Appendix I
Pump Station Technical and Detailed Report

Pre-Hurricane Katrina – View from Inlet Canal

4200 Jean Lafitte Pkwy.
Chalmette, LA 70043
504.512.6331
Position: Latitude 29.966557° Longitude -89.975821°

Pre-Hurricane Katrina – Arial view of pump station

Pump Station Description

Fortification is 1 of 8 pumping stations in St Bernard Parish owned and operated by the Lake Borne Basin Levee District. The station contains three vertical pumps that were installed in 1972 with a total pumping capacity of 980 cubic feet per second (cfs)[1]. Two of the pumps are driven by diesel engines and one by an electric motor. The drainage water is supplied to the pumps from the Florida Walk canal and discharges through the interior back levee to the marsh known as

[1] The Pump Information Table contains more details about the individual pump data and is located at the beginning of this section.

Bayou Bienvenue. The individual pump discharges have a tainter gate installed to cut off water flow in either direction.

Pump Station Operation

Pump station operators will turn the pumps on as they are required to reduce the water elevation in the canal. The pumps are normally turned on when the water in the canal reaches approximately -6 feet (NGVD) and turned off when the water level reaches -6.5 feet (NGVD). When heavy rainfall events are expected the station operators will pump the canal down to an elevation of -8.5 feet (NGVD). If the water elevation on the discharge side of the pump station is predicted to exceed 3.5 feet (NGVD) the station operator closes the discharge tainter gates.

Fuel Endurance Calculation

Assumptions:

1) #2 Diesel fuel is used with an HHV rating of 140,000 btu/gal
2) Burn rate of 35 gph @ 500 kW with above HHV rating
3) Diesel engines are running at rated capacity

PS 1 Fortification

3 pump drivers - 2 diesel and 1 electric. The diesels are rated at 1200 horsepower

The approximate burn rate for each diesel is then calculated:

$$R_{burn} := \left(35 \frac{gal}{hr}\right) \cdot \frac{1200hp}{500kW} \qquad R_{burn} = 62.639 \frac{gal}{hr}$$

Fuel Capacity

4 - 5000 gallon tanks
2 - 110 gallon day tanks

Fuel Endurance

The time the 5000 gallon tanks will last is calculated:

$$t_1 := \frac{4 \cdot 5000gal}{2R_{burn}} \qquad t_1 = 159.645\ hr$$

The time the 110 gallon tanks will last is calculated:

$$t_2 := \frac{2 \cdot 110gal}{2R_{burn}} \qquad t_2 = 1.756\ hr$$

The approximate total continous run time for the pump station is:

$$T_t := t_1 + t_2 \qquad \boxed{T_t = 161.402\ hr}$$

$$\boxed{T_t = 6.725\ day}$$

Pump Curves

Pump capacity curves were obtained either from the parish or from the manufacturer of each pump. From these curves, a curve fit process was used to create new curves and equations.

Using drawings provided, assumptions were made regarding the dimensions of the pump station and the pump. Using these assumptions, the minor and friction losses were calculated in order to create the system curve. Two system curves were created due to the range of heads reported by the parish. The two curves represent the maximum and minimum operating heads reported.

Reverse Flow

The Engineering Hydraulics Design section of the US Army Corps of Engineers Portland District office performed analysis of reverse flow characteristics for each pump. The results are reverse flow rating curves that are attached to this section. The tables present the flow rates per individual pump. The detailed calculations, assumptions, and assumed dimensions are available upon request.

Katrina Event

8/28/05 -Operators pumped water in canal down to approximately 8.5 ft.
8/29/05 -Operators evacuated pump station at approximately 1:15 am.
8/30/05 -Operators returned to the station at 10:00 am. Water was the same elevation on both sides of pump station.
9/01/05 -Both pumps running.
9/11/05 -Pump station back to normal operation.

Damage Report

The following information was obtained from the Project Information Report (PIR) for New Orleans District:
Pump Station 1 sustained relatively minor damage because its operating floor elevation is 16 feet N.G.V.D. Flooding from the storm flooded the lower level of the station but the flood waters were approximately three feet below the concrete operating floor level. Pump station equipment that was damaged includes an electric pump motor, generator, trash rack bearing and gear box, and lighting. The building sustained damage to the metal siding and roof. Additionally, the diesel engine cooling system developed a leak. Auxiliary equipment damage included flooding of a bobcat used to remove debris from the trash racks.

Post-Hurricane Katrina – View from the Inlet Canal

Post-Hurricane Katrina – Arial view of the pump station

CURVE NO. F-15915

REF. 51343-550 548x1-15-4

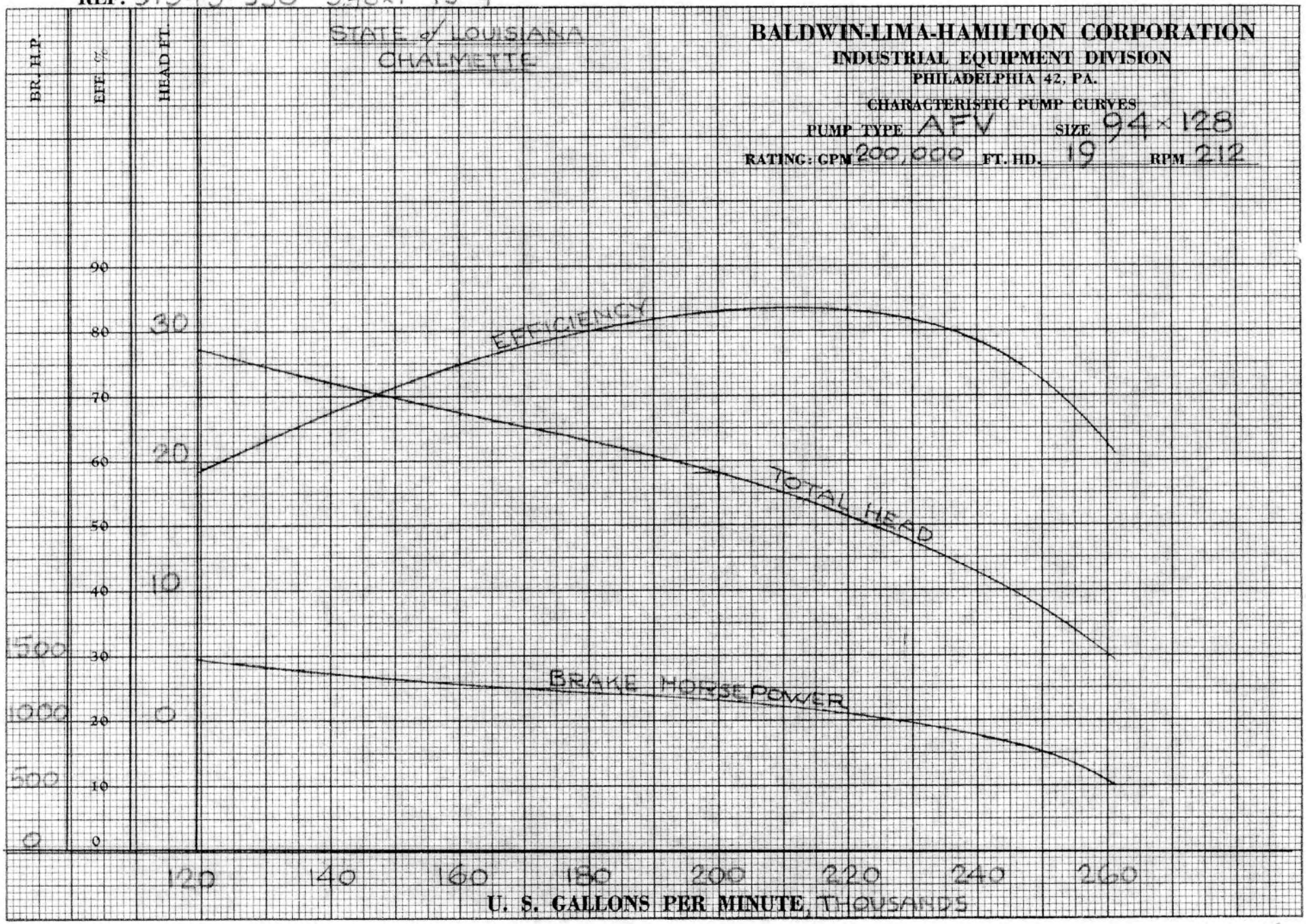
STATE of LOUISIANA
CHALMETTE

BALDWIN-LIMA-HAMILTON CORPORATION
INDUSTRIAL EQUIPMENT DIVISION
PHILADELPHIA 42, PA.

CHARACTERISTIC PUMP CURVES

PUMP TYPE AFV SIZE 94 × 128

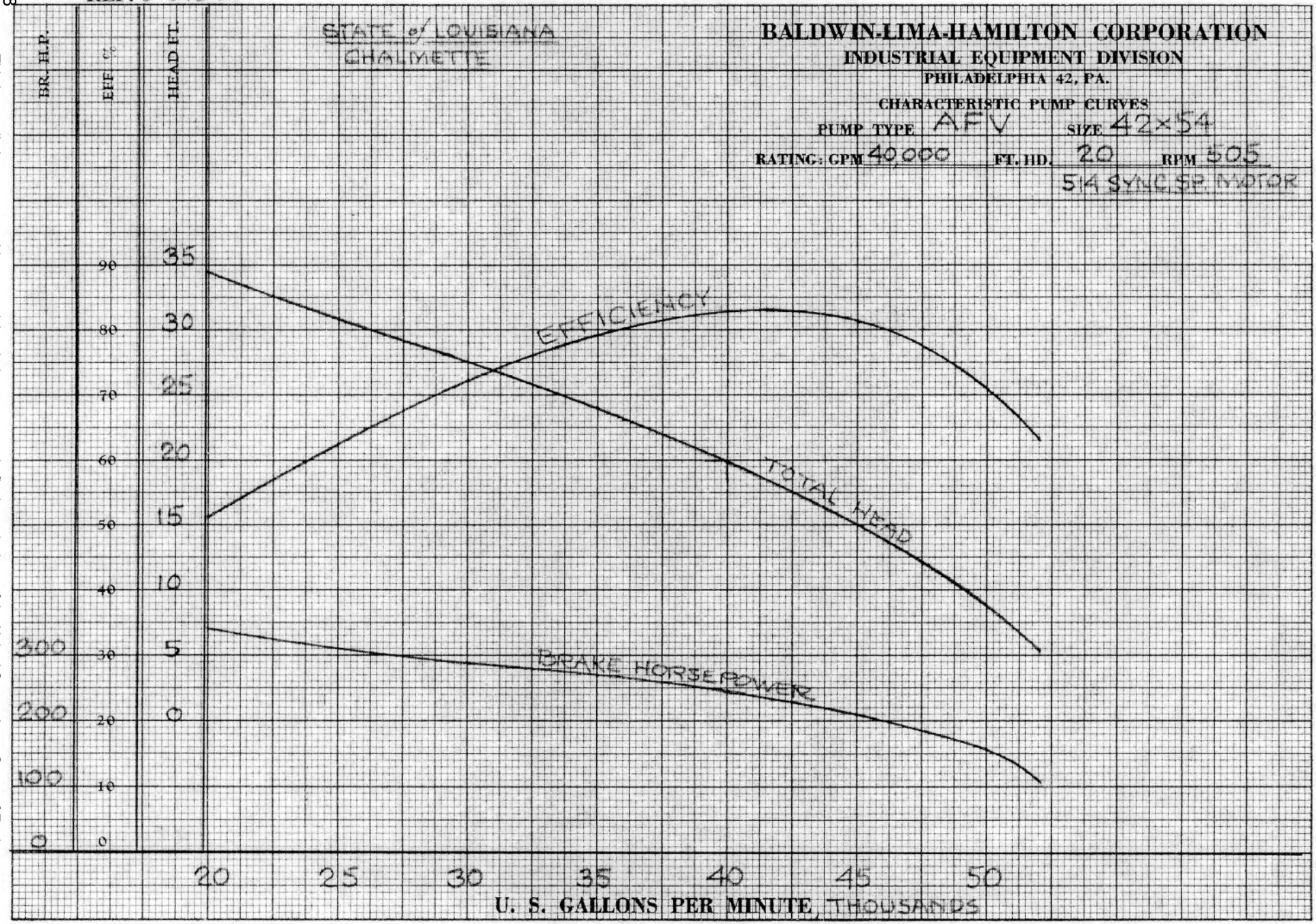
RATING: GPM 200,000 FT. HD. 19 RPM 212



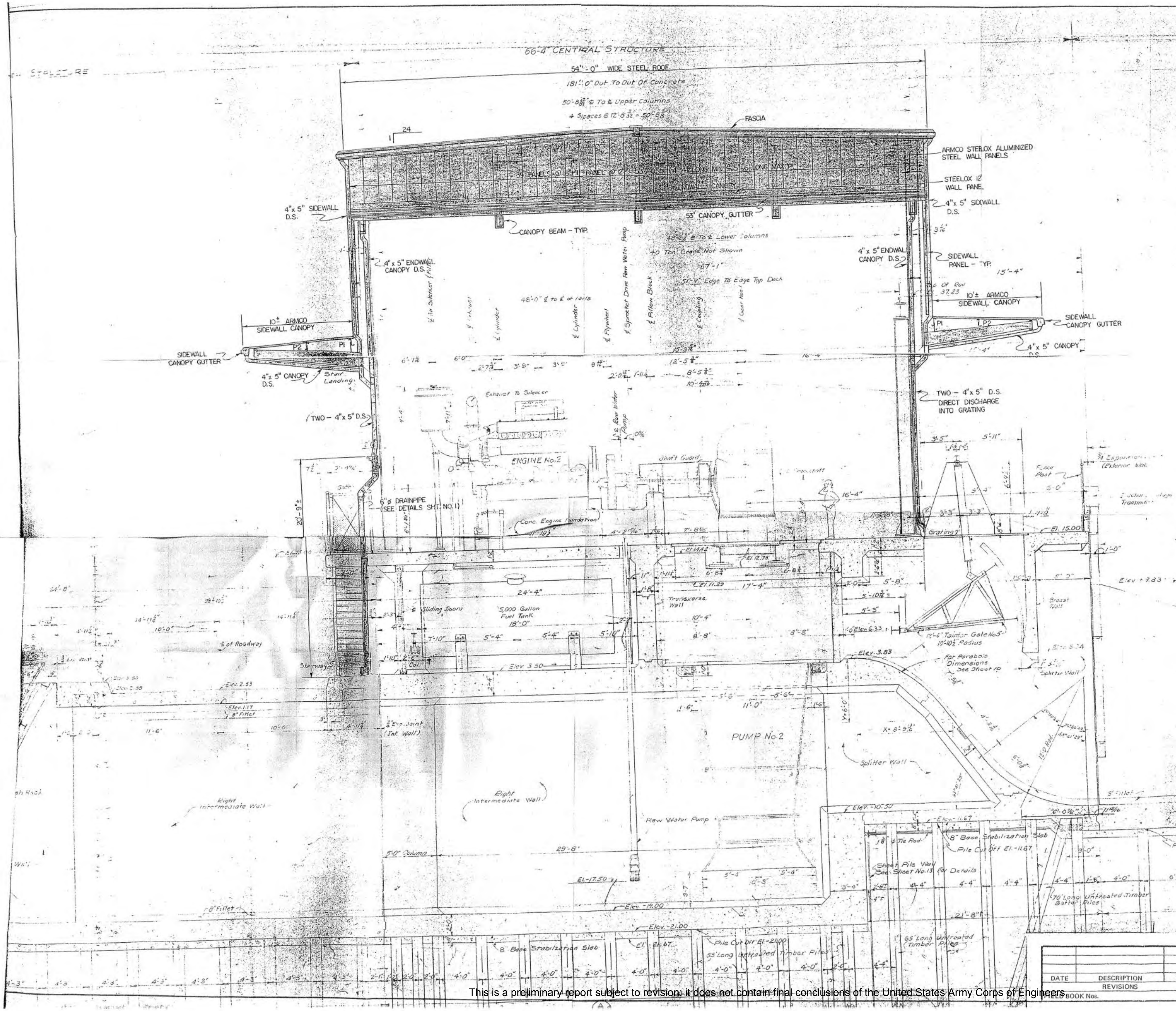
CURVE NO. F 15915

CURVE NO. F-15914

REF. 51343-550



CURVE NO. F-15914



NOTE: PROPOSED METAL ROOF AND WALL SYSTEMS, INCLUDING CANOPIES AND PROPOSED WORK, ARE SHOWN SHADED AND SUPERIMPOSED ON EXISTING CRANE RUNWAY SUPPORT. LEFT ENDWALL PROPOSED WORK IDENTICAL AS SHOWN BUT OPPOSITE HAND.

RIGHT ENDWALL ELEVATION
SCALE: $\frac{1}{4}$" = 1'-0"

RIGHT ENDWALL ELEVATION

STATE OF LOUISIANA
LOUISIANA DEPARTMENT OF PUBLIC WORKS

METAL ROOF AND WALL SYSTEMS
FOR
FORTIFICATION AND MERAUX PUMPING STATIONS
ST. BERNARD PARISH

PREPARED BY LOUISIANA DEPARTMENT OF PUBLIC WORKS
BATON ROUGE, LA.

SUBMITTED BY Earl J. Magnus Jr. DISTRICT ENGINEER — APPROVED BY Daniel V. [illegible] CHIEF ENGINEER

DATED JUNE 1975 — APPROVED BY [illegible]

DESIGNED	G.G	DETAILED	P.G.K.	TRACED	
CHECKED	A.E.S.	CHECKED	G.G.	CHECKED	
APPROVED		SHEET 3	OF 9	SHEETS	

DATE	DESCRIPTION	BY
	REVISIONS	

FIELD BOOK Nos.

Pre-Hurricane Katrina – View from the south end

4201 Jean Lafitte Pkwy.
Chalmette, LA 70043
504.512.6331
Position: Latitude 29.961649° Longitude -89.964442°

Pre-Hurricane Katrina – Arial view of pump station

Pump Station Description

Guichard is 1 of 8 pumping stations in St Bernard Parish owned and operated by the Lake Borne Basin Levee District. The station contains four horizontal pumps that were installed in the 1950's with a total pumping capacity of approximately 755 cubic feet per second (cfs)[1]. All four pumps are driven by diesel engines. The drainage water is supplied to the pumps from the Florida Walk canal and discharges through the interior back levee to the marsh known as Bayou Bienvenue.

[1] The Pump Information Table contains more details about the individual pump data and is located at the beginning of this section.

There was not enough information available to determine the rated capacity for pump 3. It was assumed it would be similar to the pump 1 (42") based on the available information.

Pump Station Operation

This pump station was available but not used in the days before Hurricane Katrina.

Fuel Endurance Calculation

Assumptions:

1) #2 Diesel fuel is used with an HHV rating of 140,000 btu/gal
2) Burn rate of 35 gph @ 500 kW with above HHV rating
3) Diesel engines are running at rated capacity

PS 2 Guichard

4 pump drivers - All diesels

2 diesels are 800 hp, 1 diesel is 335 hp, and 1 is approximately 300 hp

The approximate burn rate for each diesel is then calculated at:

$$R1_{burn} := \left(35\frac{gal}{hr}\right)\cdot\frac{800hp}{500kW} \qquad R1_{burn} = 41.759\frac{gal}{hr}$$

$$R2_{burn} := \left(35\frac{gal}{hr}\right)\cdot\frac{335hp}{500kW} \qquad R2_{burn} = 17.487\frac{gal}{hr}$$

$$R3_{burn} := \left(35\frac{gal}{hr}\right)\cdot\frac{300hp}{500kW} \qquad R3_{burn} = 15.66\frac{gal}{hr}$$

Fuel Capacity

1 - 5,000 gallon tank
4 - 60 gallon day tanks

Fuel Endurance

The time the 5,000 gallon tank will last is calculated:

$$t_1 := \frac{5000gal}{R1_{burn} + R2_{burn} + R3_{burn}} \qquad t_1 = 66.751hr$$

The time the 60 gallon tanks will last is calculated:

$$t_2 := \frac{4\cdot 60gal}{R1_{burn} + R2_{burn} + R3_{burn}} \qquad t_2 = 3.204hr$$

The approximate total continous run time for the station is:

$$T_t := t_1 + t_2 \qquad \boxed{T_t = 69.955hr}$$

$$\boxed{T_t = 2.915day}$$

Pump Curves

Pump curves were obtained from the manufacturer of the pumps. Serial numbers were unobtainable, and therefore only by making assumptions regarding the size and make of the pump as well as the similarity to that of PS 3 Bayou Villere and PS 5 E.J. Gore were any usable curves located. There was no usable information regarding pump 3, so it was assumed similar to

pump 1. From these curves, a curve fit process was used to create new curves and equations. From these curves, further assumptions were made regarding the dimensions of the pump station, pipe, and pumps so that friction and minor losses could be calculated. These calculations created the system curves. There are two curves using the maximum and minimum reported operating heads by the parish.

Reverse Flow

The Engineering Hydraulics Design section of the US Army Corps of Engineers Portland District office performed analysis of reverse flow characteristics for each pump. The results are reverse flow rating curves that are attached to this section. The tables present the flow rates per individual pump. The detailed calculations, assumptions, and assumed dimensions are available upon request.

Katrina Event

This station was designated as a backup and therefore was not used prior to Hurricane Katrina. After the hurricane the pump station could not be operated as the motors were overtopped with water.

Damage Report

The following information was obtained from the Project Information Report (PIR) for New Orleans District:
Pump Station 2 sustained substantial damage. With its operating floor at or near the natural ground elevation, the pump station was flooded to a depth of 6 to 7 feet. The four diesel engines were flooded along with control panels, compressors, motors, and vacuum pumps. The diesel fuel storage tank was moved off its concrete saddle foundation. All exterior and interior lighting was damaged. While the existing building was in poor condition prior to the storm, the wind and water caused additional damage to all four sides of the building and the building roof.

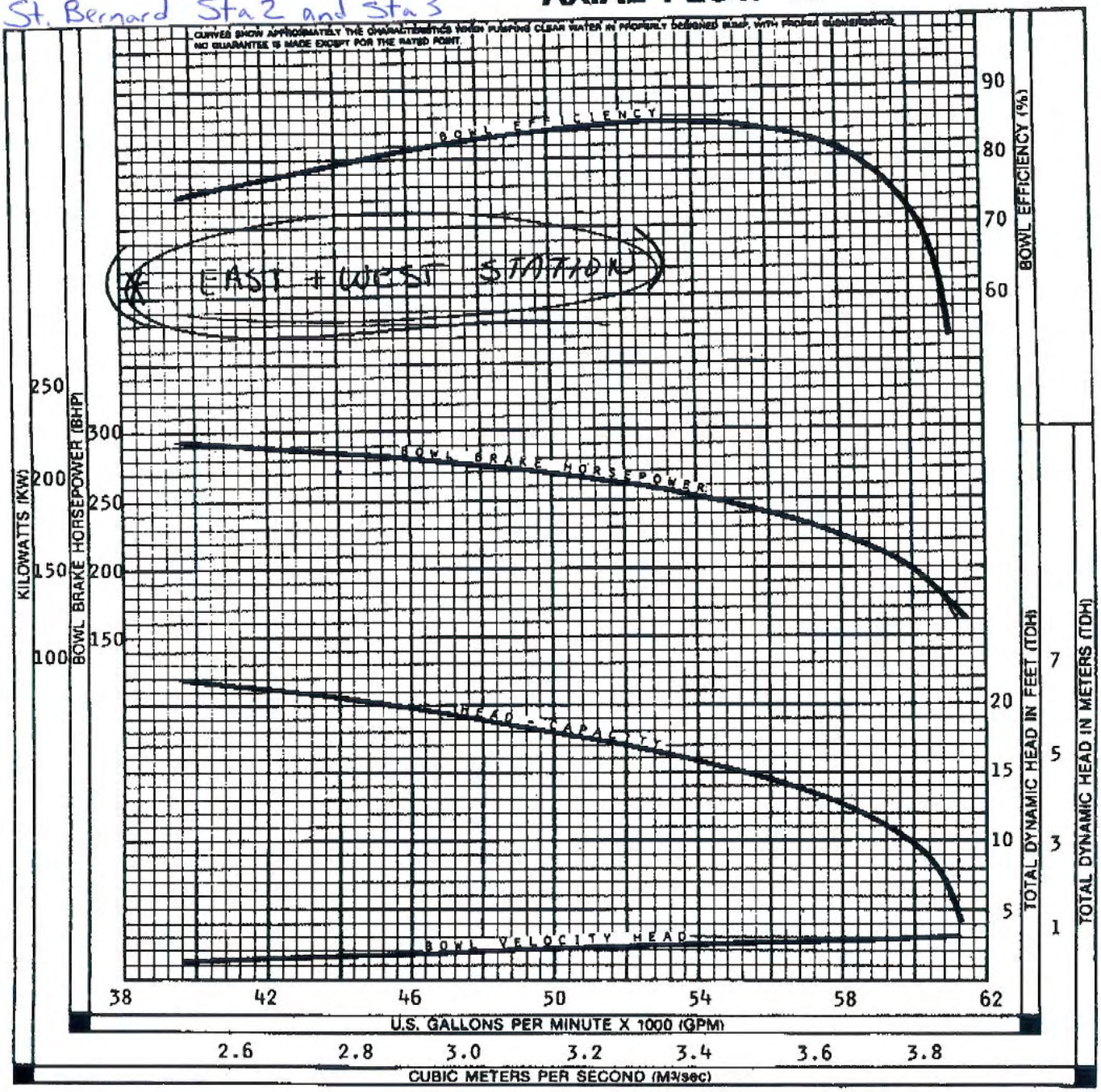
Post-Hurricane Katrina – View from the North

Post-Hurricane Katrina – Arial view of the pump station

AXIAL FLOW 42"

C169

St. Bernard Sta 2 and Sta 3



M&W PUMP-CORP.
DEERFIELD BEACH, FLORIDA 33441 U.S.A.
ESTABLISHED 1926

PUMP BOWL PERFORMANCE CURVE

TYPE: AXIAL FLOW	PROPELLER DIA.: 42"
MODEL NO.: NC342P25	SPEED (RPM): 409
INTAKE DIA.: 63"	DISCHARGE COLUMN DIA.: 42"
CURVE NO.: CS4225	Ns: 12,050 CODE: 50

SINGLE STAGE
FOR TWO STAGES MULTIPLY HEAD AND HORSEPOWER BY 2.0 AND EFFICIENCY BY 1.0

PERFORMANCE BASED ON PUMPING CLEAR COLD NON-AERATED WATER, SPECIFIC GRAVITY 1.0, TEMPERATURE 85 DEGREES (FAHRENHEIT) OR LESS, AT SEA LEVEL. PERFORMANCE MAY BE AFFECTED BY HIGHER TEMPERATURES, SPECIFIC GRAVITIES, ALTITUDES, AND SUMP CONDITIONS.

IT IS HEREBY CERTIFIED THAT THIS CURVE REPRESENTS THE TRUE PERFORMANCE CHARACTERISTICS OF THE M&W PUMP MODEL SHOWN AND WAS OBTAINED BY SCALE MODEL TEST AND CALCULATIONS IN ACCORDANCE WITH STANDARDS OF THE HYDRAULIC INSTITUTE.

