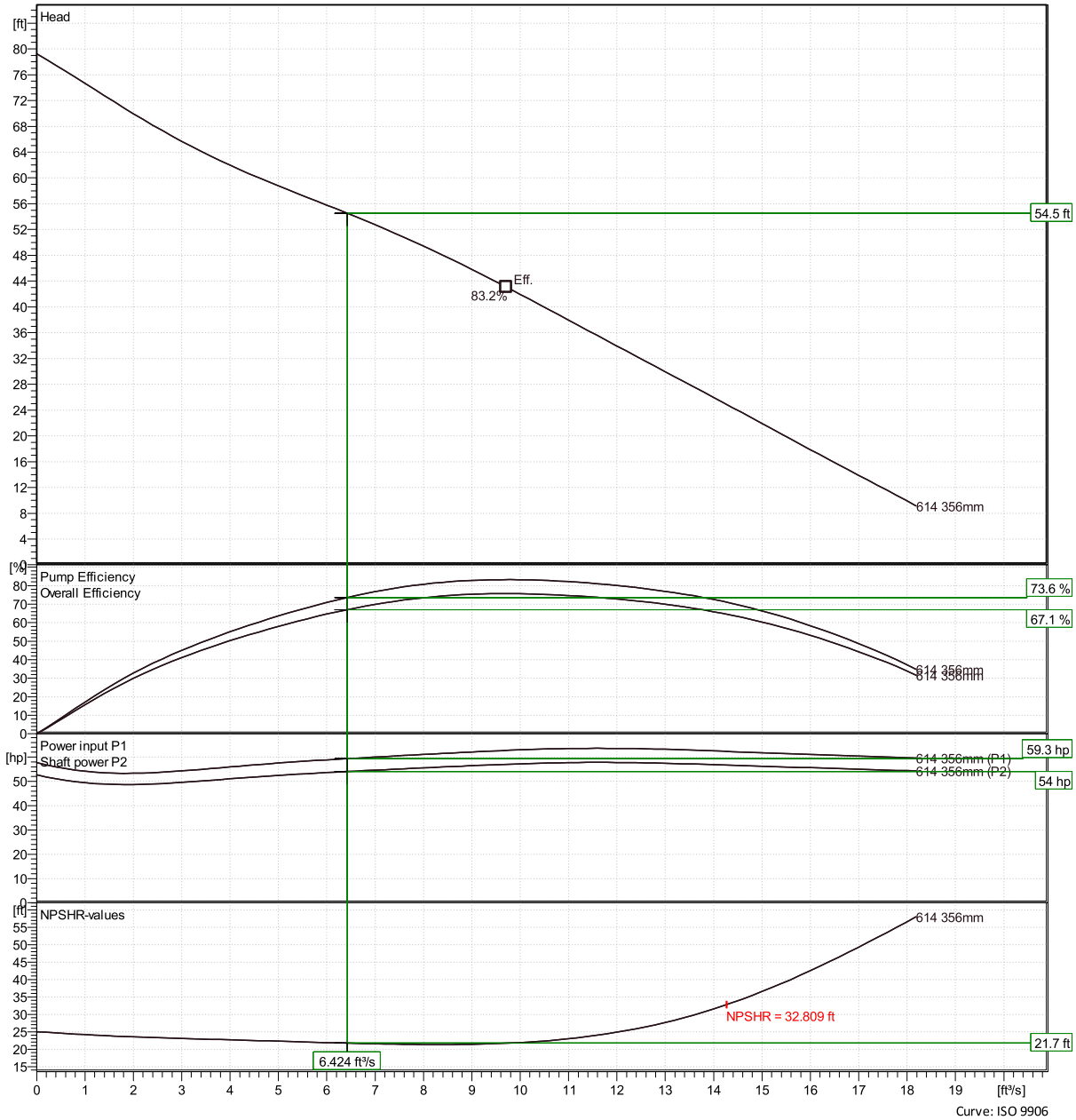
NP 3202 LT 3~ 614

Performance curve

Duty point

Flow	Head
6.42 ft³/s	54.5 ft

Curves according to: Water, pure 39.2 °F, 62.428 lb/ft³, 1.6889E-5 ft²/s



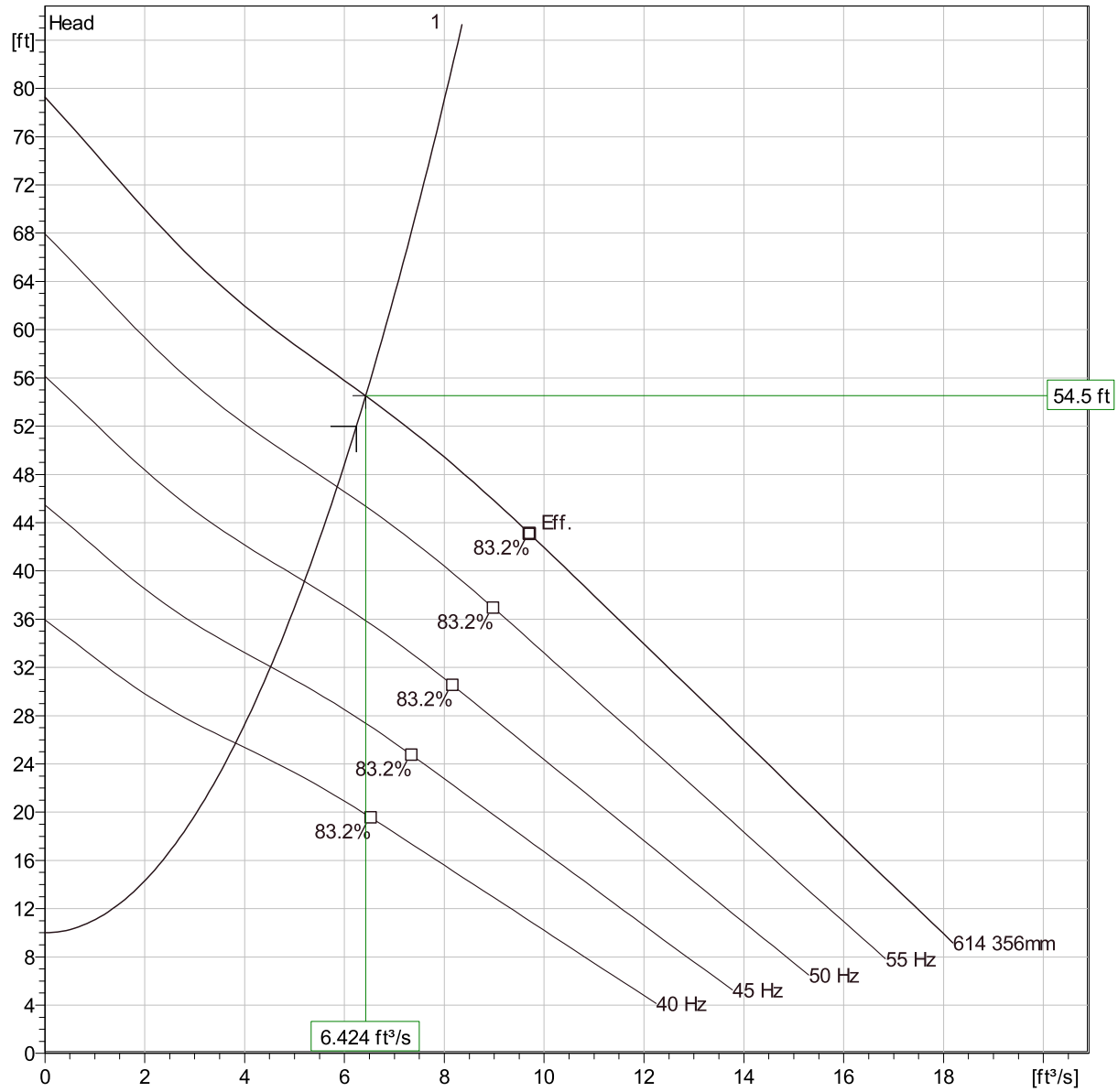
Curve: ISO 9906

Project		**Created by**			
Block	0	**Created on**	8/27/2021	**Last update**	8/27/2021