M&W PUMP CORPORATION
CERTIFIED BY
Available Upon Request
M&W PUMP CORPORATION
Deerfield Beach, Florida

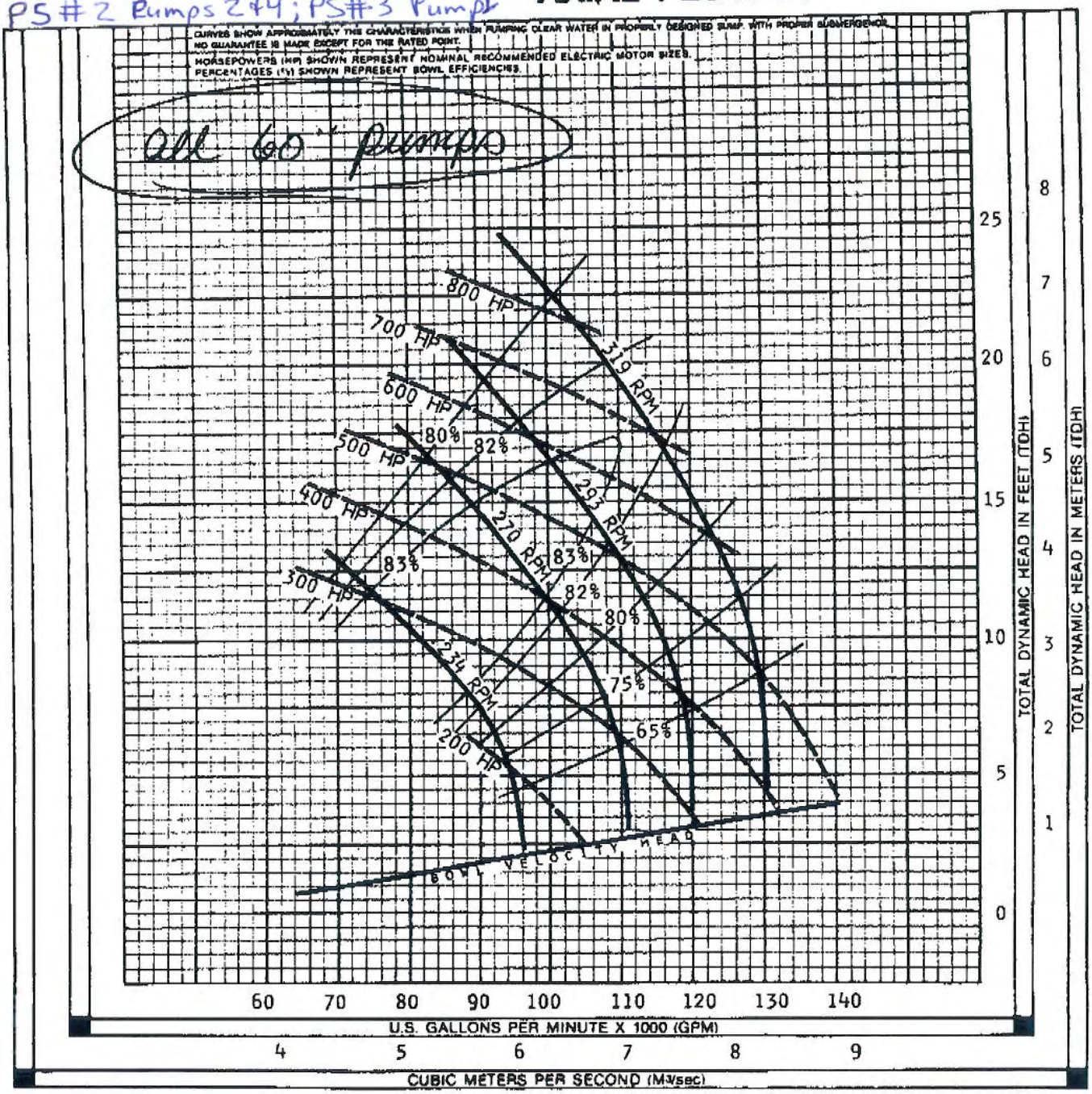
PS #2 Pumps 2+4; PS #3 Pump 1

AXIAL FLOW 60"

C190

CURVES SHOW APPROXIMATELY THE CHARACTERISTICS WHEN PUMPING CLEAR WATER IN PROPERLY DESIGNED SUMP WITH PROPER SUBMERGENCE. NO GUARANTEE IS MADE EXCEPT FOR THE RATED POINT.
HORSEPOWERS (HP) SHOWN REPRESENT NOMINAL RECOMMENDED ELECTRIC MOTOR SIZES.
PERCENTAGES (%) SHOWN REPRESENT BOWL EFFICIENCIES.

all 60" pumps



M&W PUMP CORP
DEERFIELD BEACH, FLORIDA 33441 U.S.A.
ESTABLISHED 1926

PUMP BOWL PERFORMANCE CURVE
VARIABLE SPEED

TYPE: AXIAL FLOW	PROPELLER DIA.: 60"
MODEL NO.: NC360P12	SPEED (RPM): AS NOTED
INTAKE DIA.: 90"	DISCHARGE COLUMN DIA.: 60"
CURVE NO.: VS60P12	Ns: 11,900 CODE:-50

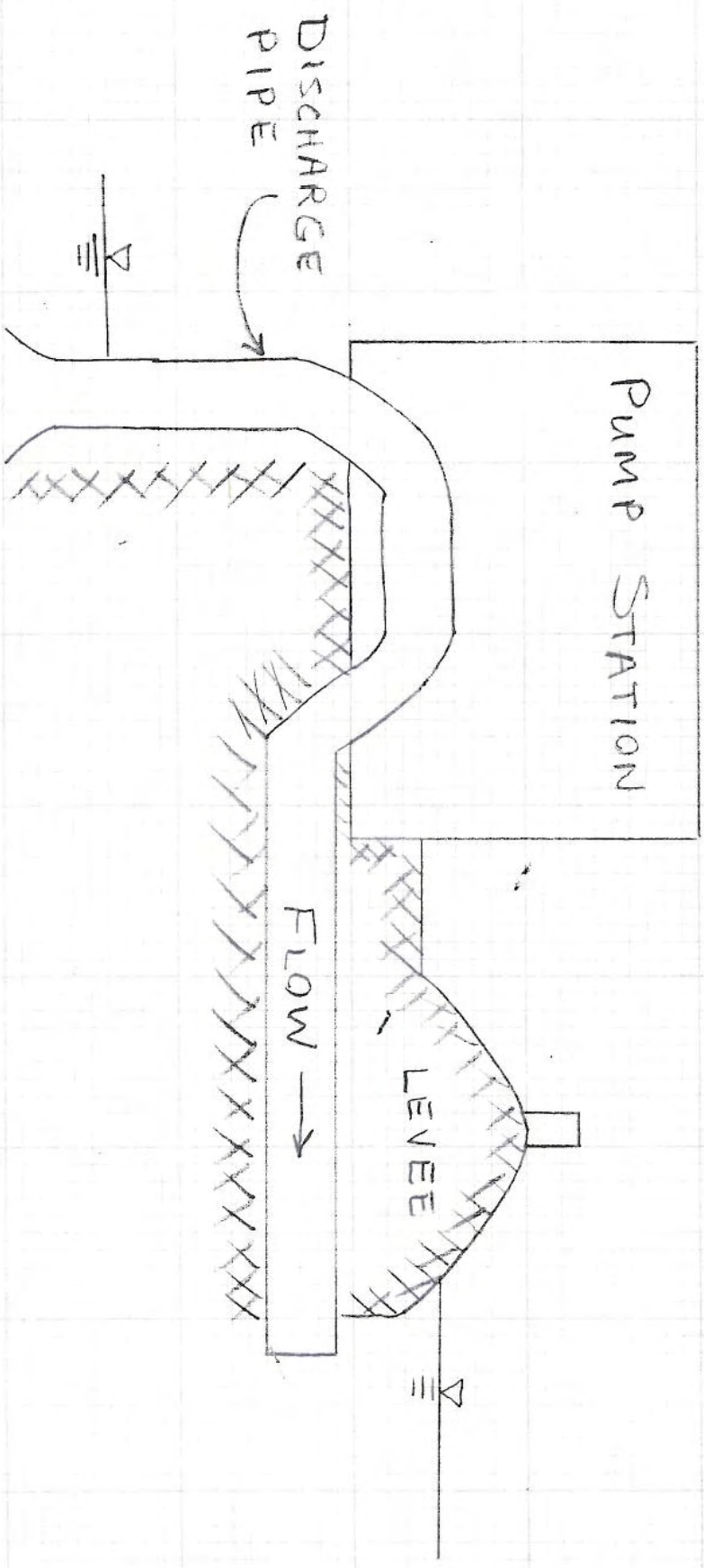
SINGLE STAGE
FOR TWO STAGES MULTIPLY HEAD AND HORSEPOWER BY 2.0 AND EFFICIENCY BY 1.0

PERFORMANCE BASED ON PUMPING CLEAR COLD NON-AERATED WATER, SPECIFIC GRAVITY 1.0, TEMPERATURE 85 DEGREES (FAHRENHEIT) OR LESS, AT SEA LEVEL. PERFORMANCE MAY BE AFFECTED BY HIGHER TEMPERATURES, SPECIFIC GRAVITIES, ALTITUDES, AND SUMP CONDITIONS.

IT IS HEREBY CERTIFIED THAT THIS CURVE REPRESENTS THE TRUE PERFORMANCE CHARACTERISTICS OF THE M&W PUMP MODEL SHOWN AND WAS OBTAINED BY SCALE MODEL TEST AND CALCULATIONS IN ACCORDANCE WITH STANDARDS OF THE HYDRAULIC INSTITUTE.

M&W PUMP CORPORATION
CERTIFIED BY:
Available Upon Request
M&W PUMP CORPORATION
Deerfield Beach, Florida

CH2MHILL SUBJECT Pump Station #2 St. Bernard Parish BY Jerry Snead II.
SHEET NO. 1 of 1 DATE 1/26/06
PROJECT NO.



Pre-Hurricane Katrina - View to the North

3700 Bartolo
Meraux, LA 70075
504.512.6331
Position: Latitude 29.951279° Longitude -89.934607°

Pre-Hurricane Katrina – Arial view of pump station

Pump Station Description

Bayou Villere is 1 of 8 pumping stations in St Bernard Parish owned and operated by the Lake Borne Basin Levee District. The station contains three horizontal pumps that were installed in the 1950's with a total pumping capacity of 800 cubic feet per second (cfs)[1]. All three pumps are driven by diesel engines. The drainage water is supplied to the pumps from the Forty Arpent

[1] The Pump Information Table contains more details about the individual pump data and is located at the beginning of this section.

canal and discharges through the interior back levee to the marsh known as Bayou Villere. Pumps 1 and 2 have butterfly valves on the inlet piping leading to the pump to cut off water flow in either direction.

Pump Station Operation

This pump station is designated as a back up and therefore was not used in the days leading up to Hurricane Katrina.

Fuel Endurance Calculation

Assumptions:

1) #2 Diesel fuel is used with an HHV rating of 140,000 btu/gal
2) Burn rate of 35 gph @ 500 kW with above HHV rating
3) Diesel engines are running at rated capacity

PS 3 Bayou Villere

3 pump drivers - All diesels

Diesels are 800 hp

The approximate burn rate for each diesel is then calculated at:

$$R_{burn} := \left(35\frac{gal}{hr}\right)\cdot\frac{800hp}{500kW} \qquad R_{burn} = 41.759\frac{gal}{hr}$$

Fuel Capacity

1 - 2500 gallon tank
3 - 60 gallon day tanks

Fuel Endurance

The time the 2500 gallon tank will last is calculated:

$$t_1 := \frac{2500gal}{3R_{burn}} \qquad t_1 = 19.956hr$$

The time the 60 gallon tank will last is calculated:

$$t_2 := \frac{3\cdot 60gal}{3R_{burn}} \qquad t_2 = 1.437hr$$

The approximate total continous run time for the station is:

$$T_t := t_1 + t_2 \qquad \boxed{T_t = 21.392hr}$$

$$\boxed{T_t = 0.891day}$$

Pump Curves

Pump capacity curves were obtained. From these curves, a curve fit process was used to create new curves and equations. During the data collection, only one pump serial number was found, so the others were assumed to be similar. Using manufacturer data and making assumptions regarding the dimensions of the pump station and pump, as well as other necessary assumptions, the minor and friction losses were calculated so that system curves could be created. Two curves were made due to the range of operating heads reported from the parish. The two curves represent the maximum and minimum operating heads reported.

Reverse Flow

The Engineering Hydraulics Design section of the US Army Corps of Engineers Portland District office performed analysis of reverse flow characteristics for each pump. The results are reverse flow rating curves that are attached to this section. The tables present the flow rates per individual pump. The detailed calculations, assumptions, and assumed dimensions are available upon request.

Katrina Event

This station was designated as a backup and therefore was not used prior to Hurricane Katrina. After the hurricane the pump station could not be operated as the motors were overtopped with water.

Damage Report

The following information was obtained from the Project Information Report (PIR) for New Orleans District:
Pump Station 3 sustained substantial damage. With its operating floor at or near the natural ground elevation, the pump station was flooded to a depth of 8 feet. The three diesel engines and hydraulic drives were flooded along with the vacuum pump system and ancillary equipment. The diesel fuel storage tank was moved off its foundation. All exterior and interior lighting was damaged. While the existing building was is poor condition prior to the storm, the wind and water caused additional damage to all four sides of the building.

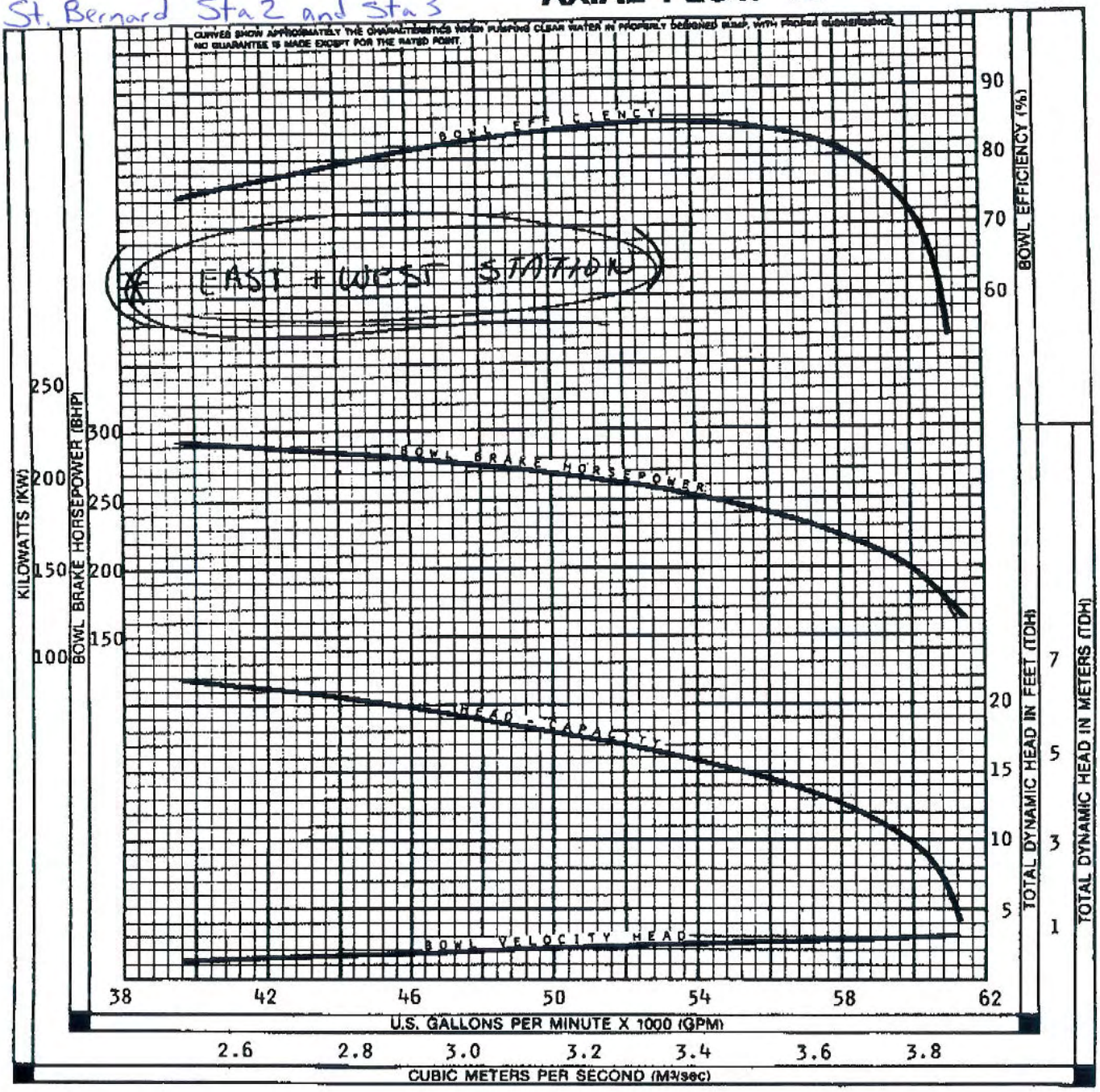
Post-Hurricane Katrina – View to the South

Post-Hurricane Katrina – Arial view of the pump station

AXIAL FLOW 42"

C169

St. Bernard Sta 2 and Sta 3



M&W PUMP-CORP.
DEERFIELD BEACH, FLORIDA 33441 U.S.A.
ESTABLISHED 1926

PUMP BOWL PERFORMANCE CURVE

TYPE: AXIAL FLOW	PROPELLER DIA.: 42"
MODEL NO.: NC342P25	SPEED (RPM): 409
INTAKE DIA.: 63"	DISCHARGE COLUMN DIA.: 42"
CURVE NO.: CS4225	Ns: 12,050 CODE: -50

SINGLE STAGE
FOR TWO STAGES MULTIPLY HEAD AND HORSEPOWER BY 2.0 AND EFFICIENCY BY 1.0

PERFORMANCE BASED ON PUMPING CLEAR COLD NON-AERATED WATER, SPECIFIC GRAVITY 1.0, TEMPERATURE 85 DEGREES (FAHRENHEIT) OR LESS, AT SEA LEVEL. PERFORMANCE MAY BE AFFECTED BY HIGHER TEMPERATURES, SPECIFIC GRAVITIES, ALTITUDES, AND SUMP CONDITIONS.

IT IS HEREBY CERTIFIED THAT THIS CURVE REPRESENTS THE TRUE PERFORMANCE CHARACTERISTICS OF THE M&W PUMP MODEL SHOWN AND WAS OBTAINED BY SCALE MODEL TEST AND CALCULATIONS IN ACCORDANCE WITH STANDARDS OF THE HYDRAULIC INSTITUTE.

M&W PUMP CORPORATION
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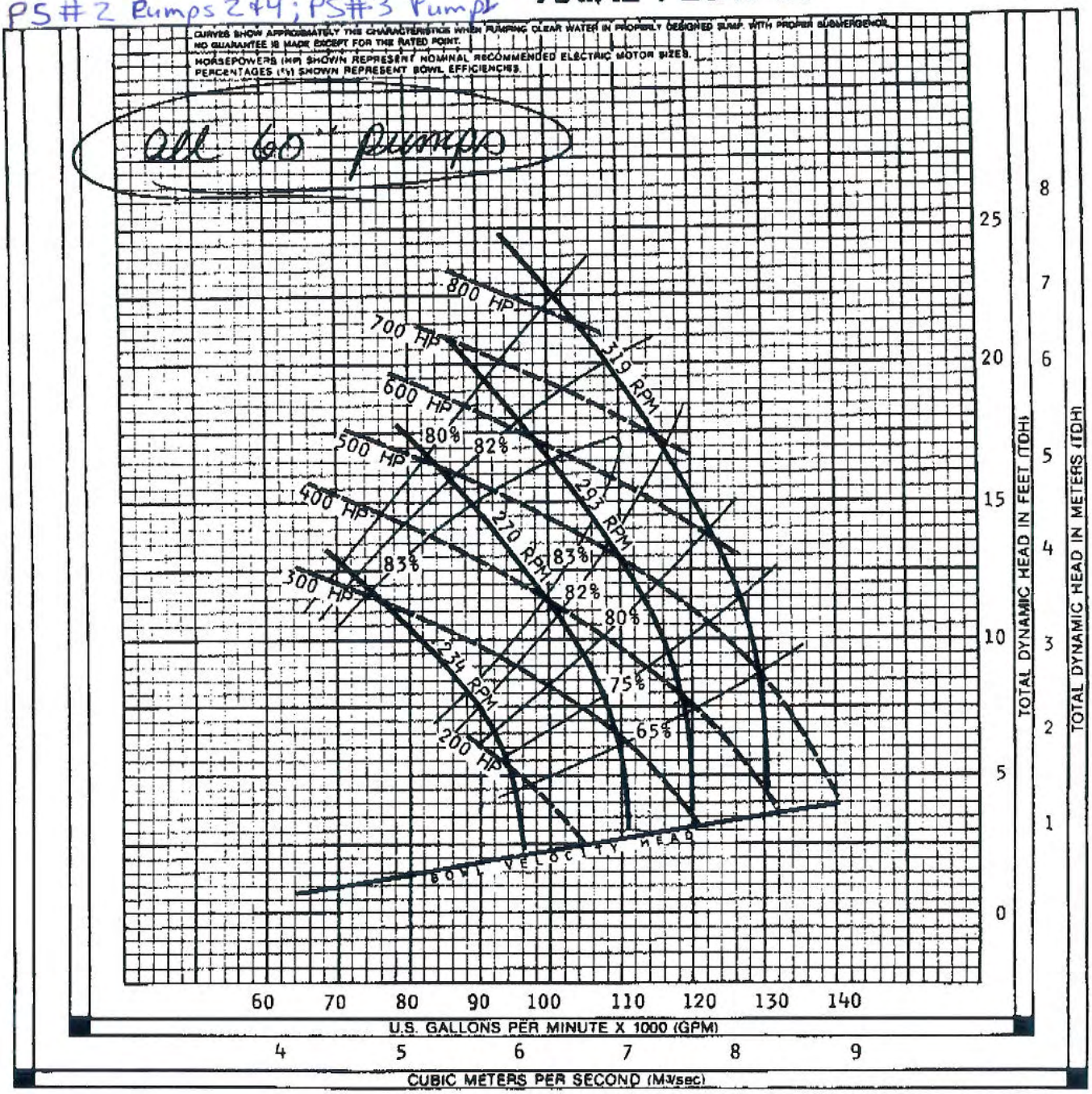
Available Upon Request
M&W PUMP CORPORATION
Deerfield Beach, Florida

PS #2 Pumps 2+4; PS #3 Pump 1

AXIAL FLOW 60"

C190



M&W PUMP CORP.
DEERFIELD BEACH, FLORIDA 33441 U.S.A.
ESTABLISHED 1926

PUMP BOWL PERFORMANCE CURVE
VARIABLE SPEED

TYPE: AXIAL FLOW	PROPELLER DIA.: 60"
MODEL NO.: NC360P12	SPEED (RPM): AS NOTED
INTAKE DIA.: 90"	DISCHARGE COLUMN DIA.: 60"
CURVE NO.: VS60P12	Ns: 11,900 CODE: 50

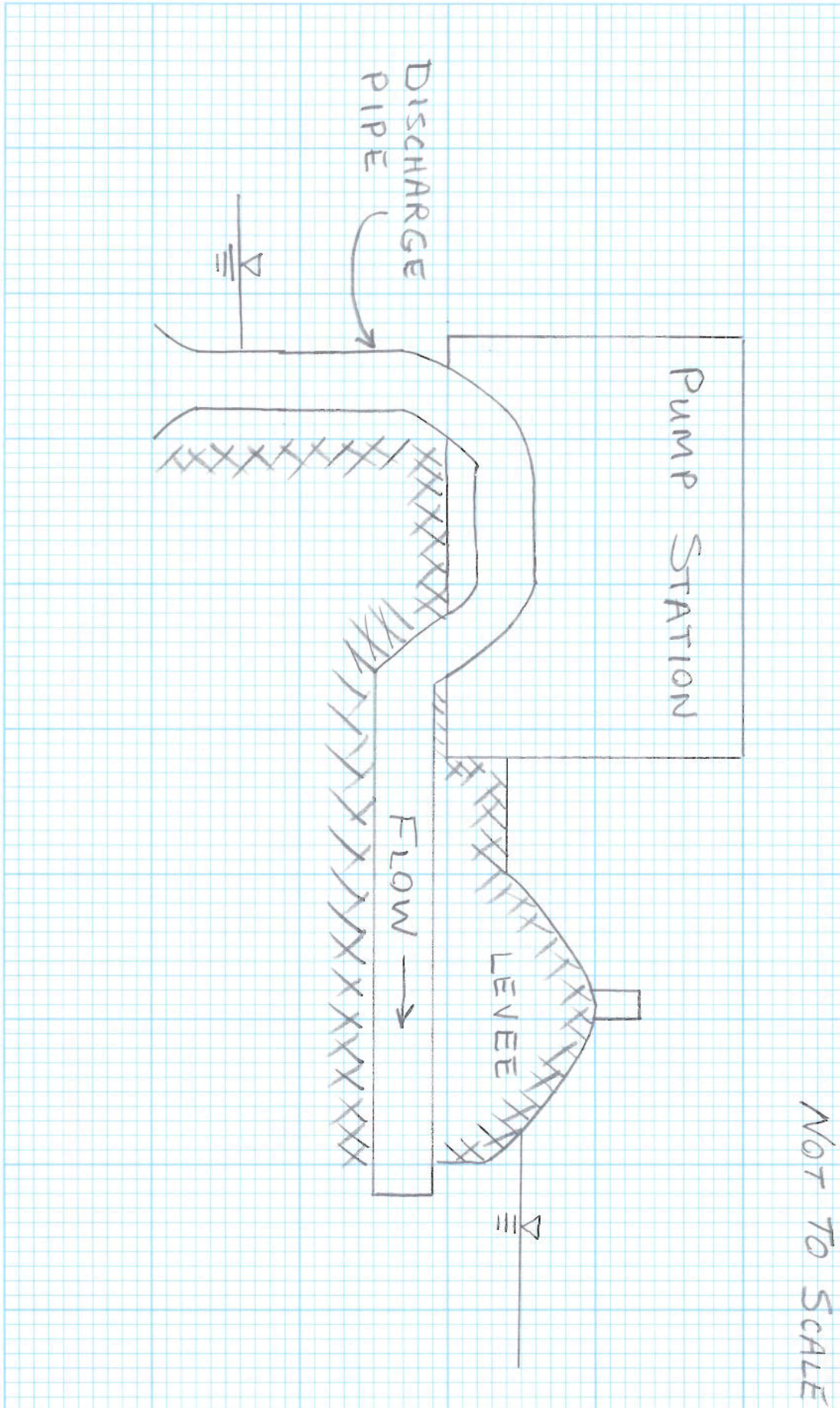
SINGLE STAGE
FOR TWO STAGES MULTIPLY HEAD AND HORSEPOWER BY 2.0 AND EFFICIENCY BY 1.0

PERFORMANCE BASED ON PUMPING CLEAR COLD NON-AERATED WATER, SPECIFIC GRAVITY 1.0, TEMPERATURE 85 DEGREES (FAHRENHEIT) OR LESS, AT SEA LEVEL. PERFORMANCE MAY BE AFFECTED BY HIGHER TEMPERATURES, SPECIFIC GRAVITIES, ALTITUDES, AND SUMP CONDITIONS.

IT IS HEREBY CERTIFIED THAT THIS CURVE REPRESENTS THE TRUE PERFORMANCE CHARACTERISTICS OF THE M&W PUMP MODEL SHOWN AND WAS OBTAINED BY SCALE MODEL TEST AND CALCULATIONS IN ACCORDANCE WITH STANDARDS OF THE HYDRAULIC INSTITUTE.

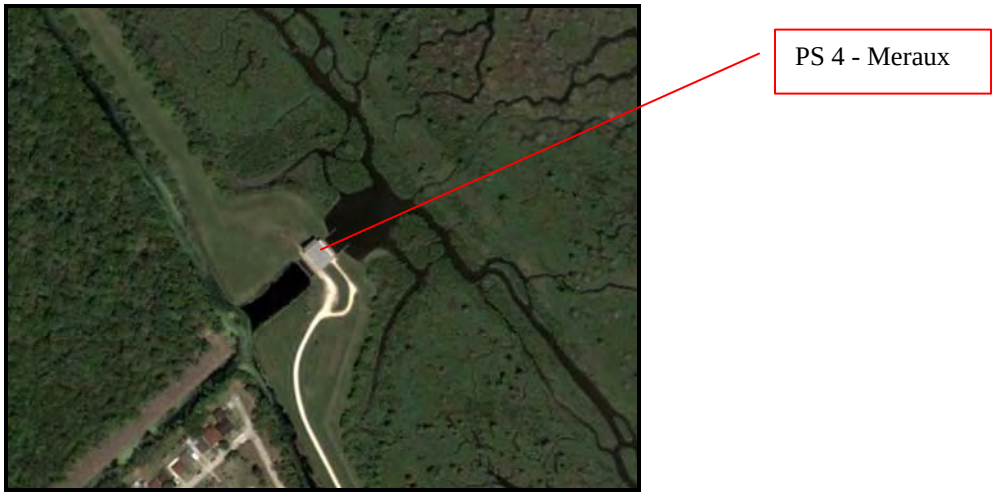
M&W PUMP CORPORATION
CERTIFIED BY:
Available Upon Request
M&W PUMP CORPORATION
Deerfield Beach, Florida

CH2MHILL SUBJECT Pump Station #3 St. Bernard Parish BY Jerry Snead II SHEET NO. 1 of 1 DATE 1/26/06 PROJECT NO.



Pre-Hurricane Katrina – View from Inlet Canal

3200 Guerra Dr.
Violet, LA 70092
504.512.6331
Position: Latitude 29.921331° Longitude -89.891292°



Pre-Hurricane Katrina – Arial view of pump station

Pump Station Description

Meraux is 1 of 8 pumping stations in St Bernard Parish owned and operated by the Lake Borne Basin Levee District. The station contains three vertical pumps that were installed in 1972 with a total pumping capacity of 980 cubic feet per second (cfs)[1]. Two of the pumps are driven by diesel engines and one by an electric motor. The drainage water is supplied to the pumps from the Forty Arpent canal and discharges through the interior back levee to the marsh known as

[1] The Pump Information Table contains more details about the individual pump data and is located at the beginning of this section.

Bayou Dupre. The individual pump discharges have a tainter gates installed to cut off water flow in either direction.

Pump Station Operation

Pump station operators will turn the pumps on as they are required to reduce the water elevation in the canal. The pumps are normally turned on when the water in the canal reaches approximately -6 feet (NGVD) and turned off when the water level reaches -6.5 feet (NGVD). When heavy rainfall events are expected the station operators will pump the canal down to an elevation of -8.5 feet (NGVD). If the water elevation on the discharge side of the pump station is predicted to exceed 3.5 feet (NGVD) the station operator closes the discharge tainter gates.

Fuel Endurance Calculation

Assumptions:

1) #2 Diesel fuel is used with an HHV rating of 140,000 btu/gal
2) Burn rate of 35 gph @ 500 kW with above HHV rating
3) Diesel engines are running at rated capacity

PS 4 Meraux

3 pump drivers - 2 are diesels and 1 is electric

The 2 diesels are 1200 hp

The approximate burn rate for each diesel is then calculated at:

$$R_{burn} := \left(35\frac{gal}{hr}\right)\cdot\frac{1200hp}{500kW} \qquad R_{burn} = 62.639\frac{gal}{hr}$$

Fuel Capacity

4 - 5000 gallon tanks
2 - 110 gallon day tanks

Fuel Endurance

The time the 5000 gallon tanks will last is calculated:

$$t_1 := \frac{4\cdot 5000gal}{2R_{burn}} \qquad t_1 = 159.645hr$$

The time the 60 gallon tanks will last is calculated:

$$t_2 := \frac{2\cdot 110gal}{2R_{burn}} \qquad t_2 = 1.756hr$$

The approximate total continous run time for the station is:

$$T_t := t_1 + t_2 \qquad \boxed{T_t = 161.402hr}$$

$$\boxed{T_t = 6.725day}$$

Pump Curves

Pump capacity curves were obtained either from the parish or from the manufacturer of each pump. From these curves, a curve fit process was used to create new curves and equations.

Using drawings provided, assumptions were made regarding the dimensions of the pump station and the pump. Using these assumptions, the minor and friction losses were calculated in order to create the system curve. Two system curves were created due to the range of heads reported by the parish. The two curves represent the maximum and minimum operating heads reported.

Reverse Flow

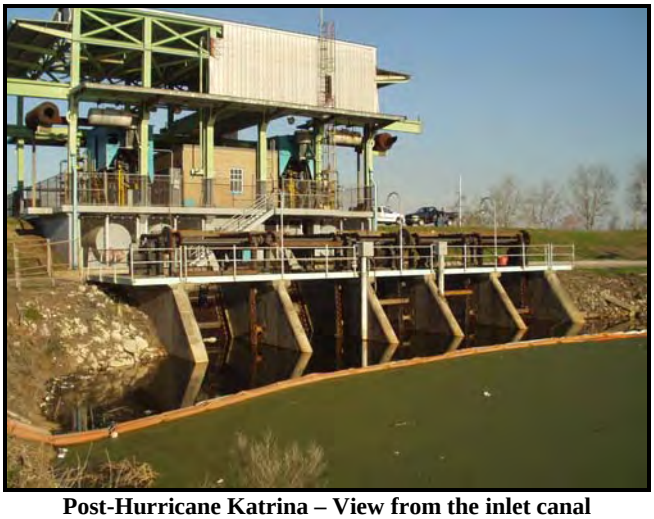
The Engineering Hydraulics Design section of the US Army Corps of Engineers Portland District office performed analysis of reverse flow characteristics for each pump. The results are reverse flow rating curves that are attached to this section. The tables present the flow rates per individual pump. The detailed calculations, assumptions, and assumed dimensions are available upon request.

Katrina Event

8/28/05 - Operators pumped water in canal down to approximately -8.5 feet (NGVD).
8/29/05 - Operators evacuated pump station at approximately 1:15 am.
9/03/05 - Operators returned to pump water down.
9/09/05 - **Pump Station back to normal operation.**

Damage Report

The following information was obtained from the Project Information Report (PIR) for New Orleans District:
Pump Station 4 sustained relatively minor damage because its operating floor elevation is 16 feet N.G.V.D. Flooding from the storm flooded the lower level of the station but the flood waters were approximately three feet below the concrete operating floor level. Pump station equipment that was damaged includes an air compressor, electomode heater, controller for compressed air dryer motor, and generator. The building sustained damage to metal siding and roof. Finally, one discharge flap gate was damaged and is not operational.



Post-Hurricane Katrina – View from the inlet canal

Post-Hurricane Katrina – Arial view of the pump station

CURVE NO. F-15915

REF. 51343-550 548x1-15-4

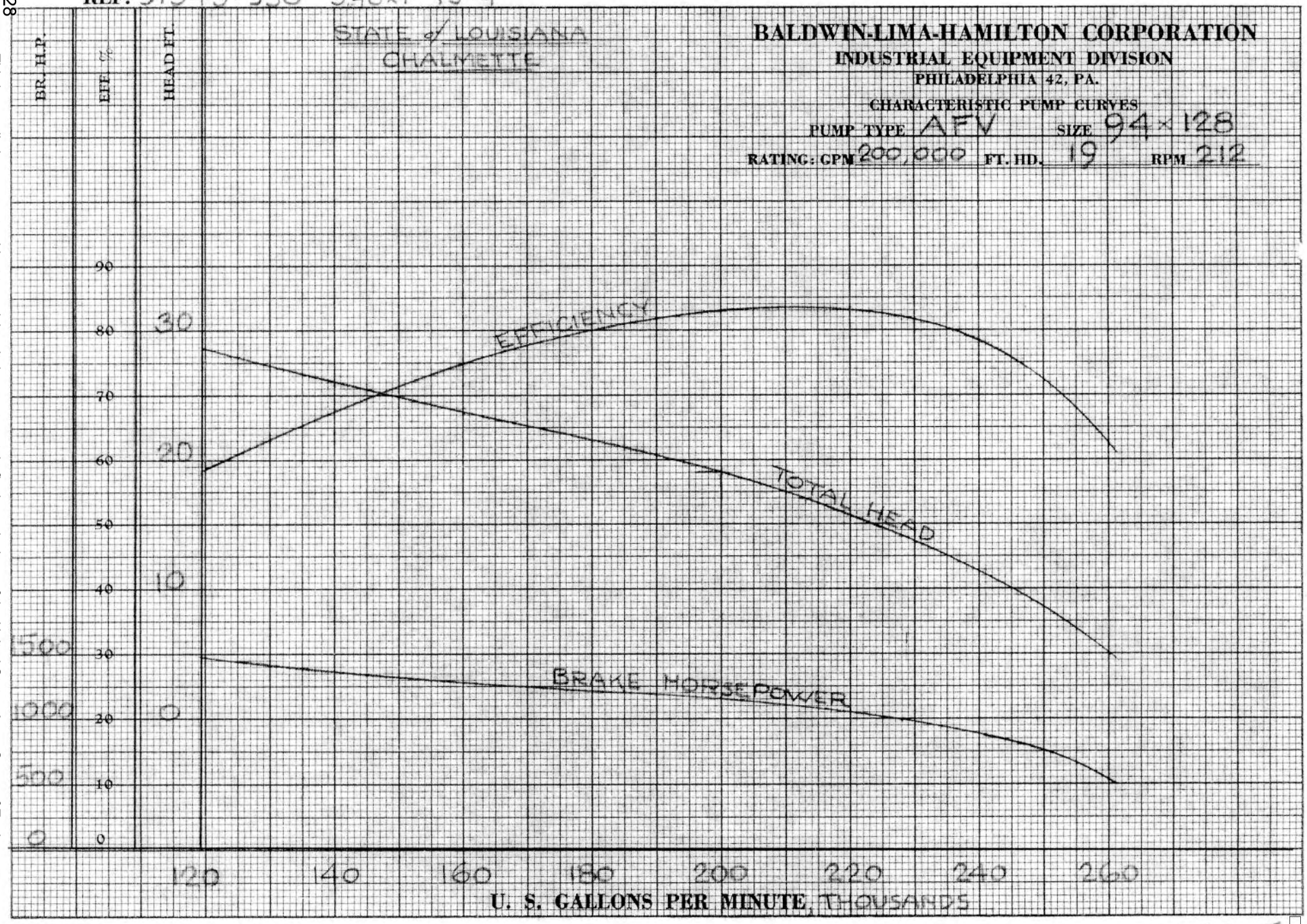
STATE of LOUISIANA
CHALMETTE

BALDWIN-LIMA-HAMILTON CORPORATION
INDUSTRIAL EQUIPMENT DIVISION
PHILADELPHIA 42, PA.

CHARACTERISTIC PUMP CURVES

PUMP TYPE AFV SIZE 94 × 128

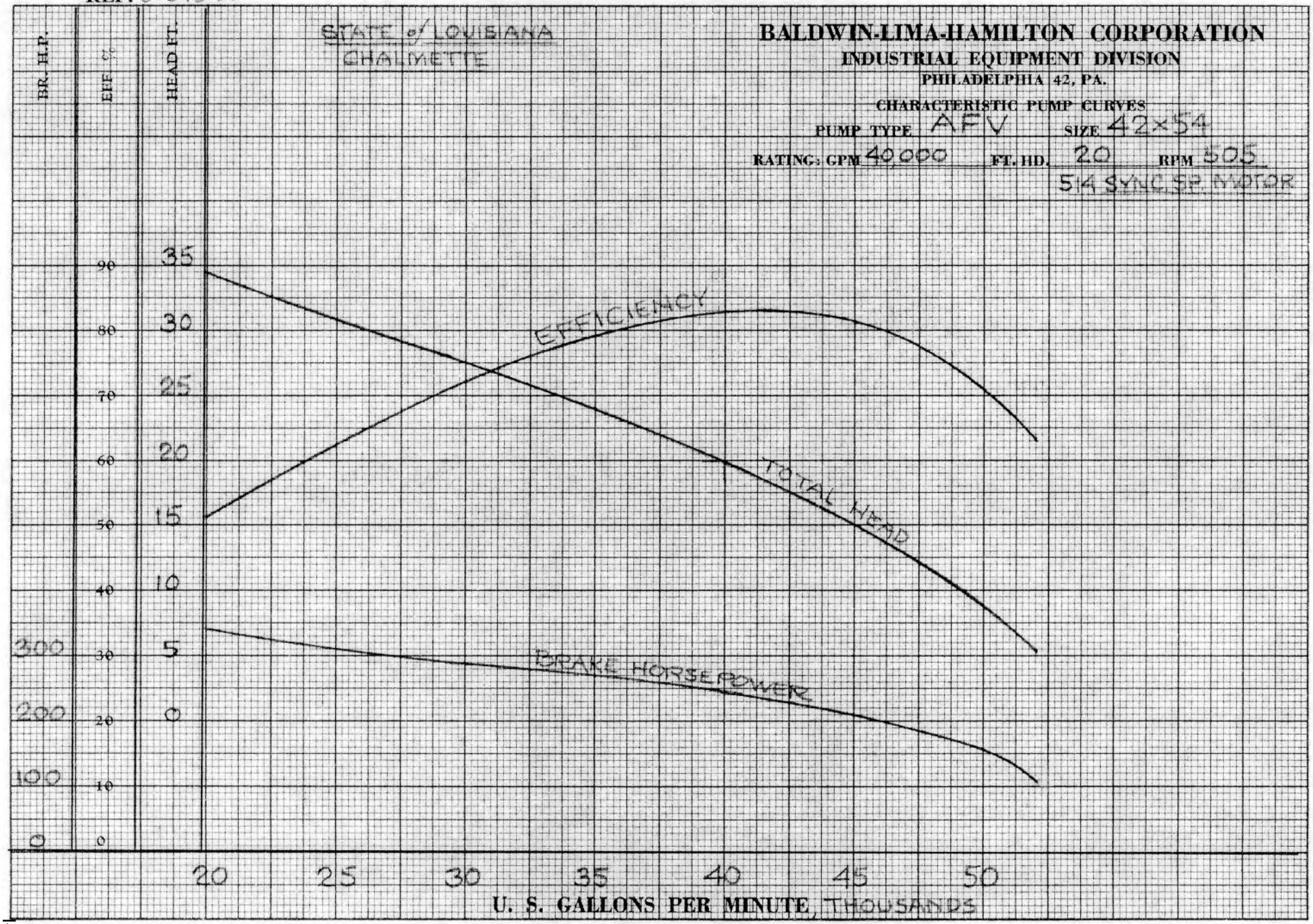
RATING: GPM 200,000 FT. HD. 19 RPM 212



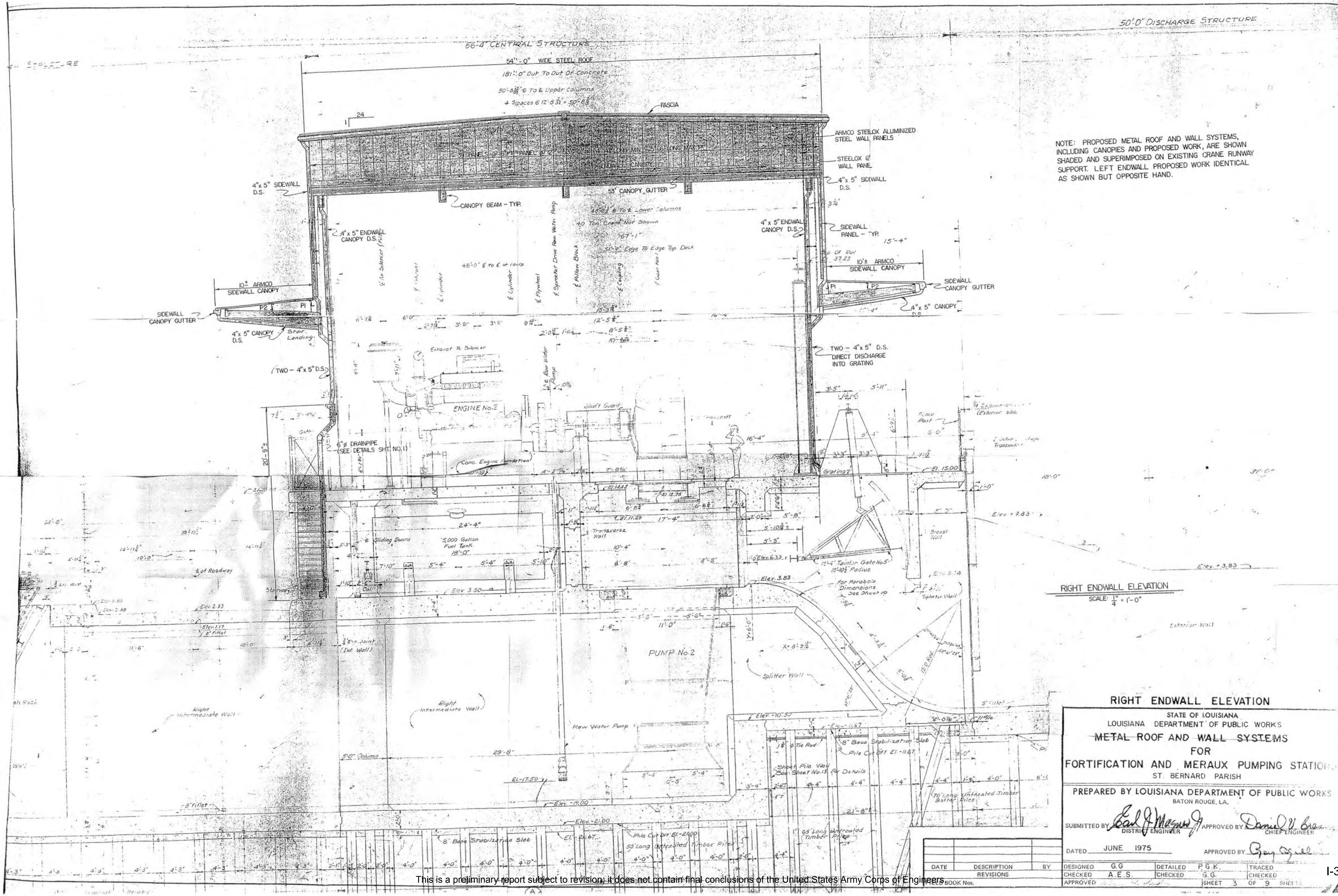
CURVE NO. F 15915

CURVE NO. F-15914

REF. 51343-550



CURVE NO. F-15914



NOTE: PROPOSED METAL ROOF AND WALL SYSTEMS, INCLUDING CANOPIES AND PROPOSED WORK, ARE SHOWN SHADED AND SUPERIMPOSED ON EXISTING CRANE RUNWAY SUPPORT. LEFT ENDWALL PROPOSED WORK IDENTICAL AS SHOWN BUT OPPOSITE HAND.

RIGHT ENDWALL ELEVATION

STATE OF LOUISIANA
LOUISIANA DEPARTMENT OF PUBLIC WORKS

METAL ROOF AND WALL SYSTEMS
FOR
FORTIFICATION AND MERAUX PUMPING STATIONS
ST. BERNARD PARISH

PREPARED BY LOUISIANA DEPARTMENT OF PUBLIC WORKS
BATON ROUGE, LA.

SUBMITTED BY Earl J. Magner Jr. DISTRICT ENGINEER
APPROVED BY Daniel V. [illegible] CHIEF ENGINEER
DATED JUNE 1975
APPROVED BY [illegible]

DATE	DESCRIPTION	BY
	REVISIONS	

FIELD BOOK Nos.

DESIGNED	G.G	DETAILED	P.G.K.	TRACED	
CHECKED	A.E.S.	CHECKED	G.G.	CHECKED	
APPROVED		SHEET 3	OF 9	SHEETS	

Pre-Hurricane Katrina – View to the North

7701 East Judge Perez Dr.
Violet, LA 70085
504.512.6331
Position: Latitude 29.961649° Longitude -89.964442°

Pre-Hurricane Katrina – Arial view of the pump station

Pump Station Description

EJ Gore is 1 of 8 pumping stations in St Bernard Parish owned and operated by the Lake Borne Basin Levee District. The station contains six horizontal pumps that were installed in the 1980's with a total pumping capacity of 665 cubic feet per second (cfs)[1] and are driven by diesel engines. The drainage water is supplied to the pumps from the Forty Arpent canal and discharges through the interior back levee to the marsh known as Bayou Dupre. All pumps are equipped flap gates.

[1] The Pump Information Table contains more details about the individual pump data and is located at the beginning of this section.

Pump Station Operation

Pump station operators will turn the pumps on as they are required to reduce the water elevation in the canal. The pumps are normally turned on when the water in the canal reaches approximately 0.0 feet (NGVD) and turned off when the water level reaches -0.5 feet (NGVD). When heavy rainfall events are expected the station operators will pump the canal down to an elevation of -3.0 feet (NGVD).

Fuel Endurance Calculation

Assumptions:

1) #2 Diesel fuel is used with an HHV rating of 140,000 btu/gal
2) Burn rate of 35 gph @ 500 kW with above HHV rating
3) Diesel engines are running at rated capacity

PS 5 E.J. Gore

6 pump drivers - All diesels

Diesels are 335 hp

The approximate burn rate for each diesel is then calculated at:

$$R_{burn} := \left(35\frac{gal}{hr}\right)\cdot\frac{335hp}{500kW} \qquad R_{burn} = 17.487\frac{gal}{hr}$$

Fuel Capacity

1 - 20,000 gallon tank
5 - 50 gallon day tanks
1 - 75 gallon tank

Fuel Endurance

The time the 20,000 gallon tank will last is calculated:

$$t_1 := \frac{20000gal}{6R_{burn}} \qquad t_1 = 190.621hr$$

The time the 50 gallon tanks will last is calculated:

$$t_2 := \frac{5\cdot 50gal}{6R_{burn}} \qquad t_2 = 2.383hr$$

The time the 75 gallon tank will last is calculated:

$$t_3 := \frac{75gal}{6R_{burn}} \qquad t_3 = 0.715hr$$

The approximate total continous run time for the station is:

$$T_t := t_1 + t_2 + t_3 \qquad \boxed{T_t = 193.719hr}$$

$$\boxed{T_t = 8.072day}$$

Pump Curves

Pump curves were obtained from both the parish and the manufacturer. From these curves, a curve fit process was used to create new curves and equations. Using this data as well as making assumptions regarding the dimensions of the pump and the pump station, minor and friction losses were accounted for. These calculations led to the creation of the system curves. Two

curves were made due to the range of operating heads provided by the parish. The two curves represent the maximum and minimum operating heads reported.

Reverse Flow

The Engineering Hydraulics Design section of the US Army Corps of Engineers Portland District office performed analysis of reverse flow characteristics for each pump. The results are reverse flow rating curves that are attached to this section. The tables present the flow rates per individual pump. The detailed calculations, assumptions, and assumed dimensions are available upon request.

Katrina Event

8/28/05 - Operators pumped water in canal down to approximately -3.0ft.
8/29/05 - Operators evacuated station at approximately 1:15 am.
8/30/05 - Motors were overtopped during storm. Pumps had not been repaired as of site visit.

Damage Report

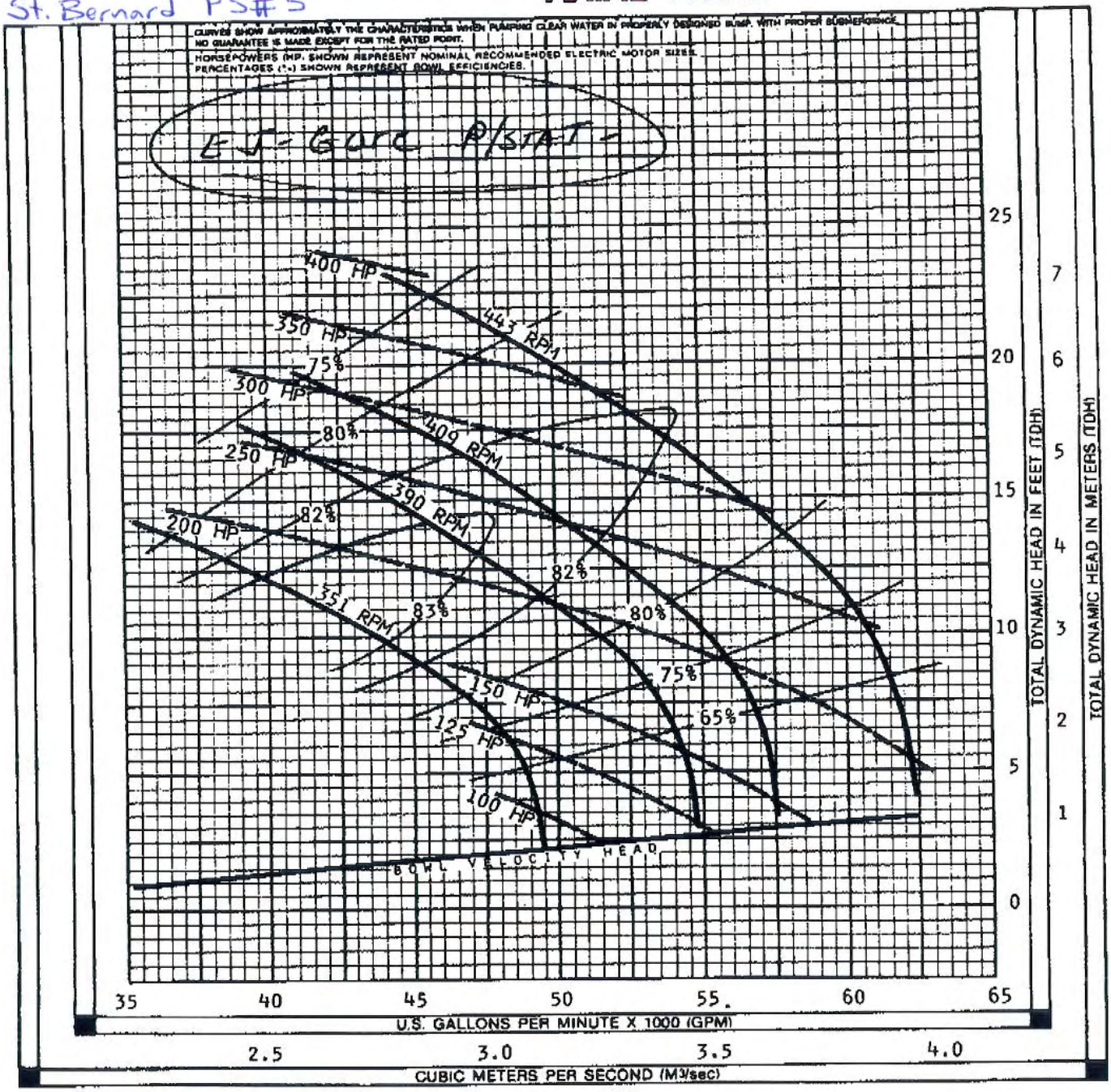
Post-Hurricane Katrina – View to the North

The following information was obtained from the Project Information Report (PIR) for New Orleans District:
Pump Station 5 sustained substantial damage. With the operating floor at approximately 2 feet N.G.V.D, flood waters within the building reached a height of 5 approximately 6 feet. The hydraulic driven pumps were damaged along with the six diesel engines. The generator and the electric pump motor and its controller were flooded. The hydraulic oil tank is not on its foundation and is contaminated with salt water along with the fuel system. The trash rack bar screens are damaged along with the slope pavement adjacent to the discharge pipes. Building damage includes damage to the rollup door, roof, and building office and restroom facility.