NP 3202 LT 3~ 614

Duty Analysis

Curves according to: Water, pure ,39.2 °F,62.428 lb/ft³,1.6889E-5 ft²/s



Operating characteristics

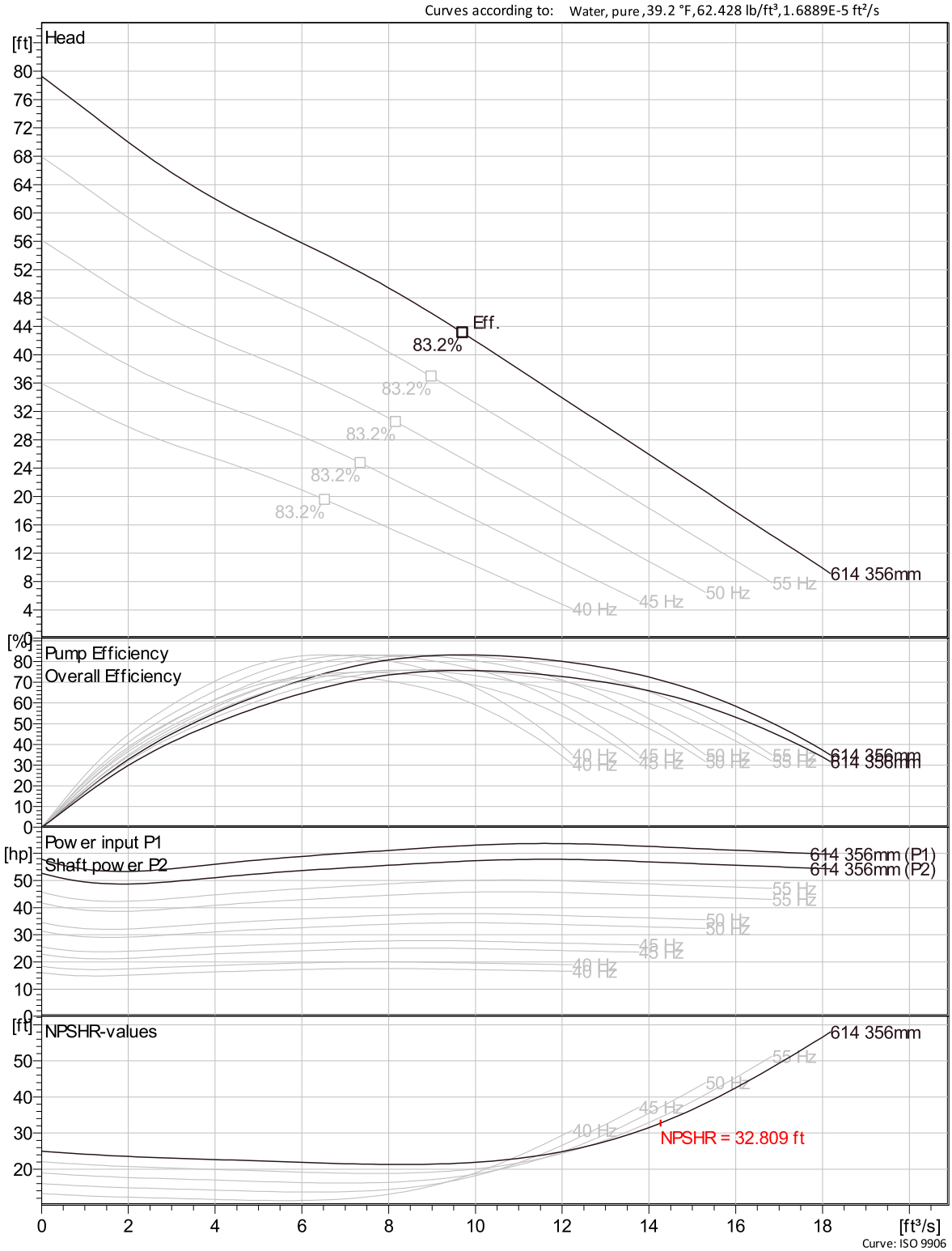
Pumps / Systems	Flow	Head	Shaft power	Flow	Head	Shaft power	Hydr.eff.	Specific Energy	NPSHre
1	6.42 ft³/s	54.5 ft	54 hp	6.42 ft³/s	54.5 ft	54 hp	73.6 %	256 kWh/US M	21.7 ft

Project		**Created by**			
Block	0	**Created on**	8/27/2021	**Last update**	8/27/2021

NP 3202 LT 3~ 614

VFD Curve

Curves according to: Water, pure ,39.2 °F,62.428 lb/ft³,1.6889E-5 ft²/s

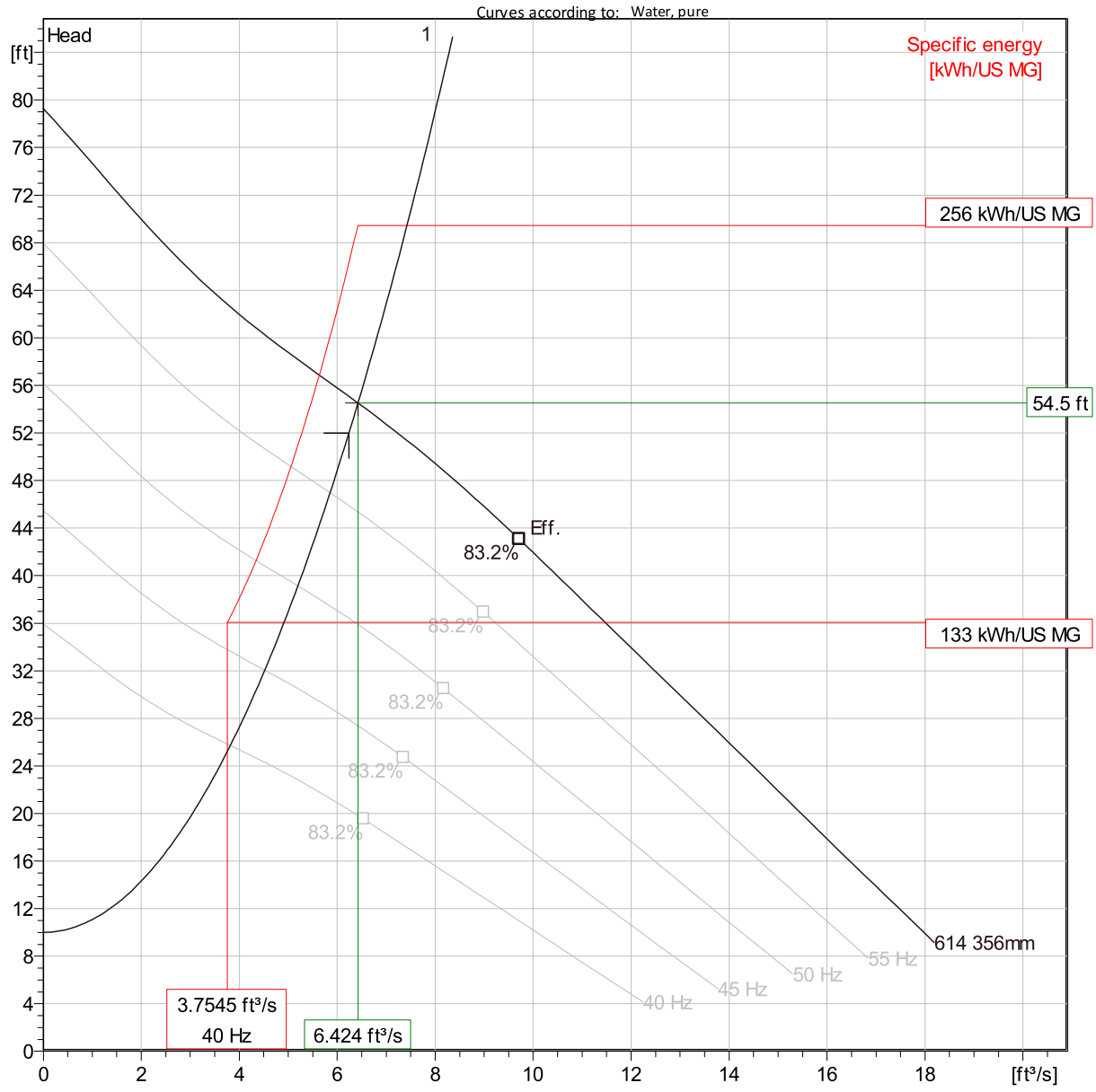


Curve: ISO 9906

Project		**Created by**			
Block	0	**Created on**	8/27/2021	**Last update**	8/27/2021

NP 3202 LT 3~ 614

VFD Analysis



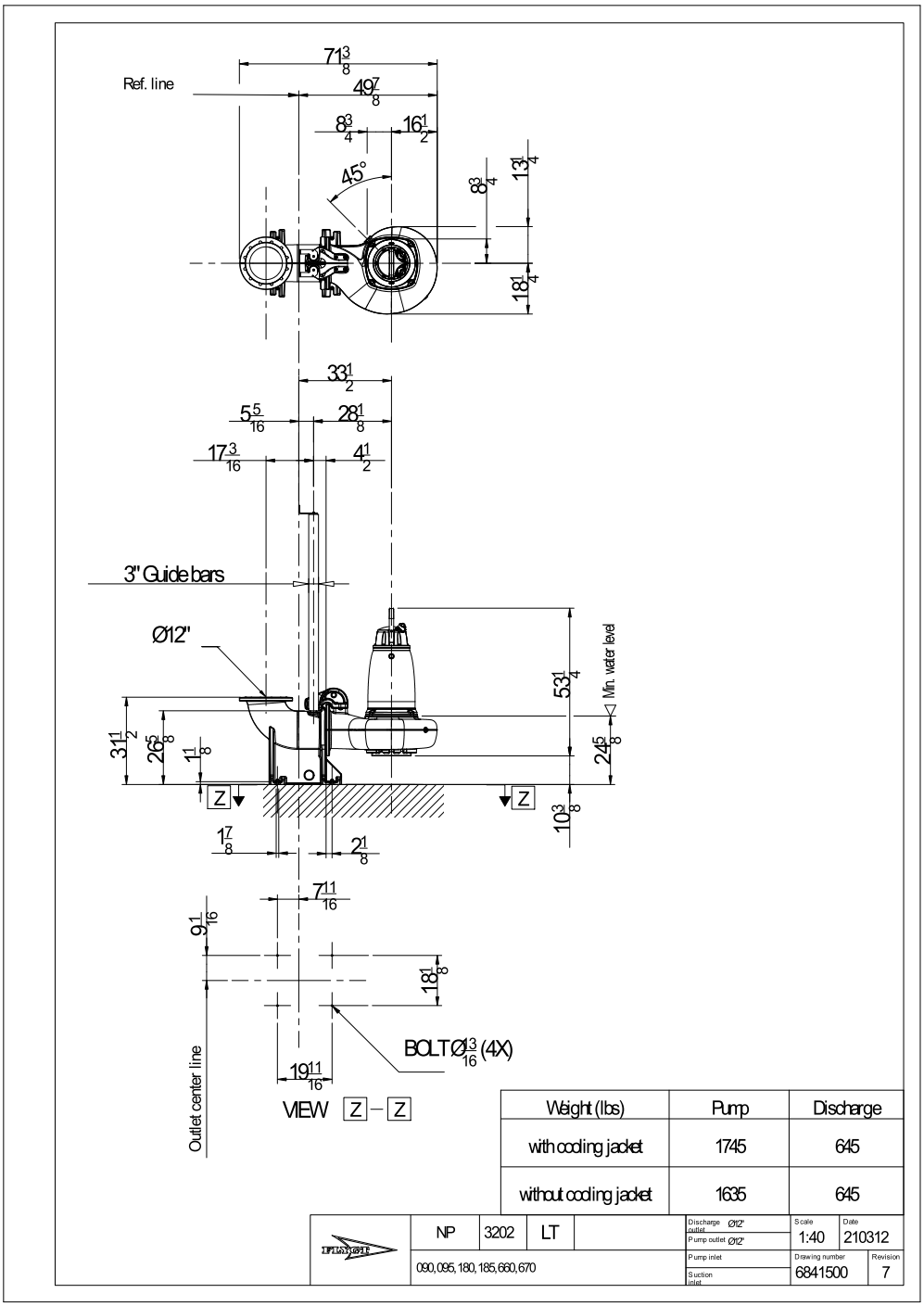
Operating characteristics

Pumps / Systems	Frequency	Flow	Head	Shaft power	Flow	Head	Shaft power	Hydr.eff.	Specific Energy	NPSHre
1	60 Hz	6.42 ft³/s	54.5 ft	54 hp	6.42 ft³/s	54.5 ft	54 hp	73.6 %	256 kWh/US M	21.7 ft
1	55 Hz	5.78 ft³/s	46 ft	41.4 hp	5.78 ft³/s	46 ft	41.4 hp	72.9 %	217 kWh/US M	18.9 ft
1	50 Hz	5.12 ft³/s	38.3 ft	31 hp	5.12 ft³/s	38.3 ft	31 hp	72 %	184 kWh/US M	16.3 ft
1	45 Hz	4.45 ft³/s	31.4 ft	22.5 hp	4.45 ft³/s	31.4 ft	22.5 hp	70.6 %	156 kWh/US M	13.8 ft
1	40 Hz	3.75 ft³/s	25.2 ft	15.7 hp	3.75 ft³/s	25.2 ft	15.7 hp	68.5 %	133 kWh/US M	11.5 ft

Project		**Created by**			
Block	0	**Created on**	8/27/2021	**Last update**	8/27/2021

NP 3202 LT 3~ 614

Dimensional drawing



Weight (lbs)	Pump	Discharge
with cooling jacket	1745	645
without cooling jacket	1635	645

	NP	3202	LT	Discharge outlet Ø12"	Scale 1:40	Date 210312
	090, 095, 180, 185, 660, 670			Pump outlet Ø12"		
				Pump inlet	Drawing number 6841500	Revision 7
				Suction inlet		

Project		**Created by**	
Block	0	**Created on**	8/27/2021 **Last update** 8/27/2021