St. Bernard PS#5

AXIAL FLOW 42"

C166



M&W PUMP-CORP.
DEERFIELD BEACH, FLORIDA 33441 U.S.A.
ESTABLISHED 1926

PUMP BOWL PERFORMANCE CURVE
VARIABLE SPEED

TYPE: AXIAL FLOW	PROPELLER DIA.: 42"
MODEL NO.: NC342P12	SPEED (RPM): AS NOTED
INTAKE DIA.: 63"	DISCHARGE COLUMN DIA.: 42"
CURVE NO.: VS42P12	Ns: 11,800 CODE: .50

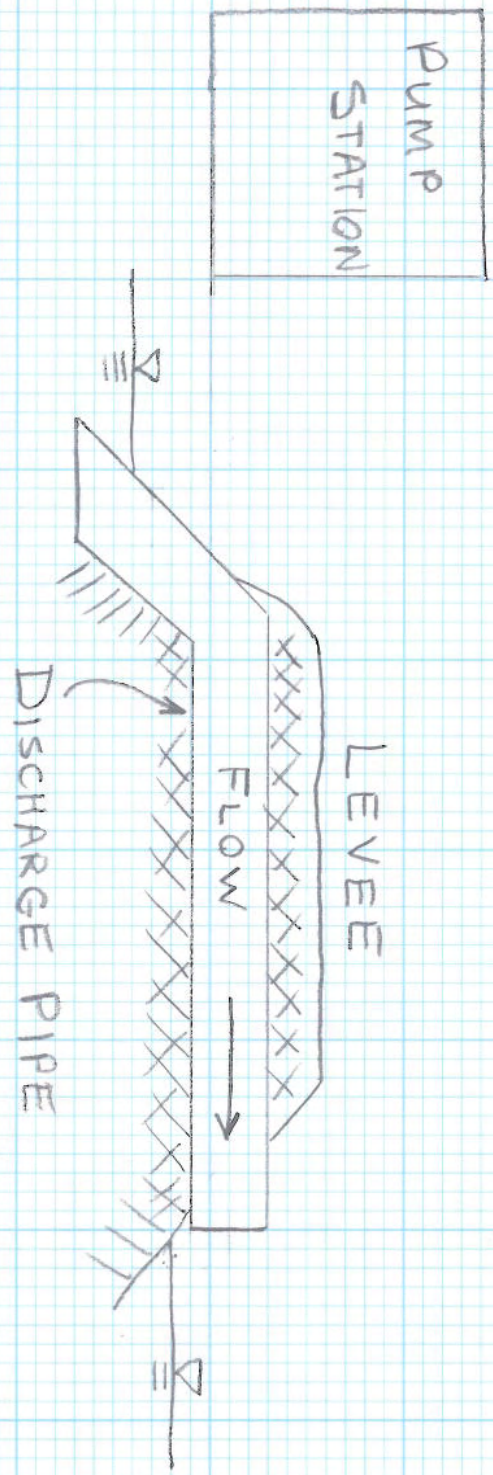
SINGLE STAGE
FOR TWO STAGES MULTIPLY HEAD AND HORSEPOWER BY 2.0 AND EFFICIENCY BY 1.0

PERFORMANCE BASED ON PUMPING CLEAR COLD NON-AERATED WATER, SPECIFIC GRAVITY 1.0, TEMPERATURE 85 DEGREES (FAHRENHEIT) OR LESS, AT SEA LEVEL. PERFORMANCE MAY BE AFFECTED BY HIGHER TEMPERATURES, SPECIFIC GRAVITIES, ALTITUDES, AND SUMP CONDITIONS.

IT IS HEREBY CERTIFIED THAT THIS CURVE REPRESENTS THE TRUE PERFORMANCE CHARACTERISTICS OF THE M&W PUMP MODEL SHOWN AND WAS OBTAINED BY SCALE MODEL TEST AND CALCULATIONS IN ACCORDANCE WITH STANDARDS OF THE HYDRAULIC INSTITUTE.

M&W PUMP CORPORATION
CERTIFIED BY
Available Upon Request
M&W PUMP CORPORATION
Deerfield Beach, Florida

CH2MHILL SUBJECT Pump Station #5 St. Bernard Parish BY Jerry Snead II SHEET NO. 1 of 1 DATE 1/26/06 PROJECT NO.



Pre-Hurricane Katrina – View from Inlet Canal

4200 Jean Lafitte Pkwy.
Chalmette, LA 70043
504.512.6331
Position: Latitude 29.966557° Longitude -89.975821°

Pre-Hurricane Katrina – Arial view of pump station

Pump Station Description

Jean Lafitte is 1 of 8 pumping stations in St Bernard Parish owned and operated by the Lake Borne Basin Levee District. The station contains three vertical pumps that were installed in 1990 with a total pumping capacity of 945 cubic feet per second (cfs)[1] and are driven by diesel engines. The drainage water is supplied to the pumps from the Florida Walk canal and discharges through the interior back levee to the marsh known as Bayou Bienvenue.

[1] The Pump Information Table contains more details about the individual pump data and is located at the beginning of this section.

Pump Station Operation

Pump station operators will turn the pumps on as they are required to reduce the water elevation in the canal. The pumps are normally turned on when the water in the canal reaches approximately -6 feet (NGVD) and turned off when the water level reaches -6.5 feet (NGVD). When heavy rainfall events are expected the station operators will pump the canal down to an elevation of -8.5 feet (NGVD).

Fuel Endurance Calculation

Assumptions:

1) #2 Diesel fuel is used with an HHV rating of 140,000 btu/gal
2) Burn rate of 35 gph @ 500 kW with above HHV rating
3) Diesel engines are running at rated capacity

PS 6 Jean Lafitte

3 pump drivers - All diesels

Diesels are 335 hp

The approximate burn rate for each diesel is then calculated at:

$$R_{burn} := \left(35\frac{gal}{hr}\right)\cdot\frac{335hp}{500kW} \qquad R_{burn} = 17.487\frac{gal}{hr}$$

Fuel Capacity

1 - 20,000 gallon tank
5 - 50 gallon day tanks
1 - 75 gallon tank

Fuel Endurance

The time the 20,000 gallon tank will last is calculated:

$$t_1 := \frac{20000gal}{6R_{burn}} \qquad t_1 = 190.621hr$$

The time the 50 gallon tanks will last is calculated:

$$t_2 := \frac{5\cdot 50gal}{6R_{burn}} \qquad t_2 = 2.383hr$$

The time the 75 gallon tank will last is calculated:

$$t_3 := \frac{75gal}{6R_{burn}} \qquad t_3 = 0.715hr$$

The approximate total continous run time for the station is:

$$T_t := t_1 + t_2 + t_3 \qquad \boxed{T_t = 193.719hr}$$

$$\boxed{T_t = 8.072day}$$

Pump Curves

Pump capacity curves were obtained. From these curves, a curve fit process was used to create new curves and equations. Using this information and making assumptions about the pump and the pump station, friction and minor head losses were accounted for. These calculations led to the creation of the systems curves. Two curves were created due to the range of operation reported by the parish using only the maximum and minimum head required.

Reverse Flow

The Engineering Hydraulics Design section of the US Army Corps of Engineers Portland District office performed analysis of reverse flow characteristics for each pump. The results are reverse flow rating curves that are attached to this section. The tables present the flow rates per individual pump. The detailed calculations, assumptions, and assumed dimensions are available upon request.

Katrina Event

8/28/05 - Operators pumped water in canal down to approximately -8.5 feet (NGVD).
8/29/05 - Operators evacuated pump station at approximately 1:15 am.
8/30/05 - Operators returned to the station at 10:00 am. Water was the same elevation on both sides of pump station.
9/11/05 - Pump station back to normal operation.

Damage Report

The following information was obtained from the Project Information Report (PIR) for New Orleans District:
Pump Station 6 sustained relatively minor damage because its operating floor elevation is 16 feet N.G.V.D. Flooding from the storm flooded the lower level of the station but the flood waters were approximately three feet below the concrete operating floor level. The building damage consists of damaged roof panels. Mechanical damage includes damage to the trash rack gear boxes, trash removal equipment, engine exhaust flappers, and sanitation plant. Electrical damage consists of damage to lighting and the remote engine alarm panel.

Post-Hurricane Katrina – View from the Inlet Canal

Post-Hurricane Katrina – Arial view of the pump station

PATTERSON PUMP COMPANY
A Subsidiary of Banner Industries Inc

REF.

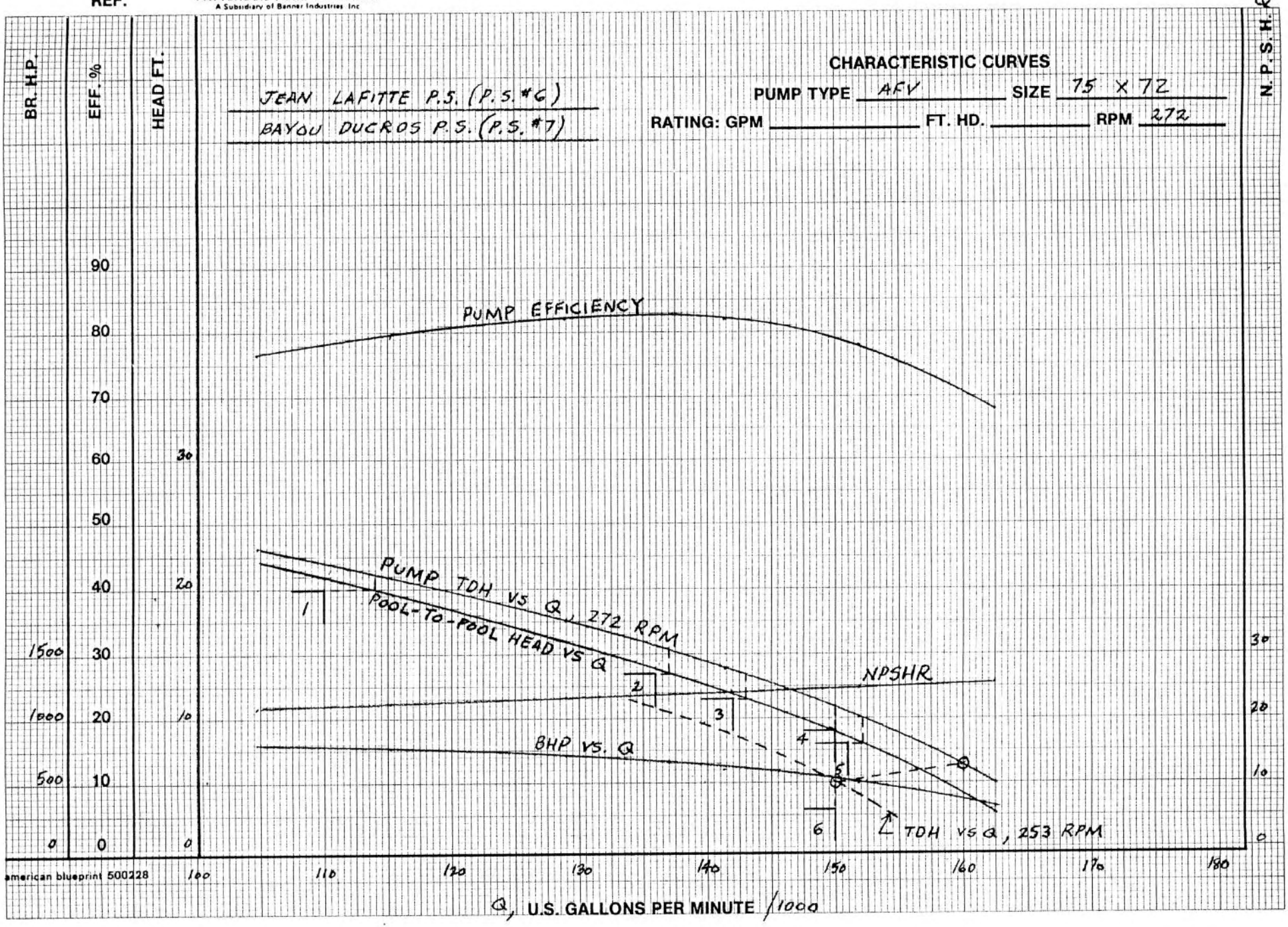
CURVE NO. JC-576-49-01

CHARACTERISTIC CURVES

JEAN LAFITTE P.S. (P.S. #6)
BAYOU DUCROS P.S. (P.S. #7)

PUMP TYPE AFV SIZE 75 X 72

RATING: GPM _____ FT. HD. _____ RPM 272



10 X 10 PER HALF INCH

MADE IN U.S.A.

PATTERSON PUMP COMPANY, TOCCOA, GEORGIA

Sold To: ______ Date 10-4-83 Tested By BW Serial No. X-624

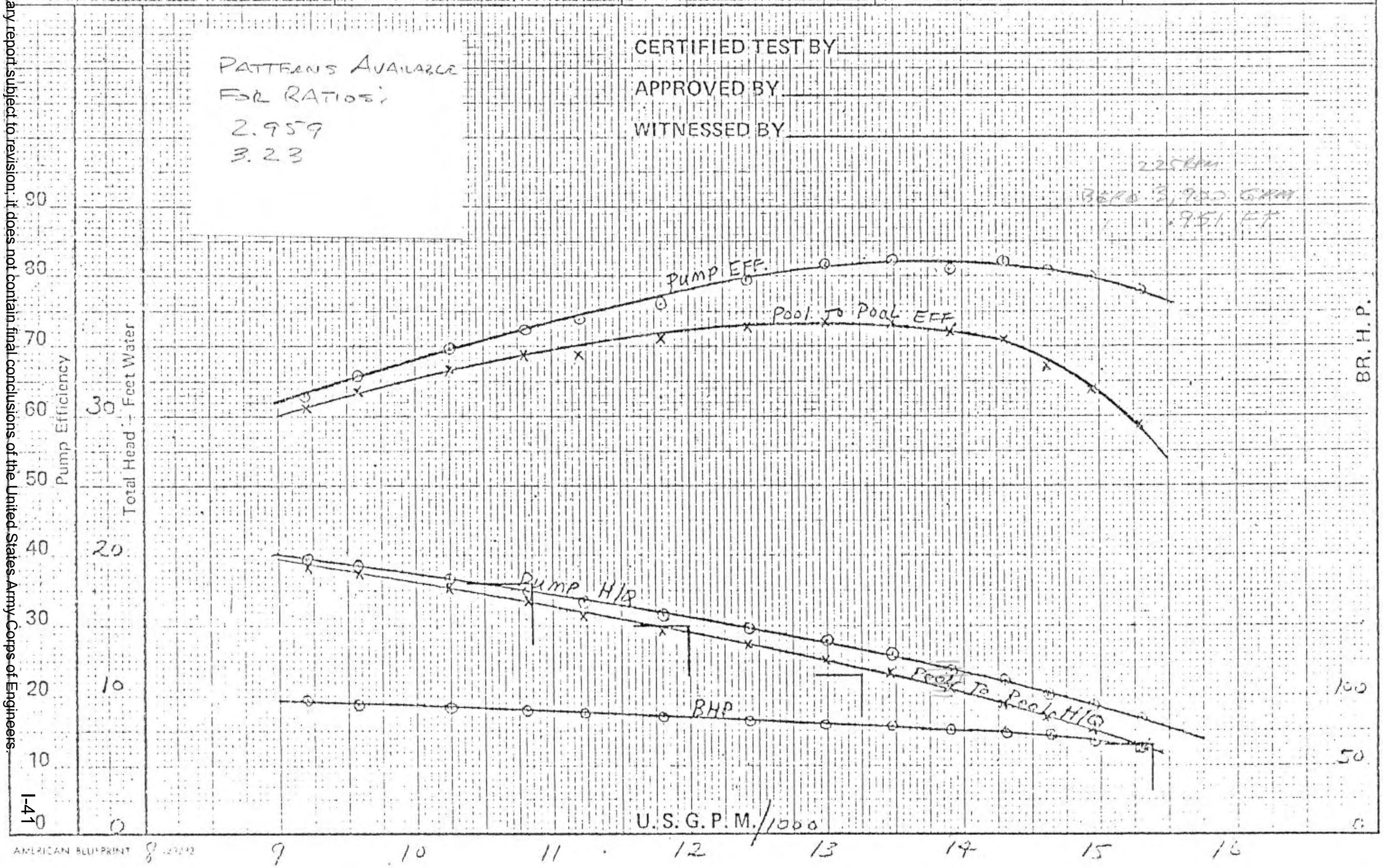
Job Driver: HP	Motor Turbine Engine	GPM	Imp. Patt.	B-7524B	Pump Type	AFV
Test Driver HP DC DRIVE	Motor. Dyn.	Ft. Hd.	Imp. Diam.	19.25" Δ 19.1° @ 17.6"	Size	24
Motor Eff'y —	Test Speed 799	Rated Speed 799	No. Stages	1	Test No.	

CERTIFIED TEST BY ______

APPROVED BY ______

WITNESSED BY ______

PATTERNS AVAILABLE FOR RATIOS:
2.959
3.23



AMERICAN BLUEPRINT

REF.

PATTERSON PUMP COMPANY
A SUBSIDIARY OF THE GORMAN-RUPP CO.

CURVE NO. 8544

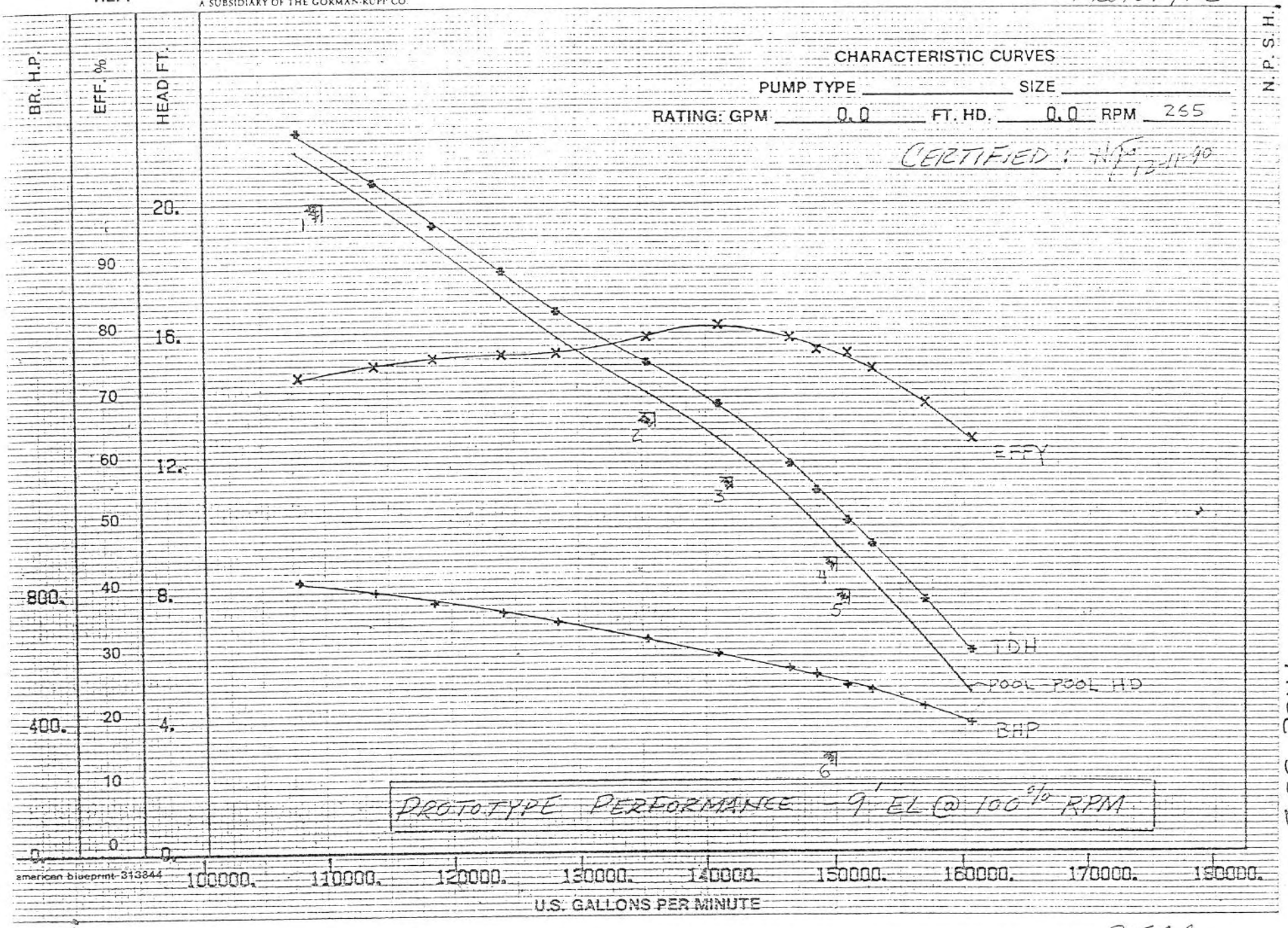
PROTOTYPE

CHARACTERISTIC CURVES

PUMP TYPE _____ SIZE _____

RATING: GPM 0.0 FT. HD. 0.0 RPM 255

CERTIFIED : HF [illegible] 90



american blueprint-313844

CURVE NO. 8544

REF.

PATTERSON PUMP COMPANY
A SUBSIDIARY OF THE GORMAN-RUPP CO.

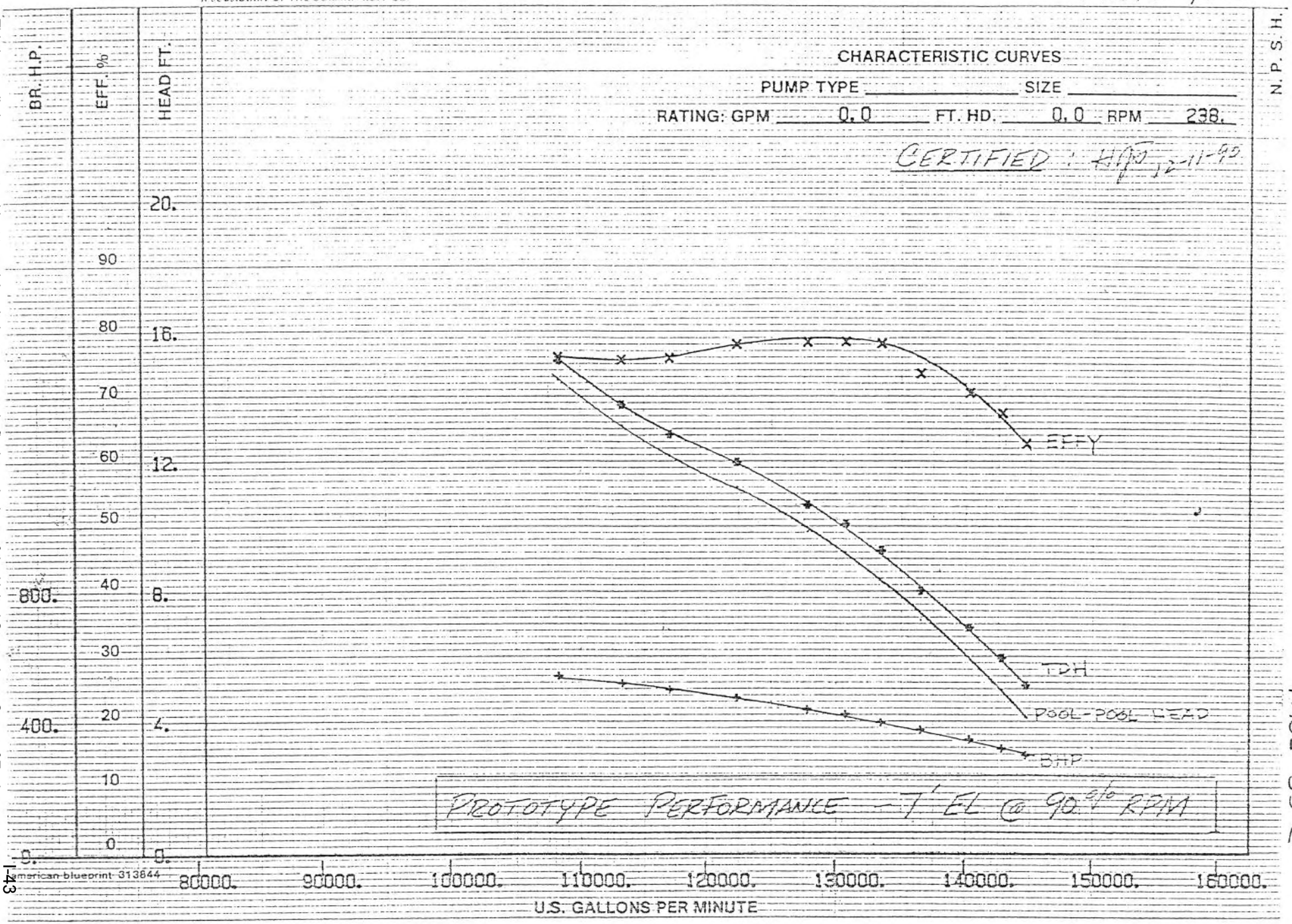
CURVE NO. 8532
PROTOTYPE

CHARACTERISTIC CURVES

PUMP TYPE _____ SIZE _____

RATING: GPM 0.0 FT. HD. 0.0 RPM 238.

CERTIFIED : HPT 12-11-90



american blueprint 313644

CURVE NO. 8533

PAGE 53 C

PATTERSON PUMP COMPANY
A SUBSIDIARY OF THE GORMAN-RUPP CO.

REF.