THOMAS & HUTTON

HYDROLOGIC AND HYDRAULIC REPORT

Sullivan's Island Multi-Basin Stormwater Drainage Improvement
Phase 1

FEMA DR-4241-SC at

Sullivan's Island, SC

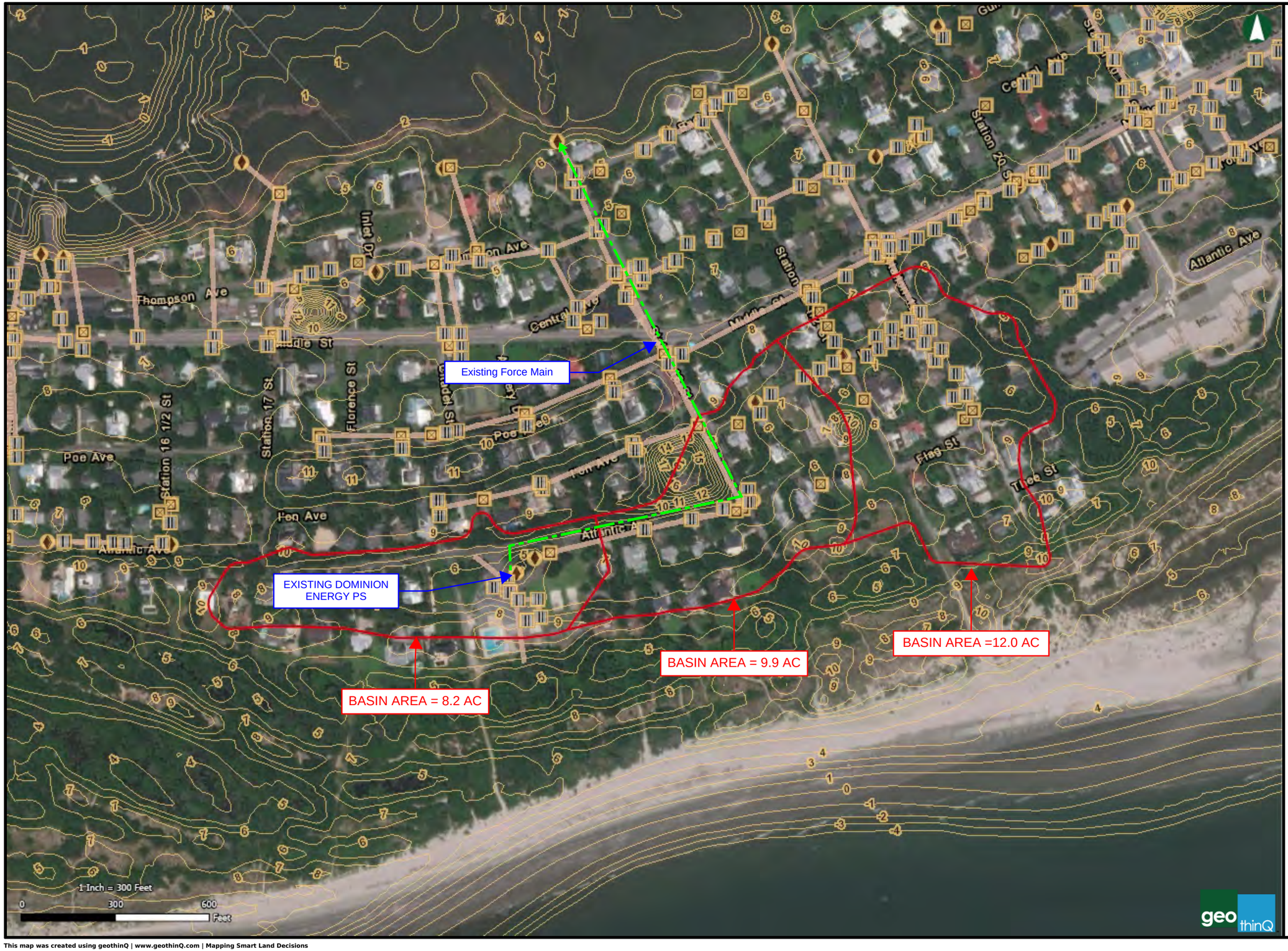
APPENDIX E

EXHIBITS

J – 27091.0000

December 2021

thomasandhutton.com



Town of Sullivan's Island

Multi-Basin Drainage Improvement

12/02/2021

- Pipes
- Culverts
- Inlets
- Junctions
- Outlets
- Existing Force Main

Existing Stormwater Drainage System

Proposed Outfall Structure

Proposed Force Main

Proposed Force Main Manifold

Existing Force Main

Proposed Sta 18 Pump Station

Proposed Sta 18.5 Pump Station

Existing Dominion Energy Pump Station

BASIN AREA =12.0 AC

BASIN AREA = 9.9 AC

BASIN AREA = 8.2 AC

1 Inch = 300 Feet

0 300 600 Feet

THOMAS & HUTTON

Town of Sullivan's Island

Multi-Basin Drainage Improvement

12/02/2021

- Pipes
- Culverts
- Inlets
- Junctions
- Outlets
- Proposed Pump Station
- Proposed Force Main
- Existing Force Main

Proposed Stormwater Drainage System - Force Main

Z:\27091\27091.0000\Engineering\Drawings\Exhibits\27091 DUAL PS Sta18 and 18.5 Location 505C.dwg — Dec 8, 2021 — 2:59:04 PM

MARSH/INTRACOASTAL WATERWAY

PROPOSED OUTFALL

SW FM

SW FM

SW FM

Station 19 St

Central Ave

Station 20 St

Middle St

SW FM

PROPOSED STORMWATER FORCE MAIN

SW FM

SW FM

Middle St

Station 18 St

PROPOSED STORMWATER FORCE MAIN MANIFOLD

Station 19 St

Hag St

TMS # 529-09-00-083

TMS # 529-09-00-084
1807 ATLANTIC,
SULLIVANS ISLAND 29482

PROPOSED PUMP STATION STATION 18

EXISTING PROPERTY LINE

PROPOSED 36" STORM DRAINAGE PIPE

PROPOSED GRATE INLET (TYP)

TMS # 529-09-00-113

PROPOSED 36" STORM DRAINAGE PIPE

PROPOSED PUMP STATION 18.5

TMS # 529-09-00-087

PROPOSED GRATE INLET (TYP)

Sullivans Island

TMS # 529-09-00-112

N
W
E
S

ft Corporation © 2021 Maxar ©CNES (2021) Distribution Airbus DS © 2021 TomT

PROPOSED STORMWATER DRAINAGE SYSTEM

SULLIVAN'S ISLAND, SC

PREPARED FOR:

TOWN OF SULLIVAN'S ISLAND

PREPARED BY:

THOMAS & HUTTON

682 Johnnie Dodds Blvd. • Suite 100
Mt. Pleasant, SC 29464 • 843.849.0200

www.thomasandhutton.com

JOB NO:	J-27091
DRAWN:	CGB
REVIEWED:	MFY

DATE:	06/21/2021
SCALE:	1" = 50'
SHEET:	1 OF 1

DAMAGES BEFORE MITIGATION

&H BEFORE MITIGATION RESUL

						H&H water elevation			DIFFERENCE			DDF BUILDING DAMAGE %			DDF CONTENT DAMAGE %			DDF BUILDING DAMAGE $			DDF CONTENT DAMAGE $		
Node	Structure ID	PROPERTY ADDRESS	Square Feet of Structure	BUILDING REPLACEMENT VALUE (BRV)	FFE	2yr	10yr	25yr	2yr	10yr	25yr	2yr	10yr	25yr	2yr	10yr	25yr	2yr	10yr	25yr	2yr	10yr	25yr
100	1	1815 Ion Av, Sullivans Island, SC, 29482, USA	2410	$ 241,000.00	8.99	6.93	7.25	7.41	-2.06	-1.74	-1.58	-	0.65%	1.05%	-	0.62%	1.01%	-	$ 1,566.50	$ 2,530.50	-	$ 783.25	$ 1,265.25
100	2	1857 Flag St, Sullivans Island, SC, 29482, USA	1280	$ 128,000.00	14.47	6.93	7.25	7.41	-7.54	-7.22	-7.06	-	-	-	-	-	-	-	-	-	-	-	-
100	3	1815 Ion Av, Sullivans Island, SC, 29482, USA	1300	$ 130,000.00	8.99	6.93	7.25	7.41	-2.06	-1.74	-1.58	-	0.65%	1.05%	-	0.62%	1.01%	-	$ 845.00	$ 1,365.00	-	$ 422.50	$ 682.50
100	4	1757 Atlantic Av, Sullivans Island, SC, 29482, USA	3698	$ 369,800.00	5.85	6.93	7.25	7.41	1.08	1.40	1.56	23.93%	26.46%	27.72%	13.67%	15.14%	15.88%	$ 88,500.54	$ 97,849.08	$ 102,523.35	$ 44,250.27	$ 48,924.54	$ 51,261.68
100	5	1901 Ion Av, Sullivans Island, SC, 29482, USA	2367	$ 236,700.00	9.28	6.93	7.25	7.41	-2.35	-2.03	-1.87	-	-	0.33%	-	-	0.31%	-	-	$ 769.27	-	-	$ 384.64
100	6	1807 Ion Av, Sullivans Island, SC, 29482, USA	1832	$ 183,200.00	12.84	6.93	7.25	7.41	-5.91	-5.59	-5.43	-	-	-	-	-	-	-	-	-	-	-	-
100	7	1801 Ion Av, Sullivans Island, SC, 29482, USA	3082	$ 308,200.00	14.24	6.93	7.25	7.41	-7.31	-6.99	-6.83	-	-	-	-	-	-	-	-	-	-	-	-
100	8	1767 Atlantic Av, Sullivans Island, SC, 29482, USA	1859	$ 185,900.00	13.27	6.93	7.25	7.41	-6.34	-6.02	-5.86	-	-	-	-	-	-	-	-	-	-	-	-
100	9	1807 Ion Av, Sullivans Island, SC, 29482, USA	1769	$ 176,900.00	13.49	6.93	7.25	7.41	-6.56	-6.24	-6.08	-	-	-	-	-	-	-	-	-	-	-	-
100	10	1801 Atlantic Av, Sullivans Island, SC, 29482, USA	227	$ 22,700.00	5.66	6.93	7.25	7.41	1.27	1.59	1.75	25.43%	27.96%	29.23%	14.54%	16.01%	16.75%	$ 5,773.29	$ 6,347.15	$ 6,634.08	$ 2,886.65	$ 3,173.57	$ 3,317.04
100	11	204 Station 19th St, Sullivans Island, SC, 29482, USA	3118	$ 311,800.00	12.96	6.93	7.25	7.41	-6.03	-5.71	-5.55	-	-	-	-	-	-	-	-	-	-	-	-
100	12	1851 Ion Av, Sullivans Island, SC, 29482, USA	5955	$ 595,500.00	14.01	6.93	7.25	7.41	-7.08	-6.76	-6.60	-	-	-	-	-	-	-	-	-	-	-	-
100	13	1711 Atlantic Av, Sullivans Island, SC, 29482, USA	2616	$ 261,600.00	14.24	6.93	7.25	7.41	-7.31	-6.99	-6.83	-	-	-	-	-	-	-	-	-	-	-	-
100	14	1801 Ion Av, Sullivans Island, SC, 29482, USA	726	$ 72,600.00	4.84	6.93	7.25	7.41	2.09	2.41	2.57	32.00%	34.85%	36.27%	18.27%	19.58%	20.24%	$ 23,232.73	$ 25,300.37	$ 26,334.20	$ 11,616.36	$ 12,650.19	$ 13,167.10
100	15	103-199 Station 18 1/2 St, Sullivans Island, SC, 29482, U	536	$ 53,600.00	6.27	6.93	7.25	7.41	0.66	0.98	1.14	19.93%	23.10%	24.41%	11.53%	13.20%	13.94%	$ 10,684.62	$ 12,382.67	$ 13,081.62	$ 5,342.31	$ 6,191.34	$ 6,540.81
100	16	1856 Flag St, Sullivans Island, SC, 29482, USA	1221	$ 122,100.00	13.60	6.93	7.25	7.41	-6.67	-6.35	-6.19	-	-	-	-	-	-	-	-	-	-	-	-
100	17	1857 Ion Av, Sullivans Island, SC, 29482, USA	3145	$ 314,500.00	8.32	6.93	7.25	7.41	-1.39	-1.07	-0.91	1.53%	2.33%	3.48%	1.46%	2.23%	2.91%	$ 4,796.13	$ 7,312.13	$ 10,947.75	$ 2,398.06	$ 3,656.06	$ 5,473.87
100	18	1908 Flag St, Sullivans Island, SC, 29482, USA	3410	$ 341,000.00	9.43	6.93	7.25	7.41	-2.50	-2.18	-2.02	-	-	-	-	-	-	-	-	-	-	-	-
100	19	1717 Atlantic Av, Sullivans Island, SC, 29482, USA	2446	$ 244,600.00	7.54	6.93	7.25	7.41	-0.61	-0.29	-0.13	6.75%	10.24%	11.98%	4.62%	6.45%	7.36%	$ 16,512.95	$ 25,044.59	$ 29,310.42	$ 8,256.47	$ 12,522.30	$ 14,655.21
100	20	1807 Atlantic Av, Sullivans Island, SC, 29482, USA	473	$ 47,300.00	6.27	6.93	7.25	7.41	0.66	0.98	1.14	19.93%	23.10%	24.41%	11.53%	13.20%	13.94%	$ 9,428.78	$ 10,927.25	$ 11,544.04	$ 4,714.39	$ 5,463.62	$ 5,772.02
100	21	1767 Atlantic Av, Sullivans Island, SC, 29482, USA	373	$ 37,300.00	5.77	6.93	7.25	7.41	1.16	1.48	1.64	24.56%	27.09%	28.36%	14.04%	15.51%	16.24%	$ 9,162.37	$ 10,105.32	$ 10,576.79	$ 4,581.19	$ 5,052.66	$ 5,288.39
100	22	1815 Ion Av, Sullivans Island, SC, 29482, USA	219	$ 21,900.00	9.49	6.93	7.25	7.41	-2.56	-2.24	-2.08	-	-	-	-	-	-	-	-	-	-	-	-
100	23	1773 Atlantic Av, Sullivans Island, SC, 29482, USA	2906	$ 290,600.00	5.73	6.93	7.25	7.41	1.20	1.52	1.68	24.88%	27.41%	28.67%	14.22%	15.69%	16.43%	$ 72,301.28	$ 79,647.65	$ 83,320.83	$ 36,150.64	$ 39,823.82	$ 41,660.42
100	24	1761 Atlantic Av, Sullivans Island, SC, 29482, USA	2611	$ 261,100.00	7.28	6.93	7.25	7.41	-0.35	-0.03	0.13	9.59%	13.07%	14.69%	6.11%	7.93%	8.78%	$ 25,026.44	$ 34,133.60	$ 38,347.76	$ 12,513.22	$ 17,066.80	$ 19,173.88
100	25	1753 Atlantic Av, Sullivans Island, SC, 29482, USA	3623	$ 362,300.00	15.12	6.93	7.25	7.41	-8.19	-7.87	-7.71	-	-	-	-	-	-	-	-	-	-	-	-
100	26	1807 Atlantic Av, Sullivans Island, SC, 29482, USA	4350	$ 435,000.00	5.56	6.93	7.25	7.41	1.37	1.69	1.85	26.22%	28.75%	30.02%	15.00%	16.47%	17.21%	$ 114,070.05	$ 125,066.85	$ 130,565.25	$ 57,035.03	$ 62,533.43	$ 65,282.63
100	27	1735 Atlantic Av, Sullivans Island, SC, 29482, USA	14631	$ 1,463,100.00	11.97	6.93	7.25	7.41	-5.04	-4.72	-4.56	-	-	-	-	-	-	-	-	-	-	-	-
100	28	1721 Atlantic Av, Sullivans Island, SC, 29482, USA	2269	$ 226,900.00	14.47	6.93	7.25	7.41	-7.54	-7.22	-7.06	-	-	-	-	-	-	-	-	-	-	-	-
100	29	200 Station 18th St, Sullivans Island, SC, 29482, USA	1531	$ 153,100.00	11.74	6.93	7.25	7.41	-4.81	-4.49	-4.33	-	-	-	-	-	-	-	-	-	-	-	-
100	30	1851 Flag St, Sullivans Island, SC, 29482, USA	1758	$ 175,800.00	14.78	6.93	7.25	7.41	-7.85	-7.53	-7.37	-	-	-	-	-	-	-	-	-	-	-	-
100	31	1814 Ion Av, Sullivans Island, SC, 29482, USA	3976	$ 397,600.00	6.50	6.93	7.25	7.41	0.43	0.75	0.91	17.66%	20.83%	22.41%	10.34%	12.00%	12.83%	$ 70,204.23	$ 82,800.20	$ 89,098.18	$ 35,102.12	$ 41,400.10	$ 44,549.09
100	32	1801 Atlantic Av, Sullivans Island, SC, 29482, USA	4227	$ 422,700.00	13.16	6.93	7.25	7.41	-6.23	-5.91	-5.75	-	-	-	-	-	-	-	-	-	-	-	-
100	33	1763 Atlantic Av, Sullivans Island, SC, 29482, USA	2418	$ 241,800.00	13.43	6.93	7.25	7.41	-6.50	-6.18	-6.02	-	-	-	-	-	-	-	-	-	-	-	-
100	34	103-199 Station 18 1/2 St, Sullivans Island, SC, 29482, U	319	$ 31,900.00	6.27	6.93	7.25	7.41	0.66	0.98	1.14	19.93%	23.10%	24.41%	11.53%	13.20%	13.94%	$ 6,358.95	$ 7,369.54	$ 7,785.51	$ 3,179.47	$ 3,684.77	$ 3,892.76
100	35	1850 Flag St, Sullivans Island, SC, 29482, USA	3465	$ 346,500.00	3.78	6.93	7.25	7.41	3.15	3.47	3.63	41.15%	43.39%	44.51%	22.56%	23.74%	24.33%	$ 142,584.75	$ 150,346.35	$ 154,227.15	$ 71,292.38	$ 75,173.18	$ 77,113.58
				$ 9,214,600.00														$ 598,637.10	$ 677,044.24	$ 718,961.69	$ 299,318.55	$ 338,522.12	$ 359,480.85