CURVE NO. 8522

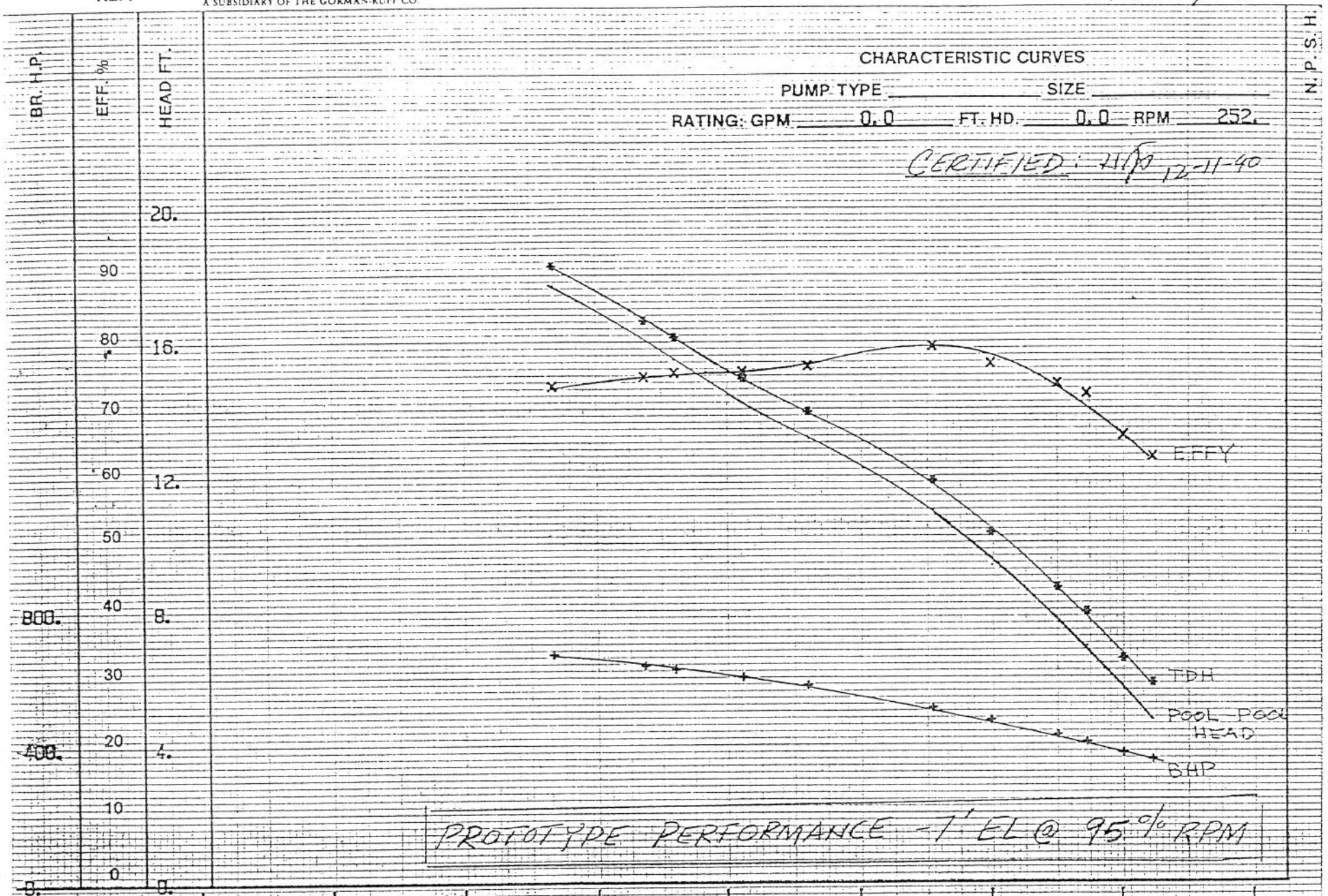
PROTOTYPE

CHARACTERISTIC CURVES

PUMP TYPE _____ SIZE _____

RATING: GPM 0.0 FT. HD. 0.0 RPM 252.

CERTIFIED: H/M 12-11-40



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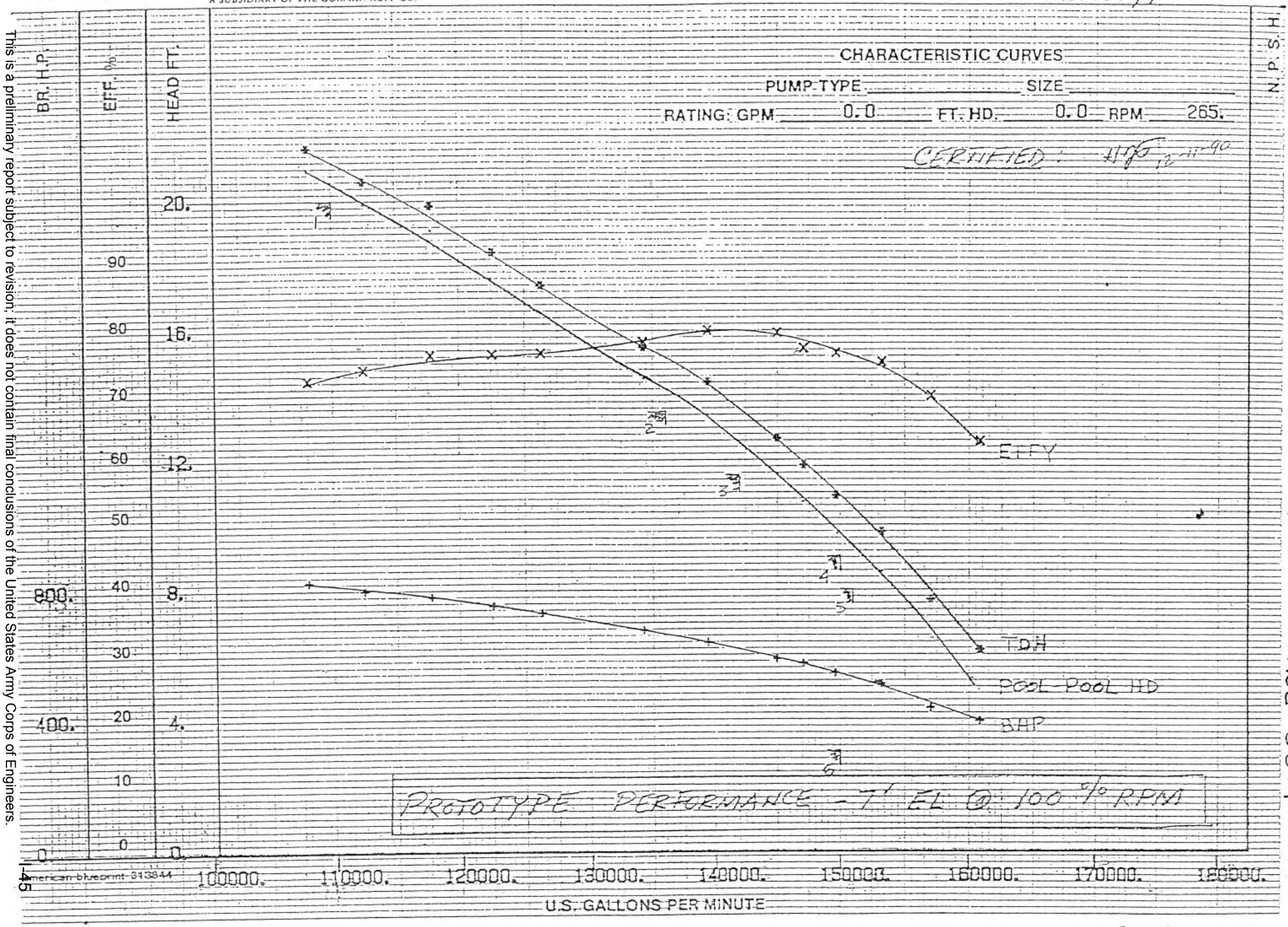
PATTERSON PUMP COMPANY
A SUBSIDIARY OF THE GORMAN-RUPP CO.

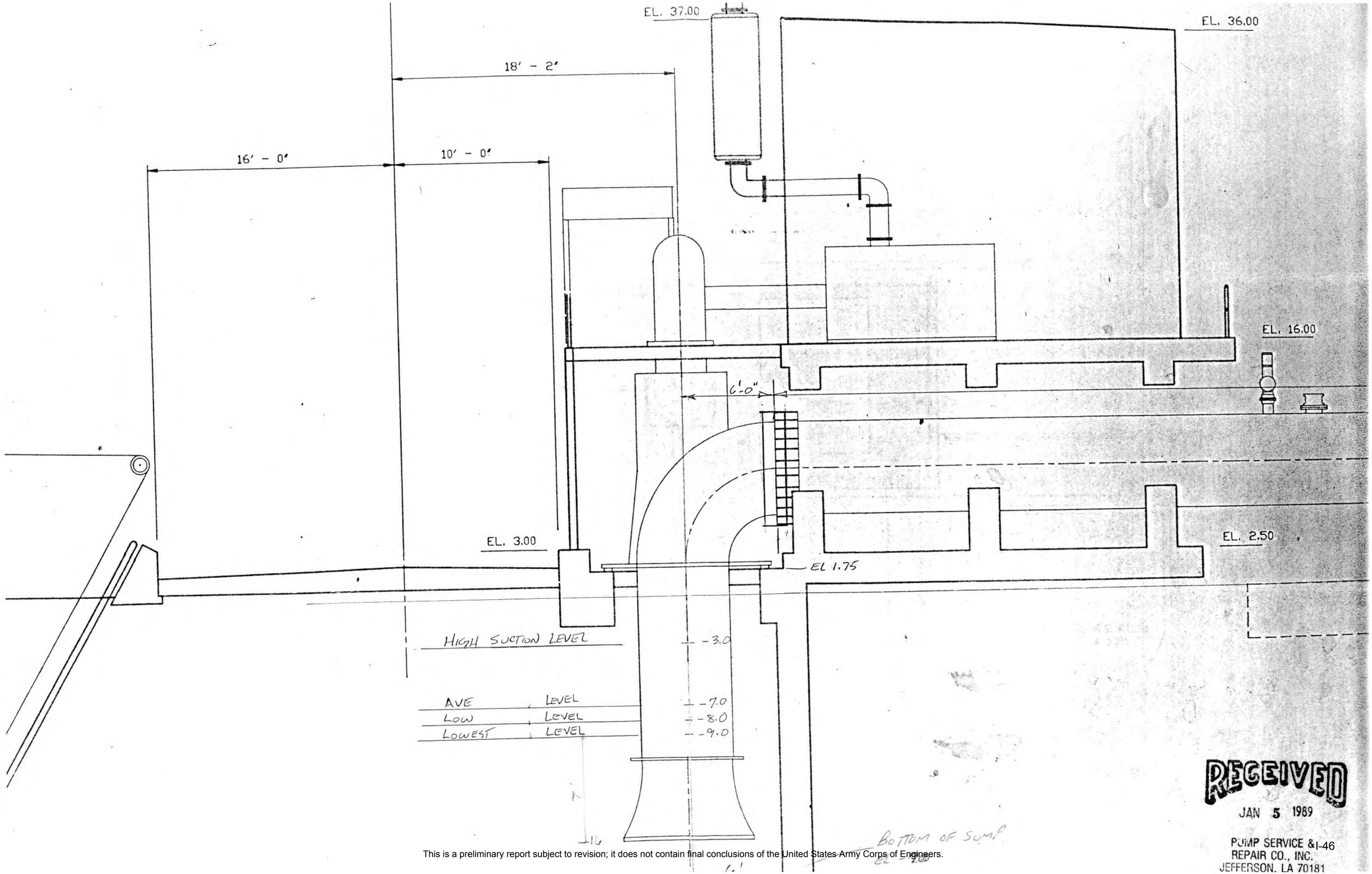
CURVE NO. 8511

PROTOTYPE



CURVE NO. 8511

PAGE 53A



Pre-Hurricane Katrina – View from Inlet Canal

3701 Bartolo Dr.
Meraux, LA 70075
504.512.6331
Position: Latitude 29.946969° Longitude -89.922244°

Pre-Hurricane Katrina – Arial view of pump station

Pump Station Description

Bayou Ducros is 1 of 8 pumping stations in St Bernard Parish owned and operated by the Lake Borne Basin Levee District. The station contains three vertical pumps that were installed in 1992 with a total pumping capacity of 1000 cubic feet per second (cfs)[1] and are driven by diesel engines. The drainage water is supplied to the pumps from the Forty Arpent canal and discharges through the interior back levee to the marsh known as Bayou Ducros.

[1] The Pump Information Table contains more details about the individual pump data and is located at the beginning of this section.

Pump Station Operation

Pump station operators will turn the pumps on as they are required to reduce the water elevation in the canal. The pumps are normally turned on when the water in the canal reaches approximately -6 feet (NGVD) and turned off when the water level reaches -6.5 feet (NGVD). When heavy rainfall events are expected the station operators will pump the canal down to an elevation of -8.5 feet (NGVD).

Fuel Endurance Calculation

Assumptions:

1) #2 Diesel fuel is used with an HHV rating of 140,000 btu/gal
2) Burn rate of 35 gph @ 500 kW with above HHV rating
3) Diesel engines are running at rated capacity

PS 7 Bayou Ducros

3 pump drivers - All diesels

Diesels are 1020 hp

The approximate burn rate for each diesel is then calculated at:

$$R_{burn} := \left(35\frac{gal}{hr}\right)\cdot\frac{1020hp}{500kW} \qquad R_{burn} = 53.243\frac{ga}{hr}$$

Fuel Capacity

2 - 10,000 gallon tanks
2 - 300 gallon day tanks

Fuel Endurance

The time the 10,000 gallon tank will last is calculated:

$$t_1 := \frac{2\cdot 10000gal}{3R_{burn}} \qquad t_1 = 125.212hr$$

The time the 300 gallon tanks will last is calculated:

$$t_2 := \frac{2\cdot 300gal}{3R_{burn}} \qquad t_2 = 3.756hr$$

The approximate total continous run time for the station is:

$$T_t := t_1 + t_2 \qquad \boxed{T_t = 128.969hr}$$

$$\boxed{T_t = 5.374day}$$

Pump Curves

Pump capacity curves were obtained. From these curves, a curve fit process was used to create new curves and equations. Using drawings and manufacturer data, assumptions regarding the pump station and the pump were made in order to determine the minor and friction losses in the system. These calculations created the system curves. Two curves were created in order to

accommodate the range of operating heads provided by the parish. The maximum and minimum head values were used to generate these curves.

Reverse Flow

The Engineering Hydraulics Design section of the US Army Corps of Engineers Portland District office performed analysis of reverse flow characteristics for each pump. The results are reverse flow rating curves that are attached to this section. The tables present the flow rates per individual pump. The detailed calculations, assumptions, and assumed dimensions are available upon request.

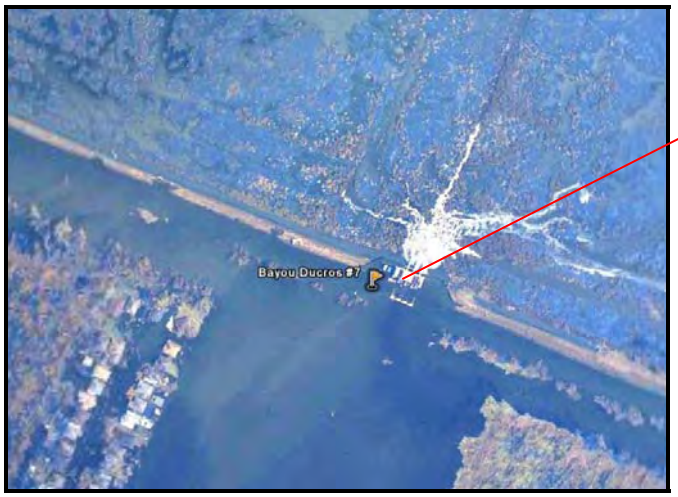
Katrina Event

8/28/05 - Operators pumped water in canal down to approximately -8.5 feet (NGVD).
8/29/05 - Operators evacuated pump station at approximately 1:15 am.
8/30/05 - Operators returned to the station at 10:00 am. Water was the same elevation on both sides of pump station.
9/11/05 - Pump station back to normal operation.

Damage Report

The following information was obtained from the Project Information Report (PIR) for New Orleans District:
Pump Station 7 sustained relatively minor damage because its operating floor elevation is 16 feet N.G.V.D. Flooding from the storm flooded the lower level of the station but the flood waters were approximately three feet below the concrete operating floor level. Bearing and gears for the trash racks were damaged. Auxiliary equipment damage included flooding of a bobcat used to remove debris from the trash racks, fuel tank, and sanitation plant. Pump damage consists of a broken drain line. Engine damage consists of damage to an engine cooling motor, radiator leak and remote engine alarm panel. Two areas had some erosion including scour behind the station and near the west end stairs.

Post-Hurricane Katrina – Erosion



Post-Hurricane Katrina – Arial view of the pump station

NO. 340R-10½ DIETZGEN GRAPH PAPER
10 X 10 PER HALF INCH

DIETZGEN CORPORATION
MADE IN U.S.A.

PATTERSON PUMP COMPANY
A Subsidiary of Banner Industries Inc

REF.

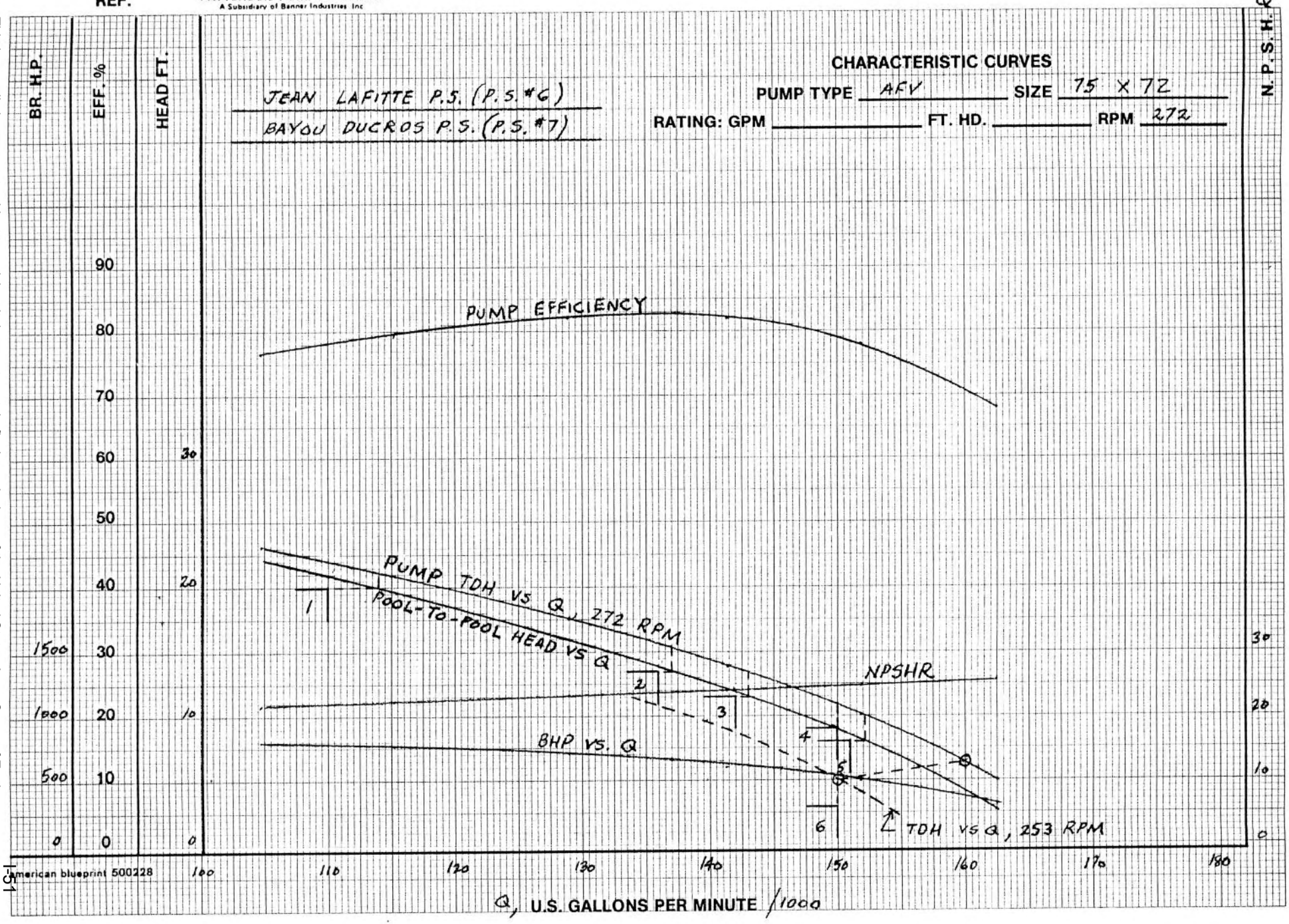
CURVE NO. JC-576-99-01

CHARACTERISTIC CURVES

JEAN LAFITTE P.S. (P.S. #6)
BAYOU DUCROS P.S. (P.S. #7)

PUMP TYPE AFV SIZE 75 X 72

RATING: GPM _____ FT. HD. _____ RPM 272



10 X 10 PER HALF INCH MADE IN U.S.A.

PATTERSON PUMP COMPANY, TOCCOA, GEORGIA

Sold To: _____ Date 10-4-83 Tested By BUJ Serial No. X-624

Job Driver: HP _____ Motor Turbine Engine	GPM	Imp. Patt. B-7524B	Pump Type AFV
Test Driver HP DC DRIVE Motor Dyn.	Ft. Hd.	Imp. Diam. 19.25" @ 19.1° @ 17.6"	Size 24
Motor Eff'y — Test Speed 799	Rated Speed 799	No. Stages 1	Test No.

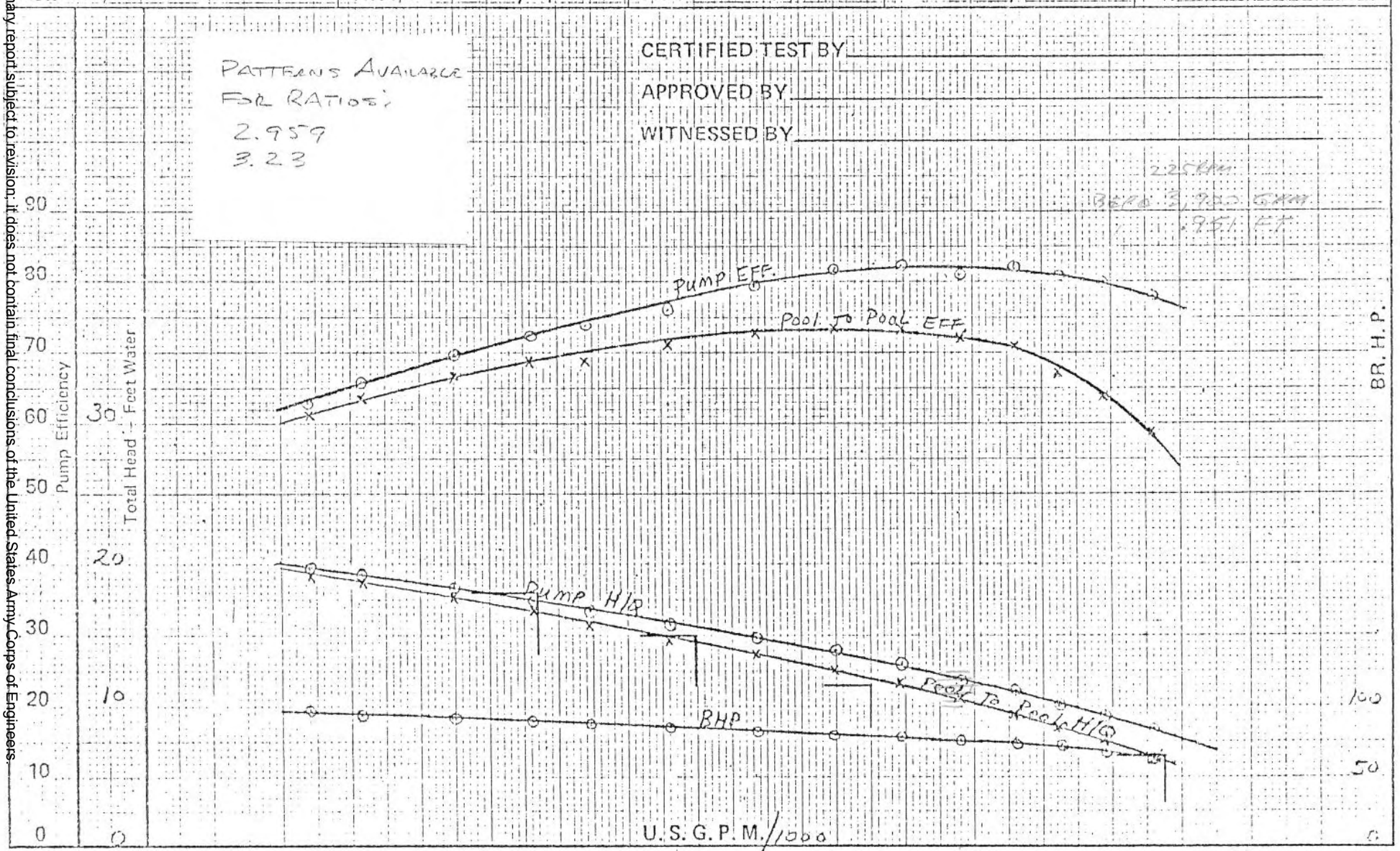
PATTERNS AVAILABLE FOR RATIOS:
2.959
3.23

CERTIFIED TEST BY _____

APPROVED BY _____

WITNESSED BY _____

2.25 RATIO
BORE 3.200 DIA
.971 FT



AMERICAN BLUEPRINT

REF.

PATTERSON PUMP COMPANY
A SUBSIDIARY OF THE GORMAN-RUPP CO.

CURVE NO. 8544

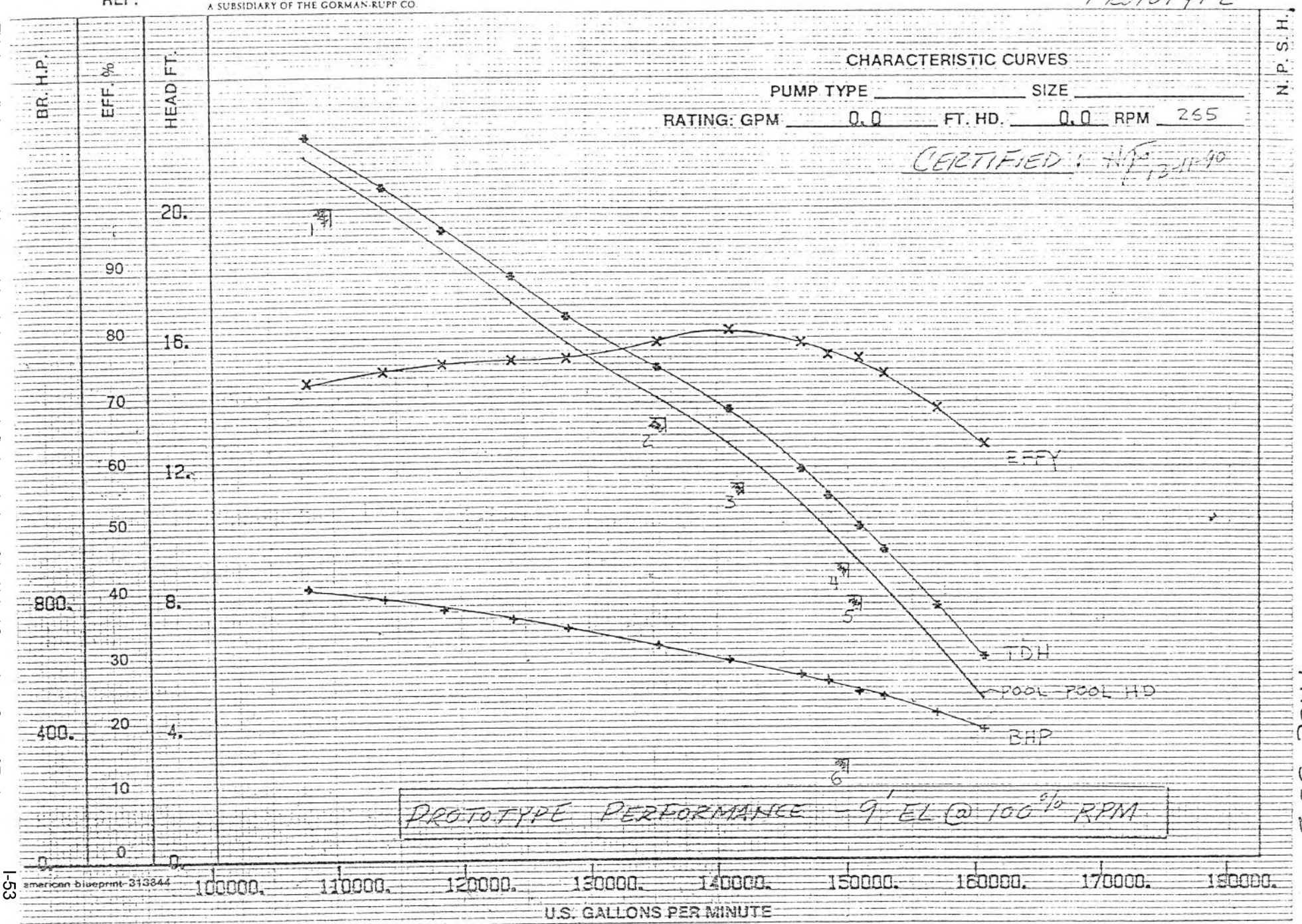
PROTOTYPE

CHARACTERISTIC CURVES

PUMP TYPE _____ SIZE _____

RATING: GPM 0.0 FT. HD. 0.0 RPM 255

CERTIFIED : HF 7-31-90



american blueprint-313844

CURVE NO. 8544

REF.