DAMAGES AFTER MITIGATION

&H AFTER MITIGATION RESULT

						H&H water elevation			DIFFERENCE			DDF BUILDING DAMAGE %			DDF CONTENT DAMAGE %			DDF BUILDING DAMAGE $			DDF CONTENT DAMAGE $		
Location	Structure ID	PROPERTY ADDRESS	Square Feet of Structure	BUILDING REPLACEMENT VALUE (BRV)	FFE	2yr	10yr	25yr	2yr	10yr	25yr	2yr	10yr	25yr	2yr	10yr	25yr	2yr	10yr	25yr	2yr	10yr	25yr
100	1	1815 Ion Av, Sullivans Island, SC, 29482, USA	2410	$ 241,000.00	8.99	2.00	2.00	2.00	-6.99	-6.99	-6.99	-	-	-	-	-	-	-	-	-	-	-	-
100	2	1857 Flag St, Sullivans Island, SC, 29482, USA	1280	$ 128,000.00	14.47	2.00	2.00	2.00	-12.47	-12.47	-12.47	-	-	-	-	-	-	-	-	-	-	-	-
100	3	1815 Ion Av, Sullivans Island, SC, 29482, USA	1300	$ 130,000.00	8.99	2.00	2.00	2.00	-6.99	-6.99	-6.99	-	-	-	-	-	-	-	-	-	-	-	-
100	4	1757 Atlantic Av, Sullivans Island, SC, 29482, USA	3698	$ 369,800.00	5.85	2.00	2.00	2.00	-3.85	-3.85	-3.85	-	-	-	-	-	-	-	-	-	-	-	-
100	5	1901 Ion Av, Sullivans Island, SC, 29482, USA	2367	$ 236,700.00	9.28	2.00	2.00	2.00	-7.28	-7.28	-7.28	-	-	-	-	-	-	-	-	-	-	-	-
100	6	1807 Ion Av, Sullivans Island, SC, 29482, USA	1832	$ 183,200.00	12.84	2.00	2.00	2.00	-10.84	-10.84	-10.84	-	-	-	-	-	-	-	-	-	-	-	-
100	7	1801 Ion Av, Sullivans Island, SC, 29482, USA	3082	$ 308,200.00	14.24	2.00	2.00	2.00	-12.24	-12.24	-12.24	-	-	-	-	-	-	-	-	-	-	-	-
100	8	1767 Atlantic Av, Sullivans Island, SC, 29482, USA	1859	$ 185,900.00	13.27	2.00	2.00	2.00	-11.27	-11.27	-11.27	-	-	-	-	-	-	-	-	-	-	-	-
100	9	1807 Ion Av, Sullivans Island, SC, 29482, USA	1769	$ 176,900.00	13.49	2.00	2.00	2.00	-11.49	-11.49	-11.49	-	-	-	-	-	-	-	-	-	-	-	-
100	10	1801 Atlantic Av, Sullivans Island, SC, 29482, USA	227	$ 22,700.00	5.66	2.00	2.00	2.00	-3.66	-3.66	-3.66	-	-	-	-	-	-	-	-	-	-	-	-
100	11	204 Station 19th St, Sullivans Island, SC, 29482, USA	3118	$ 311,800.00	12.96	2.00	2.00	2.00	-10.96	-10.96	-10.96	-	-	-	-	-	-	-	-	-	-	-	-
100	12	1851 Ion Av, Sullivans Island, SC, 29482, USA	5955	$ 595,500.00	14.01	2.00	2.00	2.00	-12.01	-12.01	-12.01	-	-	-	-	-	-	-	-	-	-	-	-
100	13	1711 Atlantic Av, Sullivans Island, SC, 29482, USA	2616	$ 261,600.00	14.24	2.00	2.00	2.00	-12.24	-12.24	-12.24	-	-	-	-	-	-	-	-	-	-	-	-
100	14	1801 Ion Av, Sullivans Island, SC, 29482, USA	726	$ 72,600.00	4.84	2.00	2.00	2.00	-2.84	-2.84	-2.84	-	-	-	-	-	-	-	-	-	-	-	-
100	15	103-199 Station 18 1/2 St, Sullivans Island, SC, 29482, U	536	$ 53,600.00	6.27	2.00	2.00	2.00	-4.27	-4.27	-4.27	-	-	-	-	-	-	-	-	-	-	-	-
100	16	1856 Flag St, Sullivans Island, SC, 29482, USA	1221	$ 122,100.00	13.60	2.00	2.00	2.00	-11.60	-11.60	-11.60	-	-	-	-	-	-	-	-	-	-	-	-
100	17	1857 Ion Av, Sullivans Island, SC, 29482, USA	3145	$ 314,500.00	8.32	2.00	2.00	2.00	-6.32	-6.32	-6.32	-	-	-	-	-	-	-	-	-	-	-	-
100	18	1908 Flag St, Sullivans Island, SC, 29482, USA	3410	$ 341,000.00	9.43	2.00	2.00	2.00	-7.43	-7.43	-7.43	-	-	-	-	-	-	-	-	-	-	-	-
100	19	1717 Atlantic Av, Sullivans Island, SC, 29482, USA	2446	$ 244,600.00	7.54	2.00	2.00	2.00	-5.54	-5.54	-5.54	-	-	-	-	-	-	-	-	-	-	-	-
100	20	1807 Atlantic Av, Sullivans Island, SC, 29482, USA	473	$ 47,300.00	6.27	2.00	2.00	2.00	-4.27	-4.27	-4.27	-	-	-	-	-	-	-	-	-	-	-	-
100	21	1767 Atlantic Av, Sullivans Island, SC, 29482, USA	373	$ 37,300.00	5.77	2.00	2.00	2.00	-3.77	-3.77	-3.77	-	-	-	-	-	-	-	-	-	-	-	-
100	22	1815 Ion Av, Sullivans Island, SC, 29482, USA	219	$ 21,900.00	9.49	2.00	2.00	2.00	-7.49	-7.49	-7.49	-	-	-	-	-	-	-	-	-	-	-	-
100	23	1773 Atlantic Av, Sullivans Island, SC, 29482, USA	2906	$ 290,600.00	5.73	2.00	2.00	2.00	-3.73	-3.73	-3.73	-	-	-	-	-	-	-	-	-	-	-	-
100	24	1761 Atlantic Av, Sullivans Island, SC, 29482, USA	2611	$ 261,100.00	7.28	2.00	2.00	2.00	-5.28	-5.28	-5.28	-	-	-	-	-	-	-	-	-	-	-	-
100	25	1753 Atlantic Av, Sullivans Island, SC, 29482, USA	3623	$ 362,300.00	15.12	2.00	2.00	2.00	-13.12	-13.12	-13.12	-	-	-	-	-	-	-	-	-	-	-	-
100	26	1807 Atlantic Av, Sullivans Island, SC, 29482, USA	4350	$ 435,000.00	5.56	2.00	2.00	2.00	-3.56	-3.56	-3.56	-	-	-	-	-	-	-	-	-	-	-	-
100	27	1735 Atlantic Av, Sullivans Island, SC, 29482, USA	14631	$ 1,463,100.00	11.97	2.00	2.00	2.00	-9.97	-9.97	-9.97	-	-	-	-	-	-	-	-	-	-	-	-
100	28	1721 Atlantic Av, Sullivans Island, SC, 29482, USA	2269	$ 226,900.00	14.47	2.00	2.00	2.00	-12.47	-12.47	-12.47	-	-	-	-	-	-	-	-	-	-	-	-
100	29	200 Station 18th St, Sullivans Island, SC, 29482, USA	1531	$ 153,100.00	11.74	2.00	2.00	2.00	-9.74	-9.74	-9.74	-	-	-	-	-	-	-	-	-	-	-	-
100	30	1851 Flag St, Sullivans Island, SC, 29482, USA	1758	$ 175,800.00	14.78	2.00	2.00	2.00	-12.78	-12.78	-12.78	-	-	-	-	-	-	-	-	-	-	-	-
100	31	1814 Ion Av, Sullivans Island, SC, 29482, USA	3976	$ 397,600.00	6.50	2.00	2.00	2.00	-4.50	-4.50	-4.50	-	-	-	-	-	-	-	-	-	-	-	-
100	32	1801 Atlantic Av, Sullivans Island, SC, 29482, USA	4227	$ 422,700.00	13.16	2.00	2.00	2.00	-11.16	-11.16	-11.16	-	-	-	-	-	-	-	-	-	-	-	-
100	33	1763 Atlantic Av, Sullivans Island, SC, 29482, USA	2418	$ 241,800.00	13.43	2.00	2.00	2.00	-11.43	-11.43	-11.43	-	-	-	-	-	-	-	-	-	-	-	-
100	34	103-199 Station 18 1/2 St, Sullivans Island, SC, 29482, U	319	$ 31,900.00	6.27	2.00	2.00	2.00	-4.27	-4.27	-4.27	-	-	-	-	-	-	-	-	-	-	-	-