PATTERSON PUMP COMPANY
A SUBSIDIARY OF THE GORMAN-RUPP CO.

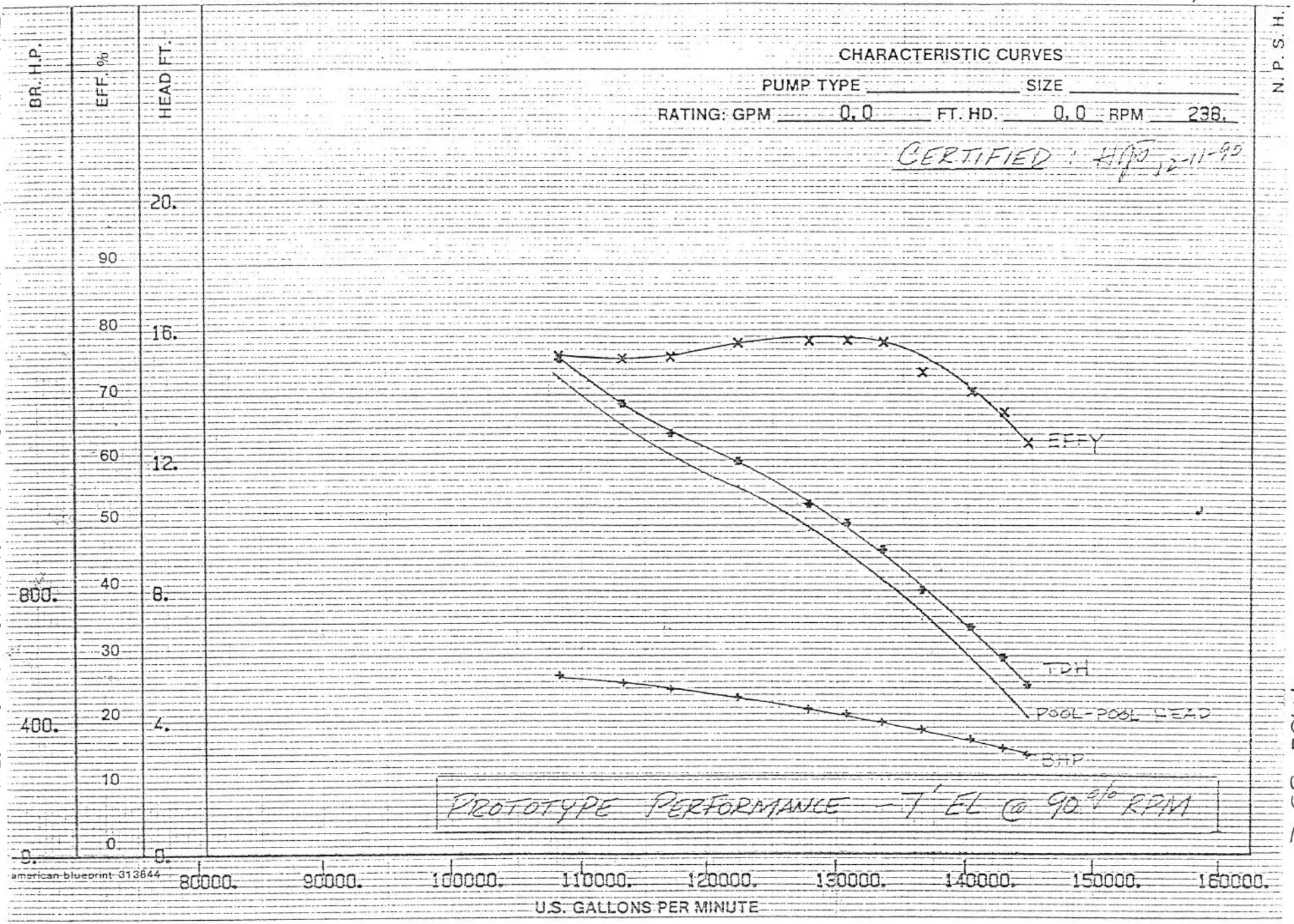
CURVE NO. 8532
PROTOTYPE

CHARACTERISTIC CURVES

PUMP TYPE _____ SIZE _____

RATING: GPM 0.0 FT. HD. 0.0 RPM 238.

CERTIFIED : HJT 12-11-90



american blueprint 313644

PAGE 53 C

CURVE NO. 8533

PATTERSON PUMP COMPANY
A SUBSIDIARY OF THE GORMAN-RUPP CO.

REF.

CURVE NO. 8522

PROTOTYPE

CHARACTERISTIC CURVES

PUMP TYPE _____ SIZE _____

RATING: GPM 0.0 FT. HD. 0.0 RPM 252.

CERTIFIED: H/M 12-11-40

BR. H.P. | EFF. % | HEAD FT. | N.P.S.H.

800.
400.
0.

90
80
70
60
50
40
30
20
10
0

20.
16.
12.
8.
4.
0.

EFFY

TDH

POOL-POOL HEAD

BHP

PROTOTYPE PERFORMANCE -1' EL @ 95% RPM

80000. 90000. 100000. 110000. 120000. 130000. 140000. 150000. 160000.

U.S. GALLONS PER MINUTE

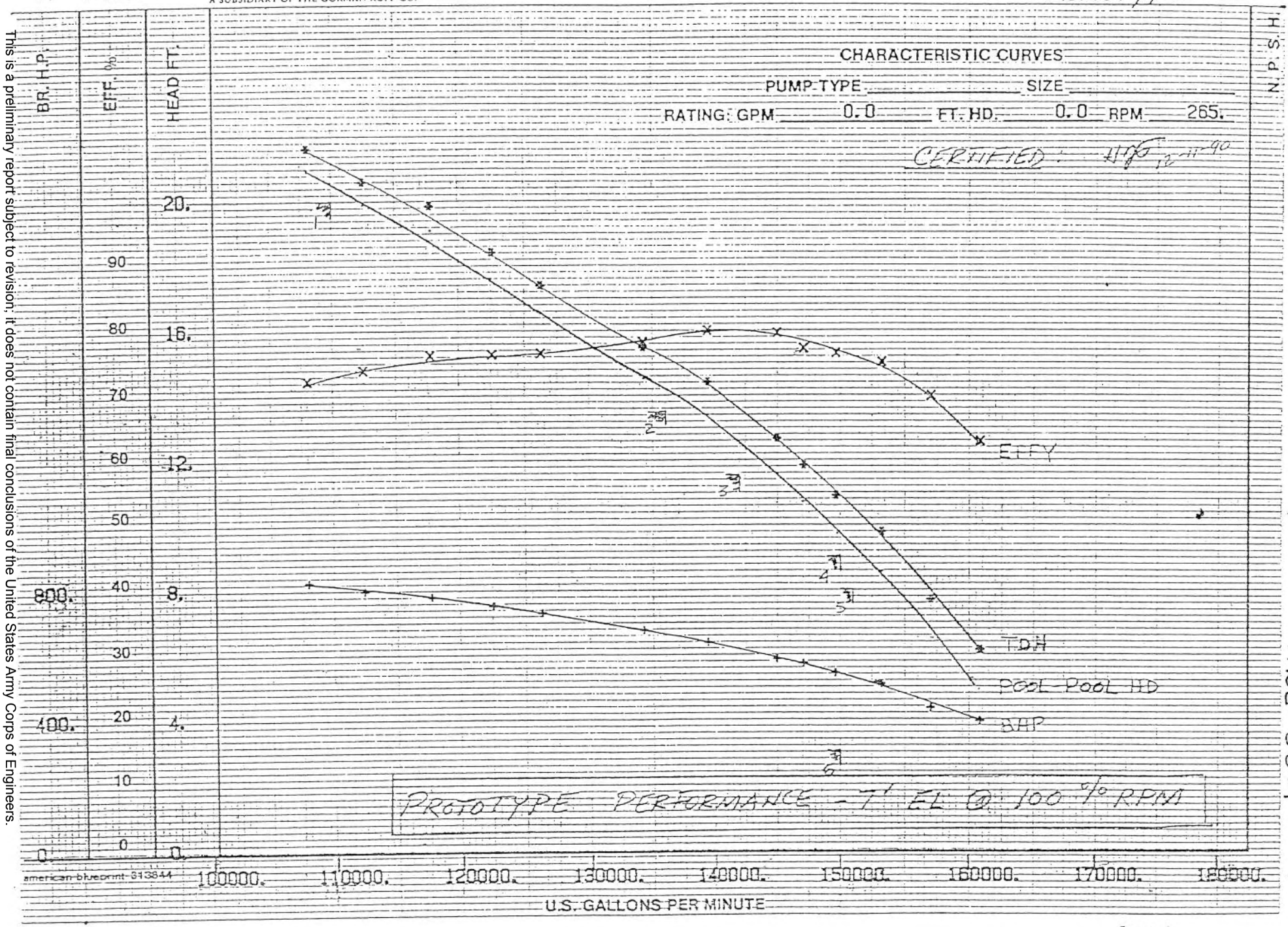
american blueprint 313844

REF.

PATTERSON PUMP COMPANY
A SUBSIDIARY OF THE GORMAN-RUPP CO.

CURVE NO. 8511

PROTOTYPE

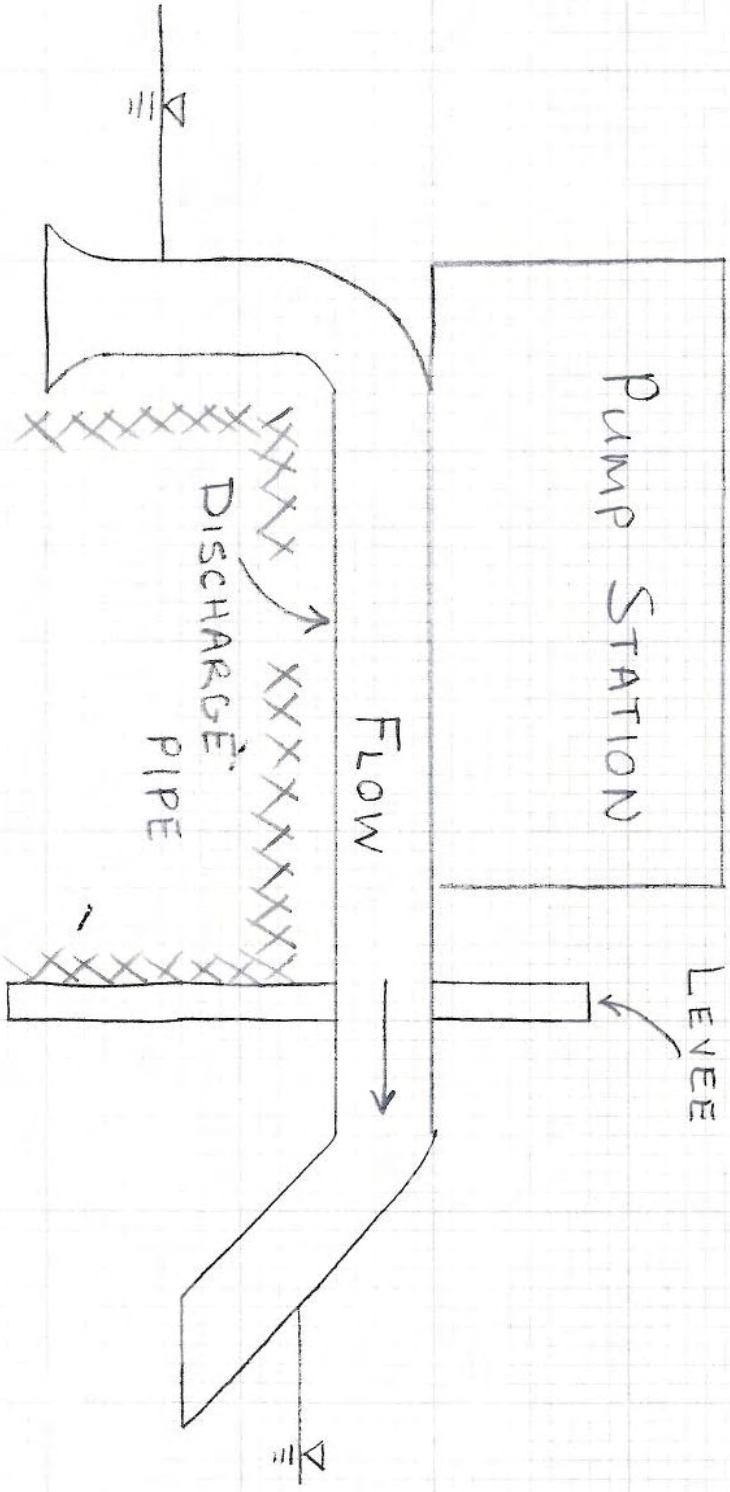


american-blueprint-613844

CURVE NO. 8511

PAGE 53A

CH2MHILL SUBJECT Pump Station #7 St. Bernard Parish BY Jerry Sneau II SHEET NO. 1 of 1 DATE 1/26/06 PROJECT NO.



NOT TO SCALE

Pre-Hurricane Katrina – View from Inlet Canal

3616 Bayou Rd.
Verret, LA 70085
504-682-0591
Position: Latitude 29.854064° Longitude -89.795715

Pump Station Description

St Mary is 1 of 8 pumping stations in St Bernard Parish owned and operated by the Lake Borne Basin Levee District. The station contains three vertical pumps that were installed in 1996 with a total pumping capacity of 835 cubic feet per second (cfs)[1] and are driven by diesel engines. The drainage water is supplied to the pumps from the Twenty Arpent canal and discharges through the hurricane protection levee to Lake Lery. The discharge pipes have check valves to prevent flow in the reverse direction.

Pump Station Operation

Pump station operators will turn the pumps on as they are required to reduce the water elevation in the canal. The pumps are normally turned on when the water in the canal reaches approximately 0.0 feet (NGVD) and turned off when the water level reaches -0.5 feet (NGVD). When heavy rainfall events are expected the station operators will pump the canal down to an elevation of -3.5 feet (NGVD).

Fuel Endurance Calculation

[1] The Pump Information Table contains more details about the individual pump data and is located at the beginning of this section.

Assumptions:

1) #2 Diesel fuel is used with an HHV rating of 140,000 btu/gal
2) Burn rate of 35 gph @ 500 kW with above HHV rating
3) Diesel engines are running at rated capacity

PS 8 St Mary

3 pump drivers - All diesels

Diesels are 1020 hp

The approximate burn rate for each diesel is then calculated at:

$$R_{burn} := \left(35\frac{gal}{hr}\right)\cdot\frac{1020hp}{500kW} \qquad R_{burn} = 53.243\frac{gal}{hr}$$

Fuel Capacity

2 - 10,000 gallon tanks
2 - 300 gallon day tanks

Fuel Endurance

The time the 10,000 gallon tank will last is calculated:

$$t_1 := \frac{2\cdot 10000gal}{3R_{burn}} \qquad t_1 = 125.212hr$$

The time the 300 gallon tanks will last is calculated:

$$t_2 := \frac{2\cdot 300gal}{3R_{burn}} \qquad t_2 = 3.756hr$$

The approximate total continous run time for the station is:

$$T_t := t_1 + t_2 \qquad \boxed{T_t = 128.969hr}$$

$$\boxed{T_t = 5.374day}$$

Pump Curves

Pump capacity curves were obtained from the parish. These curves were recreated using a curve fit process. Analysis of the system necessitated the use of assumptions about the pump station and pump dimensions. These allowed for calculations regarding minor and friction losses. The system curves were created using these calculations. Two system curves were generated to accommodate the range of operation recorded by the parish, using maximum and minimum values of head.

Reverse Flow

The Engineering Hydraulics Design section of the US Army Corps of Engineers Portland District office performed analysis of reverse flow characteristics for each pump. The results are reverse flow rating curves that are attached to this section. The tables present the flow rates per individual pump. The detailed calculations, assumptions, and assumed dimensions are available upon request.

Katrina Event

8/28/05 - Operators pumped water in canal down to approximately -3.5 feet (NGVD).
8/29/05 - Operators evacuated pump station at approximately 1:15 am.
9/11/05 - Pump station back to normal operation.

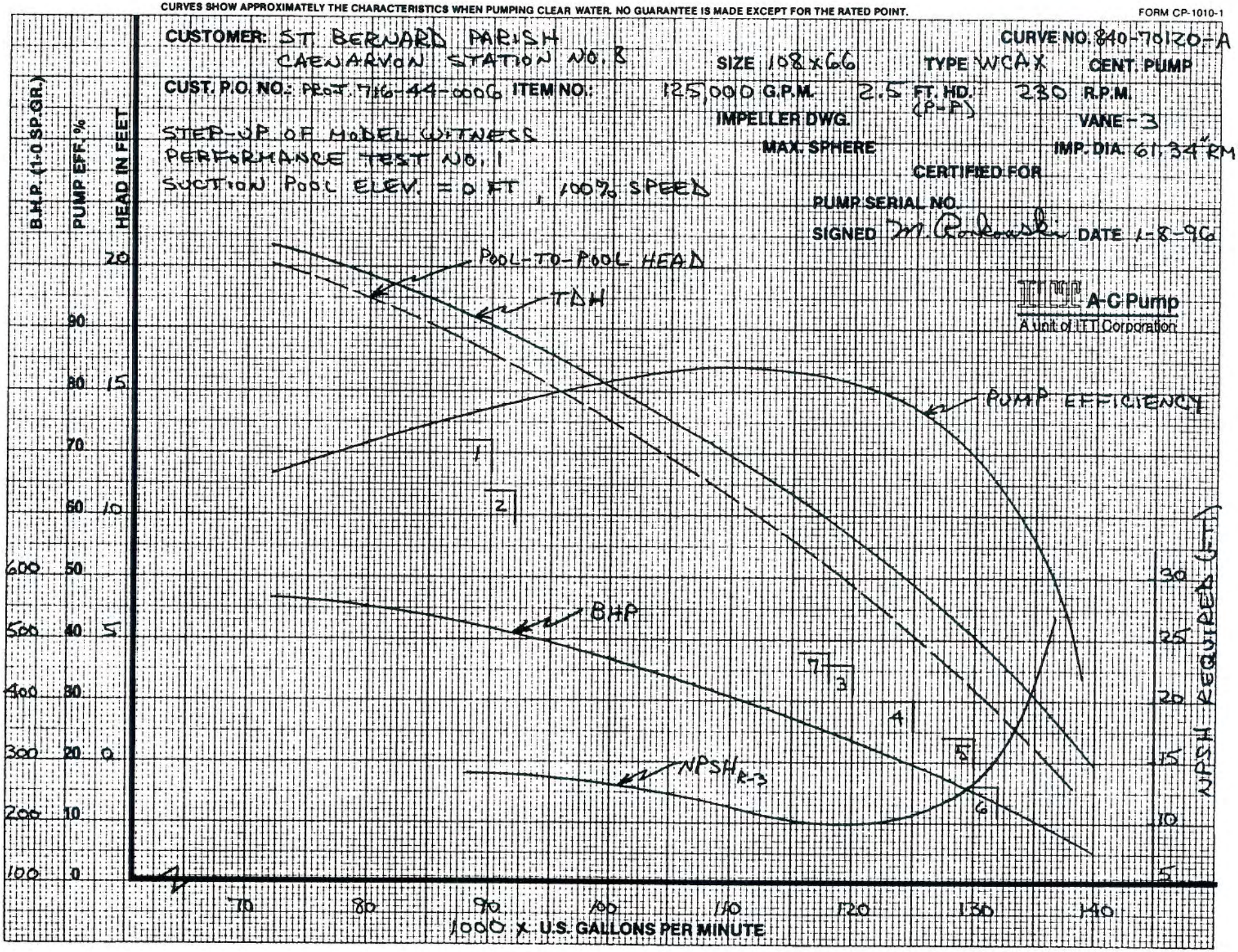
Damage Report

The following information was obtained from the Project Information Report (PIR) for New Orleans District:
Pump Station 8 sustained relatively minor damage because its operating floor elevation is 16 feet N.G.V.D. Flooding from the storm flooded the lower level of the station but the flood waters were approximately eight feet below the concrete operating floor level. Building damage consists of loose roof panels, scour section near the discharge pipes, light fixtures, and the sewage aerator motor. Bearing and gears for the trash racks were damaged. Auxiliary equipment damage includes a front end loader used to remove debris from the trash racks.

Post-Hurricane Katrina – View from the Inlet Canal

CURVES SHOW APPROXIMATELY THE CHARACTERISTICS WHEN PUMPING CLEAR WATER. NO GUARANTEE IS MADE EXCEPT FOR THE RATED POINT.

FORM CP-1010-1



CURVES SHOW APPROXIMATELY THE CHARACTERISTICS WHEN PUMPING CLEAR WATER. NO GUARANTEE IS MADE EXCEPT FOR THE RATED POINT.

FORM CP-1010-1

CUSTOMER: ST. BERNARD PARISH
CAENARVON STATION NO. 8

CURVE NO. 840-70120-B

SIZE 108 x 66 TYPE WCAX CENT. PUMP

CUST. P.O. NO.: PROJ. 716-44-0006 ITEM NO.:

G.P.M. FT. HD.: 218.5 R.P.M.

IMPELLER DWG. VANE - 3

MAX. SPHERE IMP. DIA. 61.34" TRIM

CERTIFIED FOR

PUMP SERIAL NO.

SIGNED M. Schmidt DATE 1-8-96

STEP-UP OF MODEL WITNESS
PERFORMANCE TEST NO. 2
SUCTION POOL ELEV. = 0 FT., 95% SPEED

A-C Pump
A unit of ITT Corporation

POOL-TO-POOL HEAD

TDH

PUMP EFFICIENCY

BHP

1
2
3
4
5
6
7

B.H.P. (1.0 SP.GR.)

PUMP EFF. %

HEAD IN FEET

500 40 5

400 30

300 20 0

200 10

100 0

90 15

80 10

70

60

50

20

70 80 90 100 110 120 130 140

1000 X U.S. GALLONS PER MINUTE

CURVES SHOW APPROXIMATELY THE CHARACTERISTICS WHEN PUMPING CLEAR WATER. NO GUARANTEE IS MADE EXCEPT FOR THE RATED POINT.

FORM CP-1010-1

CUSTOMER: ST BERNARD PARISH
CAENARVON STATION NO. 8

CURVE NO. 840-70120-C

SIZE 108 x 66 TYPE WCAX CENT. PUMP

CUST. P.O. NO.: PROJ. 716-44-0006 ITEM NO.:

G.P.M. FT. HD. 207 R.P.M.

IMPELLER DWG. VANE - 3

MAX. SPHERE IMP. DIA. 61 34" TRIM

STEP-UP OF MODEL WITNESS
PERFORMANCE TEST NO. 3
SUCTION POOL ELEV. = 0 FT, 90% SPEED

CERTIFIED FOR

PUMP SERIAL NO.

SIGNED M. Rukowski DATE 1-8-96

ITT A-C Pump
A unit of ITT Corporation

B.H.P. (1.0 SP.GR.) | PUMP EFF. % | HEAD IN FEET

PUMP EFFICIENCY

TDH

POOL-TO-POOL HEAD

BHP

/000 X U.S. GALLONS PER MINUTE

CLEARPRINT CHARTS

CURVES SHOW APPROXIMATELY THE CHARACTERISTICS WHEN PUMPING CLEAR WATER. NO GUARANTEE IS MADE EXCEPT FOR THE RATED POINT.

FORM CP-1010-1

CUSTOMER: ST. BERNARD PARISH
CAENARVON STATION NO. 8

CURVE NO. 840-70120-D

SIZE 108x66 TYPE WCAX CENT. PUMP

CUST. P.O. NO.: PROJ. TK-44-00006 ITEM NO.: 125,000 G.P.M. 2.5 FT. HD. (P-P) 230 R.P.M.

IMPELLER DWG. VANE-3

MAX. SPHERE IMP. DIA. 61.34" EMS

STEP-UP OF MODEL WITNESS PERFORMANCE TEST NO. 4

SUCTION POOL ELEV. = -2.0 FT, 100% SPEED

CERTIFIED FOR

PUMP SERIAL NO.

SIGNED M. Rabourdin DATE 1-8-96

ITT A-C Pump
A unit of ITT Corporation

POOL-TO-POOL HEAD

TDH

PUMP EFFICIENCY

BHP

NPSH R-3

1
2
3
4
5
6
7

B.H.P. (1.0 SP.GR.)

PUMP EFF. %

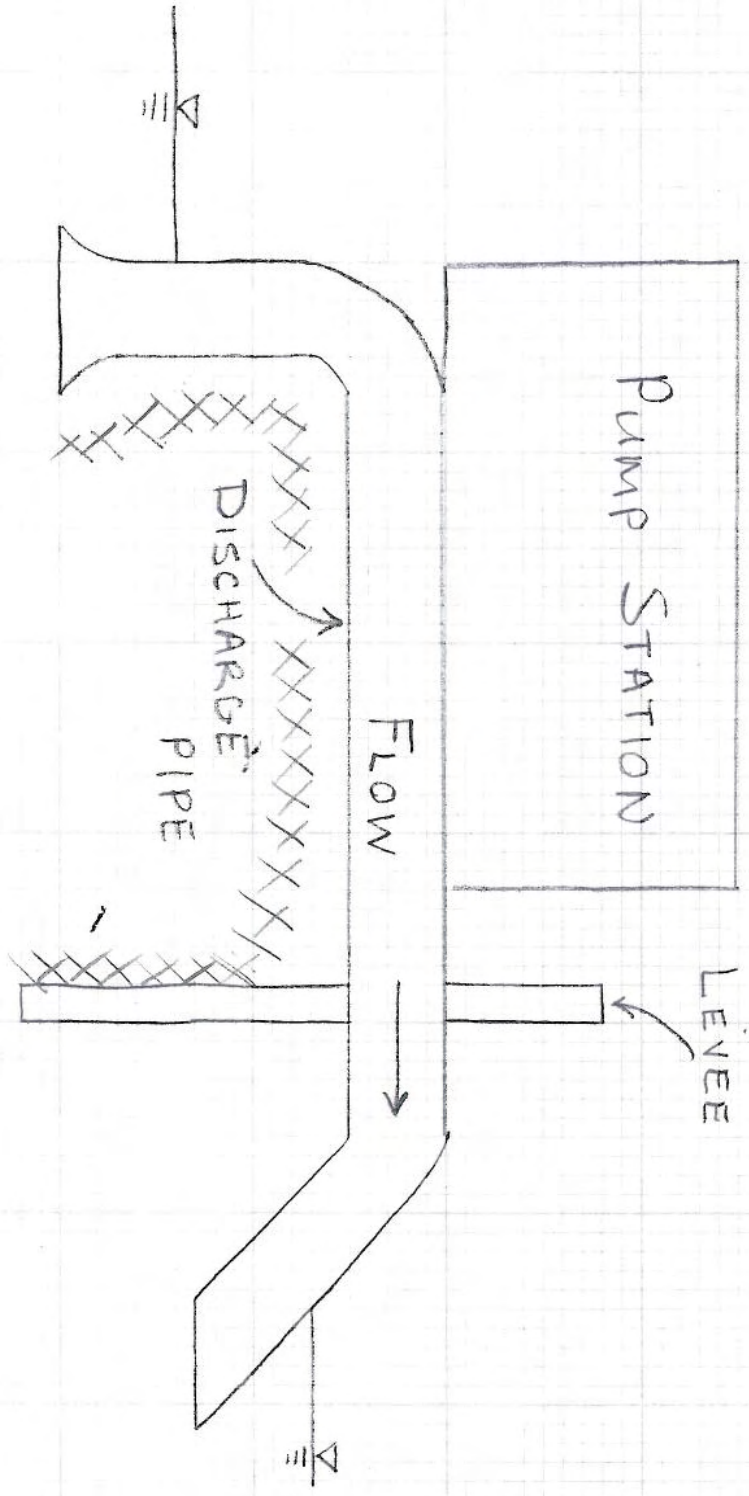
HEAD IN FEET

NPSH REQUIRED (FT.)

70 80 90 100 110 120 130 140

1000 x U.S. GALLONS PER MINUTE

CH2MHILL SUBJECT Pump Station #8 St. Bernard Parish BY Jerry Sneau II SHEET NO. 1 of 1 DATE 1/26/06 PROJECT NO.



NOT TO SCALE

CENWP-EC-HD **DRAFT** **24 February 2006**

MEMORANDUM FOR RECORD

SUBJECT 60% Draft Submission of Estimated Backflow Rating Curves for St. Bernard Parish, LA

Problem Statement: A post Katrina flood study is being conducted for a watershed in Jefferson Parish in New Orleans District. During the flood event, the pumps stopped operating and reverse flow discharged backwards through the pump station conduits. The needs of the study include an approximate rating curve for reverse flow through the pump station.

Objectives: Develop rating curve for reverse flow rate versus head differential and provide documentation of rating and methods used.

Assumptions: Many assumptions needed to be made in order to complete the draft backflow rating curves associated with this document. Assumptions made in developing the backflow rating curve estimates are listed in the Excel file worksheets for each unique pump and configuration. The most significant assumptions have been included in the rating curve worksheets attached to this memorandum and are summarized below.

- Data Assumptions:
  Many of the pump stations in St. Bernard Parish only had very sketchy information on pumps, intakes and discharge pipes with regard to: elevations, sizes, cross-sections, bends, diffusers, lengths, pump intake grates, discharge pipe baffles etc. In addition, elevations of the pump station and system were not always available or there appeared to be inconsistencies between collected questionnaire responses, sketches and photos. Lack of data may contribute to significant uncertainty in the backflow rating curves. For pump stations 1 and 4, all that was missing was the width of the discharge channel (assumed to be 10 feet from photos). The minimum error margin for all calculations is ±30%. The error margin will naturally increase for those cases where station data is missing and pertinent dimensions must be estimated.

- System Loss Assumptions:
  Intake, exit, bend, expansion, impeller and friction losses have been included for each unique pump and configuration. Some assumptions were made when system details were not available from the data (see above). The most significant loss was typically through the pump itself and is the largest cause of uncertainty. We currently estimate an error margin of ±30% related to the pump loss.

- Flow Control Assumptions:
  Conditions that trigger variations in flow control were estimated using the following criteria:

- Backflow starts when the lake or reservoir head (H1 at intake of backflow condition) is greater than the controlling crest of the discharge pipe. The first trigger point is that H1 must exceed this crest elevation to start flow.
- Siphon flow starts with rising reservoir:
  - If there is no open air valve or vent, when H1 is greater than the controlling soffit of the discharge pipe. In this case the full flow rating curves ("If pipe primes, then full outlet control….") are applied. The full flow curve table is provided in a matrix of H1 and H2 (downstream water level at normal pump intake). The second trigger point is this H1 value that initiates siphon flow condition.[1]
  - If an open air vent is available, siphon does not develop. The critical flow control shown on the left side of the rating curve ("Assuming the pipe never primes") controls. However, full flow will occur with an open air vent when certain H1 thresholds are exceeded (such that the soffit pressures exceed atmospheric pressure). The H1 thresholds are listed under respective tailwater levels in two rows beneath the full flow rating curve table.
- If siphon flow develops, then it will continue until either the pressure at the soffit of the crest pipe drops below -9.5 psi, or when H1 falls below with 1 foot of the top of the outlet to the lake (which acts as the intake in reverse flow conditions). The third trigger point is the estimated elevation at which the siphon breaks. If the siphon breaks, then critical flow controls.

Conclusions: Modifications could be made to the estimates if and when more detailed information becomes available to make more conclusive backflow rating curve assumptions. The CENWP-EC-HD will continue to seek data on pump loss coefficients.

The 60% reverse flow rating curves are attached in order of pump stations. The tables present the flow rates per individual pump. The detailed calculations, assumptions, and assumed dimensions are available upon request.

Steve Schlenker
Karen Kuhn
Hydraulic Engineers
CENWP-EC-HD

[1] The threshold for which siphon flow develops is unpredictable and is dependent on conditions and system geometry. A momentary abrupt rise in the lake water surface could send a pulse that primes the conduit. On the other hand, minor cracks or air leaks in the conduit could also prevent or break the siphon before it would normally give way (3rd trigger point). The current H1 threshold values are based on EC-HD judgment—however the values are subject to change as more information is obtained.

St. Bernard Parish, #1 Fortifications Canal Pumping Station: 42 x 54 inches

ENGINEERING DESIGN SHEET

PROJECT: St. Bernard Parish Pump Stations
#1/ Foundation Canal Pumping Station-42x54" pump
40,000 gpm (1 pump this size, 3 total in station)

SUBJECT: Backflow Rating Curves

OFFICE SYMBOL: CENWP-EC-HD
COMPUTED BY: KK/SS DATE: 22 Feb 2006
WORKSHEET: Rating Curve
CHECKED BY: SJS/KAK

Crest Elevation (ft) = 3.83
Trigger Points:
Flow starts when H1 > is greater than 3.83 ft crest of intake

Assume Tainter Gate Left Open

DRAFT Rating Curves for Approx 40,000 gpm Pump (42 X 54" diam propeller)

(assumed Pump #1 for #1 Fortification Canal Pumping Station

Discharge in CFS for H1 & H2

Rating Curve Per Pump: Flow Rate for H1 versus H2

		Elevation (H2) at Backflow Outlet C3						
		-6	-4	-2	0	2	4	6
H1 U/s Reservoir Elevation	Level Above Discharge Pipe Crest	H2 =-6	H2 =-4	H2 =-2	H2 =0	H2 =2	H2 =4	H2 =6
(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
3.00	-0.83	0	0	0	0	0	0	0
3.50	-0.33	0	0	0	0	0	0	0
4.00	0.17	2	2	2	2	2	0	-88
4.50	0.67	17	17	17	17	17	17	-76
5.00	1.17	39	39	39	39	39	39	-62
5.50	1.67	66	66	66	66	66	66	-44
6.00	2.17	98	98	98	98	98	88	0
6.50	2.67	134	134	134	134	132	98	44
7.00	3.17	173	173	173	164	139	107	62
7.50	3.67	215	210	191	170	145	116	76
8.00	4.17	232	215	196	175	152	124	88
8.50	4.67	236	219	201	181	158	132	98
9.00	5.17	240	224	206	186	164	139	107
9.50	5.67	244	228	210	191	170	145	116
10.00	6.17	248	232	215	196	175	152	124
10.50	6.67	252	236	219	201	181	158	132
11.00	7.17	256	240	224	206	186	164	139
11.50	7.67	259	244	228	210	191	170	145
12.00	8.17	263	248	232	215	196	175	152
12.50	8.67	267	252	236	219	201	181	158
13.00	9.17	270	256	240	224	206	186	164

NOTES:

1 Rating curve is accurate within ± 30% due uncertainty of pump curve loss coefficient and unknown width of discharge channel

2 Loss and Trigger Point Assumptions:
Pump loss coefficient = 3.00
Siphon flow does not start till H1 > soffit of pipe at crest(Zt)
Intake loss = 0.5
Exit Loss = 1.2 (grating effect)
Bend and expansion losses also incorporated

3 Data Assumptions:
Tainter Gate Left open
Discharge Channel width = 10 feet

4 Data Needs:
Discharge Channel width

5 Backflow prevention:
Available: Tainter Gate for closure

St. Bernard Parish, #1 Fortifications Canal Pumping Station: 94 x 128 inches

ENGINEERING DESIGN SHEET
PROJECT: St. Bernard Parish Pump Stations
#4 Meraux Pumpig Station-94x128" pumps
200,000 gpm (2 pumps this size, 3 total in station)
SUBJECT: Backflow Rating Curves

OFFICE SYMBOL: CENWP-EC-HD
COMPUTED BY: KK/SS DATE: 22 Feb 2006
WORKSHEET: Rating Curve
CHECKED BY: SJS/KAK

Crest Elevation (ft) = 3.83
Trigger Points:
Flow starts when H1 > is greater than 3.83 ft crest of weir

Assume Tainter Gate Left Open

DRAFT Rating Curves for Approx 200,000 gpm Pump (94X128" diam propeller)

(assumed Pump #2&3 for #4 Meraux Pumping Station

Discharge in CFS for H1 & H2

Rating Curve per Pump: Flow Rate for H1 versus H2

		Elevation (H2) at Backflow Outlet C3						
		-6	-4	-2	0	2	4	6
H1 U/s Reservoir Elevation	Level Above Weir Crest	H2 =-6	H2 =-4	H2 =-2	H2 =0	H2 =2	H2 =4	H2 =6
(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
3.00	-0.83	0	0	0	0	0	0	0
3.50	-0.33	0	0	0	0	0	0	0
4.00	0.17	2	2	2	2	2	0	-361
4.50	0.67	17	17	17	17	17	17	-312
5.00	1.17	39	39	39	39	39	39	-255
5.50	1.67	66	66	66	66	66	66	-180
6.00	2.17	98	98	98	98	98	98	0
6.50	2.67	134	134	134	134	134	134	134
7.00	3.17	173	173	173	173	173	173	173
7.50	3.67	215	215	215	215	215	215	215
8.00	4.17	259	259	259	259	259	259	259
8.50	4.67	306	306	306	306	306	306	306
9.00	5.17	355	355	355	355	355	355	355
9.50	5.67	405	405	405	405	405	405	405
10.00	6.17	458	458	458	458	458	458	458
10.50	6.67	512	512	512	512	512	512	512
11.00	7.17	567	567	567	567	567	567	567
11.50	7.67	624	624	624	624	624	624	598
12.00	8.17	682	682	682	682	682	682	625
12.50	8.67	741	741	741	741	741	741	650
13.00	9.17	800	800	800	800	800	765	675

NOTES:

1 Full flow Rating curve is accurate within ± 30% due uncertainty of pump curve loss coefficient and timing and degree of siphoning developed

2 Loss and Trigger Point Assumptions:
Pump loss coefficient = 3.00
Siphon flow does not start till H1 > soffit of pipe at crest(Zt)
Intake loss = 0.5
Exit Loss = 1.2
Bend and expansion losses also incorporated

3 Data Assumptions:
Tainter Gate Left open
Discharge gate width = 10 feet

4 Data Needs:
Discharge gate width

5 Backflow prevention:
Available: Tainter Gate for Closure

St. Bernard Parish, #2 Guichard and #3 Bayou Villere: 42 inch Pumps

ENGINEERING DESIGN SHEET
PROJECT: St. Bernard Parish Pump Stations
Guichard #2/ Bayou Villere #3 -42" pumps approx 50,000 gpm
SUBJECT: Backflow Rating Curves

OFFICE SYMBOL: CENWP-EC-HD
COMPUTED BY: KK/SS DATE: 22 Feb 2006
WORKSHEET: Rating Curve
CHECKED BY: SJS/KAK

Crest Elevation (ft) = 11
Trigger Points:
Flow starts when H1 > is greater than 11 ft crest of conduit
Siphon Flow starts with rising H1 when:
If no open air valve or vent, when H1 > Soffit = 14.5 ft assume siphon starts when H1 = Zt
If open vent; see bottom of table for when full flow occurs
If siphon flow develops, flow stops (approx.) when H1 < 2 ft assume drawdown at intake ≈1 ft.

DRAFT Rating Curves for Approx 50,000 gpm Pump (42" propeller)
(assumed Pump #1 for Guichard PS#2 and possible pump(s) for Bayou Villere PS#3)

Discharge in CFS for H1 & H2

Assuming Pipe never primes:

If Pipe primes then full flow outlet control as siphon:
Primed Flow (full Outlet Control) as function of H2

H1 U/s Reservoir Elevation (ft)	Level Above Discharge Pipe Crest (ft)	**Q Flow Rate** (cfs)	Elevation (H2) at Backflow Outlet C3 -6 (ft) Primed Conduit, H2 =-6	-3.16667 (ft) Primed Conduit, H2 =-3	-0.33333 (ft) Primed Conduit, H2 =0	2.5 (ft) Primed Conduit, H2 =3	5.333333 (ft) Primed Conduit, H2 =5	8.166667 (ft) Primed Conduit, H2 =8	11 (ft) Primed Conduit, H2 =11
8.00	-3.00	0	113	101	87	71	49	-12	-52
8.50	-2.50	0	115	103	90	74	54	17	-48
9.00	-2.00	0	117	105	92	77	58	28	-43
9.50	-1.50	0	119	107	95	80	62	35	-37
10.00	-1.00	0	121	109	97	83	65	41	-30
10.50	-0.50	0	123	112	99	85	69	46	-21
11.00	0.00	0	124	114	102	88	72	51	0
11.50	0.50	2	126	116	104	91	75	55	21
12.00	1.00	6	128	118	106	93	78	59	30
12.50	1.50	13	130	119	108	95	81	63	37
13.00	2.00	21	132	121	110	98	84	66	43
13.50	2.50	30	133	123	112	100	86	70	48
14.00	3.00	39	135	125	114	102	89	73	52
14.50	3.50	48	137	127	116	105	91	76	56
15.00	4.00	56	138	129	118	107	94	79	60
15.50	4.50	65	140	130	120	109	96	82	64
16.00	5.00	73	142	132	122	111	99	84	67
16.50	5.50	80	143	134	124	113	101	87	71
17.00	6.00	87	145	136	126	115	103	90	74
17.50	6.50	94	146	137	127	117	105	92	77
18.00	7.00	101	148	139	129	119	107	95	80

Estimated H1 required for full flow if Open Air Valve or vent:

	TW=-6	TW=-3	TW=0	TW=3	TW=5	TW=8	TW=11
If Open Air Valve H1 >	19	18	17	15	14	12	#NUM!

NOTES:

1 Full flow Rating curve is accurate within ± 30% due uncertainty of pump curve loss coefficient and timing and degree of siphoning developed

2 Loss and Trigger Point Assumptions:
Pump loss coefficient = 3.00
Siphon flow does not start till H1 > soffit of pipe at crest(Zt)
Intake loss = 0.5
Exit Loss = 1
Bend and expansion losses also incorporated

3 Data Assumptions:
Shape/length/angle of: bends, pipes, outlet, intake assumed from Pump info in questionnaire and photos.
Elevations assumed from information on questionnaire sheets for PS#2 & assumed similarity to PS#6.
NOTE: Information regarding elevations for PS#2 and PS#3 are not consistent (varies by about 10 feet)

4 Data Needs:
Shape/length/angle of: bends, pipes, outlet, intake.
Elevations for bends, pipes, pump, outlet, intake etc.
Pump info for Pump #3 at Guichard PS#2; and for Pumps #1, #2, #3 for Bayou Villere PS#3
Cover sheet for PS#2 indicates pump #3 is 75,000 gpm pump. No other usable info given.
Need pump diam for pump #3 to estimate backflow curve.
Cover sheet for PS#3 indicates 3 pumps @ 50,000 & 75,000 & 100,000 gpm
Questionnaire responses indicate 3 pumps @ 60" propeller, 90" intake, 60" discharge column.
More information needed to determine if curves given are usable for PS#3.

5 Backflow prevention:
Available: PS#2 No floodgates; No backflow valves
PS#3 Intake pipes to pumps 1 and 2 have butterfly valves
Installed/used: PS#2 n/a
PS#3 No backstops/brakes installed to prevent reverse rotation

St. Bernard Parish, #2 Guichard and #3 Bayou Villere: 60 inch Pumps

ENGINEERING DESIGN SHEET
PROJECT: St. Bernard Parish Pump Stations
Guichard #2/ Bayou Villere #3-60" pumps appr 100,000 gpm
SUBJECT: Backflow Rating Curves

OFFICE SYMBOL: CENWP-EC-HD
COMPUTED BY: KK/SS DATE: 22 Feb 2006
WORKSHEET: Rating Curve
CHECKED BY: SJS/KAK

Crest Elevation (ft) = 11
Trigger Points:
Flow starts when H1 > is greater than 11 ft crest of conduit
Siphon Flow starts with rising H1 when:
If no open air valve or vent, when H1 > Soffit = 16.0 ft assume siphon starts when H1 = Zt
If open vent; see bottom of table for when full flow occurs
If siphon flow develops, flow stops (approx.) when H1 < 3 ft assume drawdown at intake ≈1 ft.

DRAFT Rating Curves for Approx 100,000 gpm Pump (60" diam propeller)
(assumed Pump #2 & #4 for Guichard PS#2 and possible pump(s) for Bayou Villere PS#3)

Discharge in CFS for H1 & H2

Assuming Pipe never primes:

If Pipe primes then full flow outlet control as siphon:
Primed Flow (full Outlet Control) as function of H2

H1 U/s Reservoir Elevation (ft)	Level Above Discharge Pipe Crest (ft)	**Q Flow Rate** (cfs)	Elevation (H2) at Backflow Outlet C3						
			-6	-3.16667	-0.33333	2.5	5.333333	8.166667	11
			Primed Conduit, H2 =-6 (ft)	Primed Conduit, H2 =-3 (ft)	Primed Conduit, H2 =0 (ft)	Primed Conduit, H2 =3 (ft)	Primed Conduit, H2 =5 (ft)	Primed Conduit, H2 =8 (ft)	Primed Conduit, H2 =11 (ft)
8.00	-3.00	0	233	208	180	146	102	-25	-108
8.50	-2.50	0	237	212	185	152	111	36	-98
9.00	-2.00	0	241	217	190	159	119	57	-88
9.50	-1.50	0	245	221	195	165	127	72	-76
10.00	-1.00	0	249	226	200	170	134	84	-62
10.50	-0.50	0	253	230	205	176	141	95	-44
11.00	0.00	0	256	234	209	181	148	105	0
11.50	0.50	2	260	238	214	187	154	114	44
12.00	1.00	7	264	242	218	192	161	122	62
12.50	1.50	16	268	246	223	197	167	129	76
13.00	2.00	27	271	250	227	202	172	137	88
13.50	2.50	41	275	254	231	206	178	144	98
14.00	3.00	55	278	258	236	211	183	150	108
14.50	3.50	70	282	261	240	215	188	157	116
15.00	4.00	86	285	265	244	220	193	163	124
15.50	4.50	102	288	269	248	224	198	168	132
16.00	5.00	118	292	272	251	229	203	174	139
16.50	5.50	133	295	276	255	233	208	180	146
17.00	6.00	148	298	279	259	237	212	185	152
17.50	6.50	162	302	283	263	241	217	190	159
18.00	7.00	176	305	286	266	245	221	195	165

Estimated H1 required for full flow if Open Air Valve or vent:

		TW=-6	TW=-3	TW=0	TW=3	TW=5	TW=8	TW=11
If Open Air Valve	H1 >	19	18	16	15	14	12	#NUM!

NOTES:

1 Full flow Rating curve is accurate within ± 30% due uncertainty of pump curve loss coefficient and timing and degree of siphoning developed

2 Loss and Trigger Point Assumptions:
Pump loss coefficient = 3.00
Siphon flow does not start till H1 > soffit of pipe at crest(Zt)
Intake loss = 0.5
Exit Loss = 1
Bend and expansion losses also incorporated

3 Data Assumptions:
Shape/length/angle of: bends, pipes, outlet, intake assumed from Pump info in questionnaire and photos.
Elevations assumed from information on questionnaire sheets for PS#2 & assumed similarity to PS#6.
NOTE: Information regarding elevations for PS#2 and PS#3 are not consistent (varies by about 10 feet)

4 Data Needs:
Shape/length/angle of: bends, pipes, outlet, intake.
Elevations for bends, pipes, pump, outlet, intake etc.
Pump info for Pump #3 at Guichard PS#2; and for Pumps #1, #2, #3 for Bayou Villere PS#3
Cover sheet for PS#2 indicates pump #3 is 75,000 gpm pump. No other usable info given.
Need pump diam for pump #3 to estimate backflow curve.
Cover sheet for PS#3 indicates 3 pumps @ 50,000 & 75,000 & 100,000 gpm
Questionaire responses indicate 3 pumps @ 60" propeller, 90" intake, 60" discharge column
More information needed to determine if curves given are usable for PS#3.

5 Backflow prevention:
Available: PS#2 No floodgates; No backflow valves
PS#3 Intake pipes to pumps 1 and 2 have butterfly valves
Installed/used: PS#2 n/a
PS#3 No backstops/brakes installed to prevent reverse rotation

St. Bernard Parish, #4 Meraux Pumping Station: 42 x 54 inches

ENGINEERING DESIGN SHEET

PROJECT: St. Bernard Parish Pump Stations
#4 Meraux Pumping Station-42x54" pump
40,000 gpm (1 pump this size, 3 total in station)

SUBJECT: Backflow Rating Curves

OFFICE SYMBOL: CENWP-EC-HD
COMPUTED BY: KK/SS DATE: 22 Feb 2006
WORKSHEET: Rating Curve
CHECKED BY: SJS/KAK

Crest Elevation (ft) = 3.83
Trigger Points:
Flow starts when H1 > is greater than 3.83 ft crest of intake

Assume Tainter Gate Left Open

DRAFT Rating Curves for Approx 40,000 gpm Pump (42 X 54" diam propeller)

(assumed Pump #1 for #4 Meraux Pumping Station

Discharge in CFS for H1 & H2

Rating Curve Per Pump: Flow Rate for H1 versus H2

		Elevation (H2) at Backflow Outlet C3						
		-6	-4	-2	0	2	4	6
H1 U/s Reservoir Elevation	Level Above Discharge Pipe Crest	H2 =-6	H2 =-4	H2 =-2	H2 =0	H2 =2	H2 =4	H2 =6
(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
3.00	-0.83	0	0	0	0	0	0	0
3.50	-0.33	0	0	0	0	0	0	0
4.00	0.17	2	2	2	2	2	0	-88
4.50	0.67	17	17	17	17	17	17	-76
5.00	1.17	39	39	39	39	39	39	-62
5.50	1.67	66	66	66	66	66	66	-44
6.00	2.17	98	98	98	98	98	88	0
6.50	2.67	134	134	134	134	132	98	44
7.00	3.17	173	173	173	164	139	107	62
7.50	3.67	215	210	191	170	145	116	76
8.00	4.17	232	215	196	175	152	124	88
8.50	4.67	236	219	201	181	158	132	98
9.00	5.17	240	224	206	186	164	139	107
9.50	5.67	244	228	210	191	170	145	116
10.00	6.17	248	232	215	196	175	152	124
10.50	6.67	252	236	219	201	181	158	132
11.00	7.17	256	240	224	206	186	164	139
11.50	7.67	259	244	228	210	191	170	145
12.00	8.17	263	248	232	215	196	175	152
12.50	8.67	267	252	236	219	201	181	158
13.00	9.17	270	256	240	224	206	186	164

NOTES:

1 Rating curve is accurate within ± 30% due uncertainty of pump curve loss coefficient and unknown width of discharge channel

2 Loss and Trigger Point Assumptions:
Pump loss coefficient = 3.00
Siphon flow does not start till H1 > soffit of pipe at crest(Zt)
Intake loss = 0.5
Exit Loss = 1.2 (grating effect)
Bend and expansion losses also incorporated

3 Data Assumptions:
Tainter Gate Left open
Discharge Channel width = 10 feet

4 Data Needs:
Discharge Channel width

5 Backflow prevention:
Available: Tainter Gate for closure

St. Bernard Parish, #4 Meraux Pumping Station: 94 x 128 inches

ENGINEERING DESIGN SHEET
PROJECT: St. Bernard Parish Pump Stations
#4 Meraux Pumpig Station-94x128" pumps
200,000 gpm (2 pumps this size, 3 total in station)
SUBJECT: Backflow Rating Curves

OFFICE SYMBOL: CENWP-EC-HD
COMPUTED BY: KK/SS DATE: 22 Feb 2006
WORKSHEET: Rating Curve
CHECKED BY: SJS/KAK

Crest Elevation (ft) = 3.83
Trigger Points:
Flow starts when H1 > is greater than 3.83 ft crest of weir

Assume Tainter Gate Left Open

DRAFT Rating Curves for Approx 200,000 gpm Pump (94X128" diam propeller)

(assumed Pump #2&3 for #4 Meraux Pumping Station

Discharge in CFS for H1 & H2

Rating Curve per Pump: Flow Rate for H1 versus H2

		Elevation (H2) at Backflow Outlet C3						
		-6	-4	-2	0	2	4	6
H1 U/s Reservoir Elevation	Level Above Weir Crest	H2 =-6	H2 =-4	H2 =-2	H2 =0	H2 =2	H2 =4	H2 =6
(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
3.00	-0.83	0	0	0	0	0	0	0
3.50	-0.33	0	0	0	0	0	0	0
4.00	0.17	2	2	2	2	2	0	-361
4.50	0.67	17	17	17	17	17	17	-312
5.00	1.17	39	39	39	39	39	39	-255
5.50	1.67	66	66	66	66	66	66	-180
6.00	2.17	98	98	98	98	98	98	0
6.50	2.67	134	134	134	134	134	134	134
7.00	3.17	173	173	173	173	173	173	173
7.50	3.67	215	215	215	215	215	215	215
8.00	4.17	259	259	259	259	259	259	259
8.50	4.67	306	306	306	306	306	306	306
9.00	5.17	355	355	355	355	355	355	355
9.50	5.67	405	405	405	405	405	405	405
10.00	6.17	458	458	458	458	458	458	458
10.50	6.67	512	512	512	512	512	512	512
11.00	7.17	567	567	567	567	567	567	567
11.50	7.67	624	624	624	624	624	624	598
12.00	8.17	682	682	682	682	682	682	625
12.50	8.67	741	741	741	741	741	741	650
13.00	9.17	800	800	800	800	800	765	675

NOTES:

1 Full flow Rating curve is accurate within ± 30% due uncertainty of pump curve loss coefficient and timing and degree of siphoning developed

2 Loss and Trigger Point Assumptions:
- Pump loss coefficient = 3.00
- Siphon flow does not start till H1 > soffit of pipe at crest(Zt)
- Intake loss = 0.5
- Exit Loss = 1.2
- Bend and expansion losses also incorporated

3 Data Assumptions:
- Tainter Gate Left open
- Discharge gate width = 10 feet

4 Data Needs:
- Discharge gate width

5 Backflow prevention:
- Available: Tainter Gate for Closure

St. Bernard Parish, #5 E.J. Gore Pump Station

Flap gates on pipe exits prevent reverse flow through pumps.