100	35	1850 Flag St, Sullivans Island, SC, 29482, USA	3465	$ 346,500.00	3.78	2.00	2.00	2.00	-1.78	-1.78	-1.78	0.55%	0.55%	0.55%	0.53%	0.53%	0.53%	$ 1,905.75	$ 1,905.75	$ 1,905.75	$ 914.76	$ 914.76	$ 914.76
Total				**$ 9,214,600.00**														**$ 1,905.75**	**$ 1,905.75**	**$ 1,905.75**	**$ 914.76**	**$ 914.76**	**$ 914.76**

FERENCE INFO	
NODE	Refers to the node on your H&H that provides the information for the specific property that will benefit from the project
PROPERTY ADDRESS	Include all addresses for properties that will benefit from the project.
BUILDING REPLACEMENT VALUE	Building replacement value (BRV) can be obtain from property appraiser, RS Means or building construction calculator
FINISH FLOOR ELEVATION	First floor elevation for heated areas (not garage elevation). If survey or elevation certificate is not available, it can be an estimated number (by observation)
H&H BEFORE MITIGTION RESULTS	Using your H&H, please enter the water elevation under each scenario before mitigation (existing conditions) (The amount of scenarios and the recurrence intervals are determine by the engineer running the H&H, it is not match this sample
H&H AFTER MITIGTION RESULTS	Using your H&H, please enter the water elevation under each scenario after mitigation (proposed conditions) (The amount of scenarios and the recurrence intervals are determine by the engineer running the H&H, it is not match this sample
DIFFERENCE	Result from subtracting the peak stage elevation from the finish floor elevation, it refers to the amount of water affecting the structure under each scenario. (this value is auto calculated
DDF	USACE Depth Damage Function
DDF BUILDING DAMAGE %	Percentage of damage obtain from DDF table. Each value under difference should be match with a percentage on the table
DDF BUILDING DAMAGE $	BRV * DDF Percentage = Damage $ (this value is auto calculated)
DDF CONTENT DAMAGE %	Percentage of damage obtain from DDF table. Each value under difference should be match with a percentage on the table
DDF CONTENT DAMAGE $	BRV * DDF Percentage = Damage $ (this value is auto calculated)
DISPLACEMENT (DAYS)	Days of displacement based on DDF using "difference" value.
DISPLACEMENT $	Displacement cost is the Per Diem and Lodging cost (per federal rate for project location) for each structure multiplied by the number of individuals in the structure (household size per census data). Websites to look up project location values are belov
	Displacement ($) = Displacement (Days) x [(Per Diem + Lodging) x (Household size)]
	https://www.gsa.gov/travel/plan-book/per-diem-rates
	https://www.census.gov/data.html

Single-Family Detached Housing
(210)

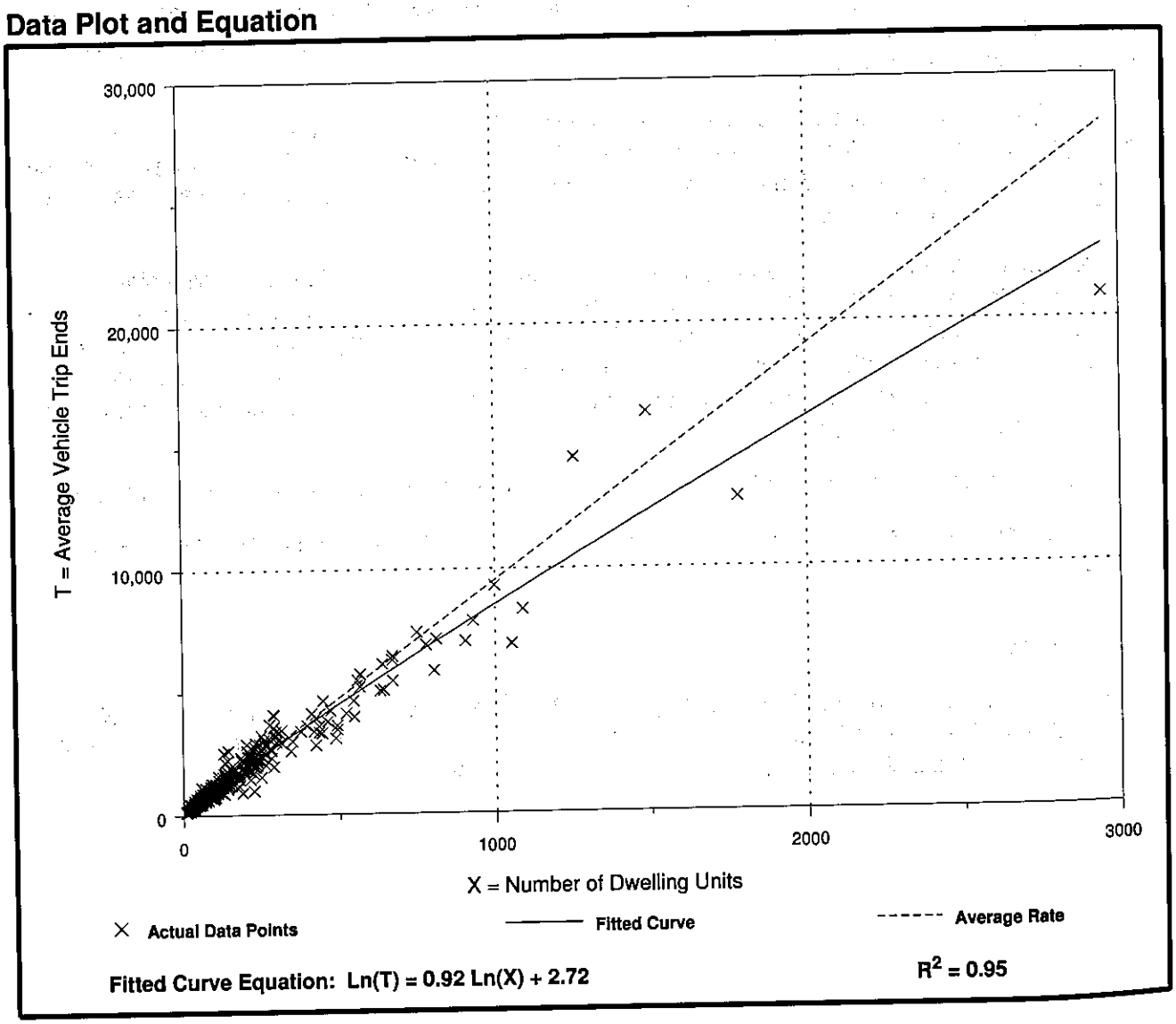
Average Vehicle Trip Ends vs: Dwelling Units
On a: Weekday

Number of Studies: 355
Avg. Number of Dwelling Units: 198
Directional Distribution: 50% entering, 50% exiting

Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
9.52	4.31 - 21.85	3.70

Data Plot and Equation



Fitted Curve Equation: Ln(T) = 0.92 Ln(X) + 2.72

R^2 = 0.95

If there is no available detour, how does that affect *hours of delay*?

For road or bridge losses that do not have an available detour, the number of daily trips would be based on the number of one-way trips (equivalent to the Average Daily Traffic or ADT), and the delay time will be 12 hours (12:00) per one-way trip. Such losses should be documented using maps that clearly show that no detour is available. In addition, no additional miles due to delay can be counted.

How should I document *additional miles*?

Use the upload document option at the bottom of the screen to attach the estimate of additional miles. This should be dated and signed and be provided on the letterhead of the estimating official. The methodology used in determining the additional miles should be explained either in the estimate document or in the justification field.

Town of Sullivan's Island
DR-4241 Hazard Mitigation Grant
Sullivan's Island Multi-Basin Stormwater
Drainage Improvement Project
DUAL PUMP STATIONS @ STA 18 & STA 18.5
LOCATION :South Basin (Station 18 & 18.5 PS)
Sullivan's Island, South Carolina
ESTIMATOR : CGB/MFY

THOMAS & HUTTON

OPINION OF PROBABLE CONSTRUCTION COST

DATE PREPARED : 02/19/2019	REVISED: 12/15/2021

BASIS FOR ESTIMATE

	(No design completed-Conceptual)
	(Design Development)
X	(Preliminary Final design)

OPINION OF PROBABLE CONSTRUCTION COST

Since the Engineer has no control over the cost of labor, materials, equipment, over the Contractor's methods of determining prices, or over competitive bidding or market conditions, the Opinions of Probable Construction Costs provided for herein are made on the basis of his experience and qualifications. These opinions represent his best judgment as a design professional familiar with the construction industry. However, the Engineer cannot and does not guarantee that proposals, bids, or the construction cost will not vary from Opinions of Probable Construction Costs prepared by him.

	QUANTITY		COST	
DESCRIPTION	NUMBER OF UNITS	UNIT MEASURE	UNIT PRICE	TOTAL COST
IDENTIFICATION				
Inlets	18	each	$4,000	$72,000
Sediment Inlets (grate inlets)	2	each	$7,500	$15,000
Connect to existing Inlets	1	each	$2,500	$2,500
15-Inch Drainage pipes	50	lf	$75	$3,750
18-Inch Drainage pipes	535	lf	$80	$42,800
24-Inch Drainage pipes	320	lf	$90	$28,800
36-Inch Drainage pipes	220	lf	$130	$28,600
Stormwater Pump Station 18	1	Job	$750,000	$750,000
Stormwater Pump Station 18.5	1	Job	$700,000	$700,000
Stormwater Pump Station Installation	2	Job	$75,000	$150,000
Pump station Site Work & related	2	ea.	$30,000	$60,000
18" Force Main	1,000	lf	$100	$100,000
18" Force Main Fitting	1	job	$140,000	$140,000
20" Force Main	560	lf	$125	$70,000
20" Force Main fitting	1	job	$152,000	$152,000
30" Force Main	1,250	lf	$150	$187,500
30" Force Main Fitting	1	job	$200,000	$200,000
Water line Offset	8	ea.	$5,000	$40,000
Driveways	300	sy	$100	$30,000
Road cuts	10	ea.	$5,000	$50,000
Drainage swales	900	lf	$7	$6,300
SCDOT Road Restoration	3,000	lf	$100	$300,000
Site Restoration	2,000	lf	$12	$24,000
Station 18 St (Asphalt Overlay)	1	job	$30,000	$30,000
Atlantic Ave (Asphalt Overlay)	1	job	$25,000	$25,000
Subtotal				**$3,208,250**
MISCELLANEOUS ITEMS				
Mobilization	1	Job	$10,000	$10,000
Tree Protection/Perimeter Fencing (Orange Plastic)	1	Job	$3,500	$3,500
Silt Fence	1	Job	$20,000	$20,000
Traffic Control	15	days	$1,000	$15,000
Utility Conflicts	4	ea.	$20,000	$80,000
Erosion Control	1	Job	$7,500	$7,500
Bonding & Insurance	1.5	%		$48,124
Subtotal				**$184,124**
Total				**$3,392,374**
Generator	2	ea.	$ 100,000	$200,000

Town of Sullivan's Island
DR-4241 Hazard Mitigation Grant
Sullivan's Island Multi-Basin Stormwater
Drainage Improvement Project
DUAL PUMP STATIONS @ STA 18 & STA 18.5
LOCATION :South Basin (Station 18 & 18.5 PS)
Sullivan's Island, South Carolina
ESTIMATOR : CGB/MFY

THOMAS & HUTTON

OPINION OF PROBABLE CONSTRUCTION COST

DATE PREPARED : 02/19/2019	REVISED: 12/15/2021

BASIS FOR ESTIMATE

	(No design completed-Conceptual)
	(Design Development)
X	(Preliminary Final design)

OPINION OF PROBABLE CONSTRUCTION COST

Since the Engineer has no control over the cost of labor, materials, equipment, over the Contractor's methods of determining prices, or over competitive bidding or market conditions, the Opinions of Probable Construction Costs provided for herein are made on the basis of his experience and qualifications. These opinions represent his best judgment as a design professional familiar with the construction industry. However, the Engineer cannot and does not guarantee that proposals, bids, or the construction cost will not vary from Opinions of Probable Construction Costs prepared by him.

	QUANTITY		COST	
DESCRIPTION	**NUMBER OF UNITS**	**UNIT MEASURE**	**UNIT PRICE**	**TOTAL COST**
Electrical	2	ea.	$ 100,000	$200,000
GRAND TOTAL				**$3,792,374**
OPINION OF PROBALBE CONSTRUCTION COST				**$3,800,000**

Notes:

THOMAS & HUTTON

thomasandhutton.com

DELIVERABLE 8:

Photographs of the Project Area

This deliverable presents photographs of the project areas.

The pages that follow present some of the areas that flood even with small rain events.

Immediately after a brief rain shower.

Immediately after a brief rain shower.

The day after a rainfall event which is less than the 1-year storm.

The day after a rainfall event which is less than the 1-year storm.

Brief afternoon rain shower.

Brief afternoon rain shower.

Four days after a rain event (water floods).

Four days after a rain event.

Three days after a rain event.

Three days after a rain event (vehicle stuck in standing water).

Just after a 2-year storm.

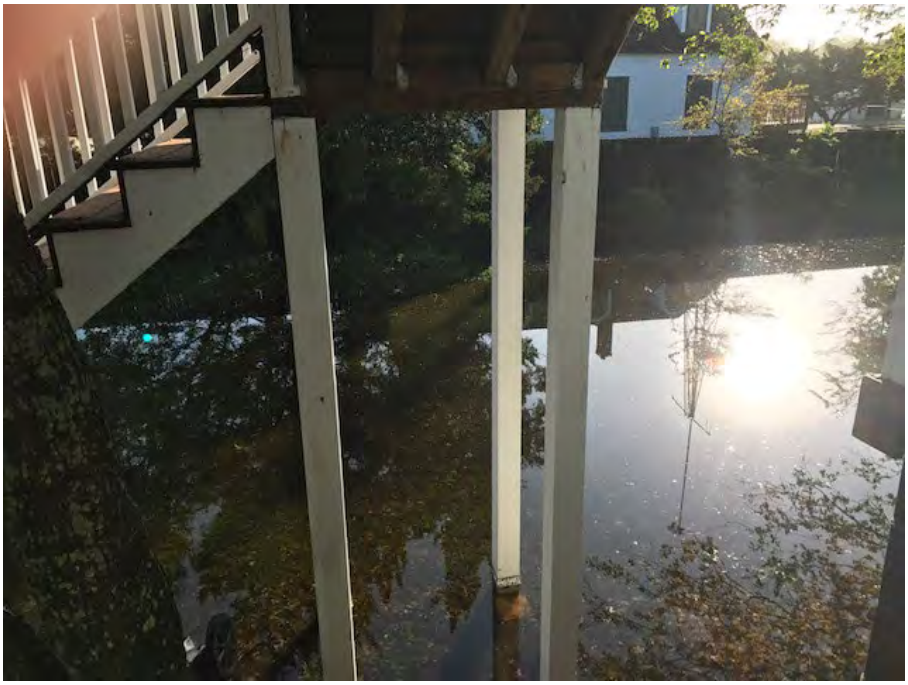
Just after a 2-year storm.

Flooding from short rainfall uphill from proposed pump station site at Sta 18.

Flooding upstream of pump station site from small rain.

Flooding at proposed pump station site days after the event.

Flooding at proposed pump station site days after the event.



Flooding one week after a rain event.

Flooding one week after a rain event.

Lite rainfall – standing water due to no outlet.

30 hours after short duration rain.