St. Bernard Parish, #6 Jean Laffitte and #7 Bayou Ducros pumps

ENGINEERING DESIGN SHEET
PROJECT: St. Bernard Parish Pump Stations
Jean Lafitte #6 & Bayou Ducros #7
SUBJECT: Backflow Rating Curves

OFFICE SYMBOL: CENWP-EC-HD
COMPUTED BY: KK/SS DATE: 22 Feb 2006
WORKSHEET: Rating Curve
CHECKED BY: SJS/KAK

Crest Elevation (ft) = 5
Trigger Points:
Flow starts when H1 > is greater than 5 ft crest of conduit
Siphon Flow starts with rising H1 when:
If no open air valve or vent, when H1 > Soffit = 11.0 ft assume siphon starts when H1 = Zt
If open vent; see bottom of table for when full flow occurs
If siphon flow develops, flow stops (approx.) when H1 < 4 ft assume drawdown at intake ?1 ft.

DRAFT Rating Curves for Each Pump (3 total for each pump station)

Discharge in CFS for H1 & H2

Assuming Pipe never primes:

If Pipe primes then full flow outlet control as siphon:
Primed Flow (full Outlet Control) as function of H2

			Elevation (H2) at Backflow Outlet C3						
			-7.0	-5.0	-3.0	-1.0	1.0	3.0	5.0
H1 U/s Reservoir Elevation	Level Above Discharge Pipe Crest	**Q Flow Rate**	Primed Conduit, H2 =-7	Primed Conduit, H2 =-5	Primed Conduit, H2 =-3	Primed Conduit, H2 =-1	Primed Conduit, H2 =1	Primed Conduit, H2 =3	Primed Conduit, H2 =5
(ft)	(ft)	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
5.00	0.00	0	301	274	245	213	174	123	0
5.45	0.45	2	306	280	252	220	183	136	58
5.90	0.90	7	312	286	259	228	192	148	82
6.35	1.35	14	317	292	265	235	201	159	101
6.80	1.80	25	322	298	272	242	209	169	116
7.25	2.25	37	328	304	278	249	217	179	130
7.70	2.70	51	333	309	284	256	225	188	143
8.15	3.15	65	338	315	290	262	232	197	154
8.60	3.60	80	343	320	295	269	239	205	165
9.05	4.05	95	348	325	301	275	246	213	175
9.50	4.50	110	352	330	307	281	253	221	184
9.95	4.95	125	357	335	312	287	260	229	193
10.40	5.40	139	362	340	318	293	266	236	202
10.85	5.85	154	367	345	323	299	272	243	210
11.30	6.30	167	371	350	328	304	278	250	218
11.75	6.75	181	376	355	333	310	284	257	225
12.20	7.20	194	380	360	338	315	290	263	233
12.65	7.65	206	385	364	343	321	296	270	240
13.10	8.10	219	389	369	348	326	302	276	247
13.55	8.55	231	393	374	353	331	307	282	254
14.00	9.00	242	398	378	358	336	313	288	260

Estimated H1 required for full flow if Open Air Valve or vent:

		TW=-7	TW=-5	TW=-3	TW=-1	TW=1	TW=3	TW=5
If Open Air Valve	H1 >	17	15	13	11	9	7	5

NOTES:

1 Full flow Rating curve is accurate within ± 30% due uncertainty of pump curve loss coefficient and timing and degree of siphoning developed

2 Loss and Trigger Point Assumptions:
Pump loss coefficient = 3.00
Siphon flow does not start till H1 > soffit of pipe at crest(Zt)
Intake loss = 2 (diffusion chamber at normal exit)
Exit Loss = 1
Bend and expansion losses also incorporated

3 Data Assumptions:

Shape/length/angle of diffuser/baffle based on photos
Shape/length/angle of 2nd bend based on sketch and photos
Pipe lengths estimated from photos and 1988 Design Worksheet.
Elevations in msl and NGVD are same

4 Data Needs:
Shape/length/angle of diffuser & detail of baffle
Detail of pumps incl bend to discharge pipe, impeller

St. Bernard Parish, #8 St Mary pumps

ENGINEERING DESIGN SHEET
PROJECT: St. Bernard Parish Pump Stations
St. Mary #8
SUBJECT: Backflow Rating Curves

OFFICE SYMBOL: CENWP-EC-HD
COMPUTED BY: KK/SS DATE: 22 Feb 2006
WORKSHEET: Rating Curve
CHECKED BY: SJS/KAK

Crest Elevation (ft) = 4.75
Trigger Points:
Flow starts when H1 > is greater than 4.75 ft crest of conduit
Siphon Flow starts with rising H1 when:
If no open air valve or vent, when H1 > Soffit = 10.3 ft assume siphon starts when H1 = Zt
If open vent; see bottom of table for when full flow occurs
If siphon flow develops, flow stops (approx.) when H1 < 4 ft assume drawdown at intake ?1 ft.

DRAFT Rating Curves for Each Pump,108x66 Centrifual, approx 125,000 gpm, No. of Identical Pumps = 3

Discharge in CFS for H1 & H2

Assuming Pipe never primes:

H1 U/s Reservoir Elevation (ft)	Level Above Discharge Pipe Crest (ft)	**Q Flow Rate** (cfs)
3.00	-1.75	0
3.50	-1.25	0
4.00	-0.75	0
4.50	-0.25	0
5.00	0.25	1
5.50	0.75	4
6.00	1.25	12
6.50	1.75	22
7.00	2.25	35
7.50	2.75	49
8.00	3.25	63
8.50	3.75	78
9.00	4.25	92
9.50	4.75	107
10.00	5.25	120
10.50	5.75	134
11.00	6.25	147
11.50	6.75	159
12.00	7.25	172
12.50	7.75	183
13.00	8.25	195

If Pipe primes then full flow outlet control as siphon:
Primed Flow (full Outlet Control) as function of H2
Elevation (H2) at Backflow Outlet C3

-7 Primed Conduit, H2 =-7 (ft)	-5 Primed Conduit, H2 =-5 (ft)	-3 Primed Conduit, H2 =-3 (ft)	-1 Primed Conduit, H2 =-1 (ft)	1 Primed Conduit, H2 =1 (ft)	3 Primed Conduit, H2 =3 (ft)	5 Primed Conduit, H2 =5 (ft)
228	204	176	144	102	0	-102
233	210	184	153	114	51	-88
239	216	191	161	125	72	-72
244	222	197	169	135	88	-51
249	228	204	176	144	102	0
255	233	210	184	153	114	51
260	239	216	191	161	125	72
265	244	222	197	169	135	88
269	249	228	204	176	144	102
274	255	233	210	184	153	114
279	260	239	216	191	161	125
283	265	244	222	197	169	135
288	269	249	228	204	176	144
292	274	255	233	210	184	153
297	279	260	239	216	191	161
301	283	265	244	222	197	169
306	288	269	249	228	204	176
310	292	274	255	233	210	184
314	297	279	260	239	216	191
318	301	283	265	244	222	197
322	306	288	269	249	228	204

Estimated H1 required for full flow if Open Air Valve or vent:

	TW=-7	TW=-5	TW=-3	TW=-1	TW=1	TW=3	TW=5
If Open Air Valve H1 >	16	14	12	10	8	6	#NUM!

NOTES:

1 Full flow Rating curve is accurate within ± 30% due uncertainty of pump curve loss coefficient and timing and degree of siphoning developed

2 Loss and Trigger Point Assumptions:
Pump loss coefficient = 3.00
Siphon flow does not start till H1 > soffit of pipe at crest(Zt)
Intake loss = 2
Exit Loss = 1
Bend and expansion losses also incorporated

3 Data Assumptions:

Shape/length/angle of diffuser/baffle based on photos for PS#6 and PS#8 (similar to PS#6 but longer pipe)
Shape/length/angle of 2nd bend based on 1/2 dwg and photos (assumed similar to PS#6/7)
Pipe lengths estimated from photos and 1988 Design Worksheet for PS#6 and photos for PS#8.

4 Data Needs:
Shape/length/angle of diffuser & detail of baffle
Detail of pumps incl bend to discharge pipe, impeller

Name	Pump	Capacity	Manufacture	Size	Model Number	Serial Number	Installed	Driver	Rated Pump Speed	Pump Type	Pump Elevation*	Pump Curve	Discharge Gates	Rated Head	Track Rack Design Head	Intake Location	Discharge Location	Intake water elevation at Start	Intake water elevation at Stop	Intake water elevation range	Water elevations that effects station	Bearing Lubrication	Backstops or brakes
		(cfs)		(in)			(year)	Electric /Diesel	(rpm)	(Vertical/Horizontal)	(NGVD)	(yes/no)	(type)	(ft)	(ft)			(NGVD)	(NGVD)	(NGVD)	(NGVD)	(oil/water)	(yes/no)
Fortification #1	1	445	Baldwin-Lima-Hamilton (Patterson)	94 x 128	AFV	?	1972	Diesel	212	Vertical	-1.5	yes	tainter gates	19	n/a	Florida Walk Canal	Bayou Bienvenue	-6.0	-6.5	0.5	8	Oil	No
	2	90	Baldwin-Lima-Hamilton (Patterson)	42 x 54	AFV	?	1972	Electric 60 Hz	505	Vertical	-1.5	yes	tainter gates	20	n/a	Florida Walk Canal	Bayou Bienvenue	-6.0	-6.5	0.5	8	Oil	No
	3	445	Baldwin-Lima-Hamilton (Patterson)	94 x 128	AFV	?	1972	Diesel	212	Vertical	-1.5	yes	tainter gates	19	n/a	Florida Walk Canal	Bayou Bienvenue	-6.0	-6.5	0.5	8	Oil	No
	Total	**980**																					
Guichard #2	1**	111	M&W (MWI)	42	NC342P12	?	1950's	Diesel	n/a	Horizontal	-8	yes	none	n/a	n/a	Florida Walk Canal	Bayou Bienvenue	-6.0	-6.5	0.5	4	Oil	No
	2**	267	M&W (MWI)	60	NC360P12	?	1950's	Diesel	n/a	Horizontal	-8	yes	none	n/a	n/a	Florida Walk Canal	Bayou Bienvenue	-6.0	-6.5	0.5	4	Oil	No
	3**	110	?	?	?	?	1950's	Diesel	n/a	Horizontal	-8	yes	none	n/a	n/a	Florida Walk Canal	Bayou Bienvenue	-6.0	-6.5	0.5	4	Oil	No
	4**	267	M&W (MWI)	60	NC360P12	?	1950's	Diesel	n/a	Horizontal	-8	yes	none	n/a	n/a	Florida Walk Canal	Bayou Bienvenue	-6.0	-6.5	0.5	4	Oil	No
	Total	**755**																					
Bayou Villere #3	1**	266	M&W (MWI)	60	NC360P12	?	1950's	Diesel	n/a	Horizontal	-8	yes	butterfly valve	n/a	n/a	Forty Arpent Canal	Bayou Villere	-6.0	-6.5	0.5	12	Oil	Yes
	2**	267	M&W (MWI)	60	NC360P12	?	1950's	Diesel	n/a	Horizontal	-8	yes	butterfly valve	n/a	n/a	Forty Arpent Canal	Bayou Villere	-6.0	-6.5	0.5	12	Oil	Yes
	3***	267	M&W (MWI)	60	NC360P12	?	1950's	Diesel	n/a	Horizontal	-8	yes	none	n/a	n/a	Forty Arpent Canal	Bayou Villere	-6.0	-6.5	0.5	12	Oil	No
	Total	**800**																					
Meraux #4	1	445	Baldwin-Lima-Hamilton (Patterson)	94 x 128	AFV	?	1972	Diesel	212	Vertical	-1.5	yes	floodgate	n/a	n/a	Forty Arpent Canal	Bayou Dupre	-6.0	-6.5	0.5	16	Grease	No
	2	90	Baldwin-Lima-Hamilton (Patterson)	42 x 54	AFV	?	1972	Electric 60 Hz	505	Vertical	-1.5	yes	floodgate	n/a	n/a	Forty Arpent Canal	Bayou Dupre	-6.0	-6.5	0.5	16	Grease	No
	3	445	Baldwin-Lima-Hamilton (Patterson)	94 x 128	AFV	?	1972	Diesel	212	Vertical	-1.5	yes	floodgate	n/a	n/a	Forty Arpent Canal	Bayou Dupre	-6.0	-6.5	0.5	16	Grease	No
	Total	**980**																					
E.J. Gore #5	1	111	M&W (MWI)	42	NC342P12	?	1980's	Diesel	n/a	Horizontal	-8	yes	flap gates	n/a	n/a	Forty Arpent Canal	Bayou Dupre	0.0	-0.5	0.5	2	Oil	No
	2	111	M&W (MWI)	42	NC342P13	?	1980's	Diesel	n/a	Horizontal	-8	yes	flap gates	n/a	n/a	Forty Arpent Canal	Bayou Dupre	0.0	-0.5	0.5	2	Oil	No
	3	111	M&W (MWI)	42	NC342P14	?	1980's	Diesel	n/a	Horizontal	-8	yes	flap gates	n/a	n/a	Forty Arpent Canal	Bayou Dupre	0.0	-0.5	0.5	2	Oil	No
	4	111	M&W (MWI)	42	NC342P15	?	1980's	Diesel	n/a	Horizontal	-8	yes	flap gates	n/a	n/a	Forty Arpent Canal	Bayou Dupre	0.0	-0.5	0.5	2	Oil	No
	5	111	M&W (MWI)	42	NC342P16	?	1980's	Diesel	n/a	Horizontal	-8	yes	flap gates	n/a	n/a	Forty Arpent Canal	Bayou Dupre	0.0	-0.5	0.5	2	Oil	No
	6	110	M&W (MWI)	42	NC342P17	?	1980's	Diesel	n/a	Horizontal	-8	yes	flap gates	n/a	n/a	Forty Arpent Canal	Bayou Dupre	0.0	-0.5	0.5	2	Oil	No
	Total	**665**																					
Jean Lafitte #6	1	315	Patterson Pump Co.	75 x 72	AFV	90PT-14688-90-G72	1990	Diesel	272	Vertical	-8	yes	none	10.5	n/a	Florida Walk Canal	Bayou Bienvenue	-6.0	-6.5	0.5	9	Grease	Yes
	2	315	Patterson Pump Co.	75 x 72	AFV	90PT-14688-90-G72	1990	Diesel	272	Vertical	-8	yes	none	10.5	n/a	Florida Walk Canal	Bayou Bienvenue	-6.0	-6.5	0.5	9	Grease	Yes
	3	315	Patterson Pump Co.	75 x 72	AFV	90PT-14688-90-G73	1990	Diesel	272	Vertical	-8	yes	none	10.5	n/a	Florida Walk Canal	Bayou Bienvenue	-6.0	-6.5	0.5	9	Grease	Yes
	Total	**945**																					
Bayou Ducros #7	1	333	Patterson Pump Co.	75 x 72	AFV	90PT-14688-90-G73	1992	Diesel	272	Vertical	-8	yes	none	10.5	n/a	Forty Arpent Canal	Bayou Ducros	-6.0	-6.5	0.5	16	Grease	Yes
	2	333	Patterson Pump Co.	75 x 72	AFV	90PT-14688-90-G73	1992	Diesel	272	Vertical	-8	yes	none	10.5	n/a	Forty Arpent Canal	Bayou Ducros	-6.0	-6.5	0.5	16	Grease	Yes
	3	334	Patterson Pump Co.	75 x 72	AFV	90PT-14688-90-G73	1992	Diesel	272	Vertical	-8	yes	none	10.5	n/a	Forty Arpent Canal	Bayou Ducros	-6.0	-6.5	0.5	16	Grease	Yes
	Total	**1000**																					
St. Mary #8	1	278	ITT-AC	108 x 66	115-143543	1-0840-70720-02	1996	Diesel	230	Vertical	-9 (intake)	yes	none	2.5	n/a	Twenty Arpent Canal	Lake Lery	0.0	-0.5	0.5	8	Grease	Yes
	2	278	ITT-AC	108 x 66	115-143543	1-0840-70720-01	1996	Diesel	230	Vertical	-9 (intake)	yes	none	2.5	n/a	Twenty Arpent Canal	Lake Lery	0.0	-0.5	0.5	8	Grease	Yes
	3	279	ITT-AC	108 x 66	115-143543	1-0840-70720-03	1996	Diesel	230	Vertical	-9 (intake)	yes	none	2.5	n/a	Twenty Arpent Canal	Lake Lery	0.0	-0.5	0.5	8	Grease	Yes
	Total	**835**																					

*** Elevations estimated by Bob Turner/Lake Borgne Levee District and from engineering plans (when available)**

Pump Station	Pump	Capacity (cfs)	8/28/2005 Start Stop	8/29/2005 Start Stop	8/30/2005 Start Stop	8/31/2005 Start Stop	9/1/2005 Start Stop	9/2/2005 Start Stop	9/3/2005 Start Stop	9/4/2005 Start Stop	9/5/2005 Start Stop	9/6/2005 Start Stop	9/7/2005 Start Stop	9/8/2005 Start Stop	9/9/2005 Start Stop	9/10/2005 Start Stop	9/11/2005 Start Stop	9/12/2005 Start Stop	9/13/2005 Start Stop	9/14/2005 Start Stop	9/15/2005 Start Stop
Fortification #1	1 (East)	577					NA	NR	NR	NR	NR	NR	NR	NR	22:30 Run	Run 22:00	NR	NR			
	2 (Center)	100					NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR			
	3 (West)	577					20:00 Run	Run 11:30	9:00 16:00	9:00 22:00	NR	NR	NR	NR	NR	20:30 22:00	23:00 Run	Run 1:40			
	Total	**1254**																			
Guichard #2	1	111	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	2	223	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	3	167	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	223	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Total	**724**																			
Bayou Villere #3	1	n/a	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	2	n/a	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	3	n/a	NR	NR	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Total	**500**																			
Meraux #4	1 (East)	557	19:05 20:25						9:20 16:20			4:30 Run	Run Run	Run Run	Run Run	Run 1:30					
	2 (Electric)	89	NR						NR			NR	NR	NR	NR	NR					
	3 (West)	557	NR						NR			NR	NR	NR	NR	NR					
	Total	**1203**																			
E.J. Gore #5	1	110			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	2	110			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	3	110			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	110			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	5	110			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	6	110			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Total	**660**																			
Jean Lafitte #6	1	334	16:00 16:45		14:45 22:00	6:00 20:00	6:00 Run	Run 6:00	8:00 19:30 20:30 Run	Run 14:00	7:30 22:00	22:00 Run	Run 1:00 22:00 Run	Run Run	Run Run	Run Run	Run 9:00 11:30 13:30 16:30 18:30 22:30 0:00	3:30 5:00			
	2	334	16:00 16:45		14:45 22:00	6:00 20:00	6:00 Run	Run 6:00	8:00 19:30 20:30 Run	Run 14:00	7:30 22:00	22:00 Run	Run 1:00 22:00 Run	Run Run	Run Run	Run Run	Run 9:00 11:30 13:30 16:30 18:30 22:30 0:00	3:30 5:00			
	3	334	16:00 16:45		14:45 22:00	6:00 20:00	6:00 Run	Run 6:00	8:00 19:30 20:30 Run	Run 14:00	7:30 22:00	22:00 Run	Run 1:00 22:00 Run	Run Run	Run Run	Run Run	Run 9:00 11:30 13:30 16:30 18:30 22:30 0:00	3:30 5:00			
	Total	**1002**																			
Bayou Ducros #7	1	334	7:40 9:10 17:00 17:45 19:35 20:05						8:00 Run	Run 16:00 18:00 Run	Run Run	Run Run	Run Run	Run Run	Run 0:00	8:30 12:00					
	2	334	7:40 9:10 17:00 17:45 19:35 20:05						8:00 Run	Run 16:00 18:00 Run	Run Run	Run Run	Run Run	Run Run	Run 0:00	8:30 12:00					
	3	334	7:40 9:10 17:00 17:45 19:35 20:05						8:00 Run	Run 16:00 18:00 Run	Run Run	Run Run	Run Run	Run Run	Run 0:00	8:30 12:00					
	Total	**1002**																			
St. Mary #8	1	279					15:45 Run	Run Run	Run Run	Run Run	Run Run	Run Run	Run Run	Run 20:00		15:00 Run	Run 17:30	14:00 19:30	7:00 Run	Run Run	Run 1:00
	2	279	9:15 0:00				15:45 Run	Run Run	Run Run	Run Run	Run Run	Run Run	Run Run	Run Run	Run 14:00	6:00 Run	Run 21:30	14:00 16:30	7:15 Run	Run Run	Run 3:00
	3	279							11:45 Run	Run Run	Run Run	Run Run	Run Run	Run Run	Run 14:00	6:00 Run	Run Run	Run Run	Run Run	Run Run	Run 6:00
	Total	**837**																			

Time in Local CST Day Light Savings

Pumps Not Available	**NA**
No Reported Run Times	**NR**
Continued to Run	**Run**
Damaged/ Lost/ Unavaible Record	
Information was not obtained (Area considered Unwatered)	

St Bernard Parish Canal and Tide Level Readings

Pump Stations		Time	28-Aug-05	29-Aug-05	30-Aug-05	31-Aug-05	1-Sep-05	2-Sep-05	3-Sep-05	4-Sep-05	5-Sep-05	6-Sep-05	7-Sep-05	8-Sep-05	9-Sep-05	10-Sep-05	11-Sep-05	12-Sep-05	13-Sep-05	14-Sep-05	15-Sep-05
PS 1 - Fortication	Canal	2:00						5.2	4.2	2.5	0.0	-0.7	-1.7	-2.5		-0.8	-6.8				
	Canal	6:00					6.3	5.1	3.9	2.4	0.0	-0.8	-1.9	-2.5		-1.1	-6.2				
	Canal	10:00					6.0	5.0	3.8	2.3	-0.1	-1.0	-1.9	-2.6		-1.7					
	Canal	14:00					6.0	5.0	3.0	1.5	-0.3	-1.1	-2.0	-2.6		-2.2					
	Canal	18:00					6.0	4.8	2.9	0.9	-0.5	-1.4	-2.1	-2.7		-3.5					
	Canal	22:00					5.8	4.5	2.5	0.2	-0.6	-1.6	-2.3	(22:30)	-0.5	-5.8					
	Tide	2:00						5.2	4.2	2.5	2.9	2.8	2.9	3.0			2.0				
	Tide	6:00					6.3	5.1	3.9	2.4	2.8	2.9	2.8	3.0		2.2	1.9				
	Tide	10:00					6.0	5.0	3.8	2.3	2.8	2.9	2.8	2.7		2.2					
	Tide	14:00					6.0	5.0	3.0	2.2	2.6	3.0	2.9	2.7		2.2					
	Tide	18:00					6.0	4.8	2.9	3.0	2.6	3.0	2.9	2.5		2.8					
	Tide	22:00					5.8	4.5	2.5	3.0	2.6	3.0	2.8	(22:30) 2.1		2.1					
PS 2 - Guichard	Canal	2:00																			
	Canal	6:00																			
	Canal	10:00																			
	Canal	14:00																			
	Canal	18:00																			
	Canal	22:00																			
	Tide	2:00																			
	Tide	6:00																			
	Tide	10:00																			
	Tide	14:00																			
	Tide	18:00																			
	Tide	22:00																			
PS 3 - Bayou Villere	Canal	2:00																			
	Canal	6:00																			
	Canal	10:00																			
	Canal	14:00																			
	Canal	18:00																			
	Canal	22:00																			
	Tide	2:00																			
	Tide	6:00																			
	Tide	10:00																			
	Tide	14:00																			
	Tide	18:00																			
	Tide	22:00																			
PS 4 - Meraux	Canal	2:00											2.0			7.0					
	Canal	6:00	6.5										1.9		-1.3						
	Canal	10:00	7.5										1.8	0.5	-1.9						
	Canal	14:00	7.3									2.6	1.7	0.2	-2.7						
	Canal	18:00	7.0									2.5	1.5	-0.1	-3.7						
	Canal	22:00	8.3									2.3		-0.8	5.5						
	Tide	2:00																			
	Tide	6:00	0.6																		
	Tide	10:00	0.6																		
	Tide	14:00	0.6																		
	Tide	18:00	0.6																		
	Tide	22:00	0.6																		
PS 5 - E.J. Gore	Canal	2:00																			
	Canal	6:00																			
	Canal	10:00																			
	Canal	14:00																			
	Canal	18:00																			
	Canal	22:00																			
	Tide	2:00																			
	Tide	6:00																			
	Tide	10:00																			
	Tide	14:00																			
	Tide	18:00																			
	Tide	22:00																			
PS 6 - Jean Lafitte	Canal	2:00		8.4				13.3	13.3	13.3	13.3	12.8	12.2	11.6	11.0	-0.8	-6.0	6.7			
	Canal	6:00				13.3	13.3	13.3	13.3	13.3	13.3	12.6	12.2	11.6	10.6	-1.1	-6.2	6.7			
	Canal	10:00			13.3	13.3	13.3	13.3	13.3	13.3	13.3	12.6	12.2	11.3	10.3	-1.9	6.9				
	Canal	14:00	6.3		13.3	13.3	13.3	13.3	13.3	13.3	13.3	12.4	12.1	11.3	10.2	-2.5	7.1				
	Canal	18:00	7.2		13.3	13.3	13.3	13.3	13.3	13.3	12.9	12.2	12.0	11.0	-0.2	-3.5	7.4				
	Canal	22:00	7.6		13.3	13.3	13.3	13.3	13.3	13.3	12.9	12.2	11.8	11.0	-0.5	-5.8	6.0				
	Tide	2:00		2.0				5.6	4.2	3.4	2.7	2.8	2.8	2.8	2.2	2.1		1.9			
	Tide	6:00				7.8	6.3	5.1	4.0	3.3	2.5	3.0	2.8	2.8	2.2	2.1	2.0	1.9			
	Tide	10:00			13.3	7.5	6.1	4.9	3.8	3.2	2.7	3.0	2.8	2.8	2.4	2.1	2.1				
	Tide	14:00	1.8		13.0	7.2	6.0	4.7	3.8	3.1	2.7	3.0	3.0	2.7	2.3	2.3	2.2				
	Tide	18:00	1.9		13.0	6.9	5.8	4.5	3.6	3.0	2.7	3.0	3.0	2.5	2.2	2.3	2.0				
	Tide	22:00	1.9		13.0	6.7	5.6	4.3	3.5	3.0	2.8	2.8	2.8	2.4	2.1	2.1	1.9				
PS 7 - Bayou Ducros	Canal	2:00									-1.6	-2.1	-2.7		-0.9	-5.8	-6.1				
	Canal	6:00	-6.3								-1.7	-2.2	-3.0	0.7	-1.3	-6.0	-6.0				
	Canal	10:00	-7.2							-1.3	-1.8	-2.4		0.4	-2.0	-6.5					
	Canal	14:00	-7.2							-1.4	-1.9	-2.4		0.1	-2.8	-6.6					
	Canal	18:00	-7.3							-1.4	-1.9	-2.5		-0.2	-4.0	-6.4					
	Canal	22:00	-8.3							-1.5	-1.9	-2.6		-0.6	-5.8	-6.2					
	Tide	2:00																			
	Tide	6:00	2.0																		
	Tide	10:00	2.0																		
	Tide	14:00	2.0																		
	Tide	18:00	2.0																		
	Tide	22:00	2.0																		
PS 8 - St. Mary	Canal	2:00						3.9			5.0	4.9	4.4	3.8	3.3	2.9	2.1	1.7	1.4	0.8	-2.3
	Canal	6:00	-0.9					3.8		5.7	5.3	4.8	4.2	3.7	3.2	2.8	2.0	1.7	1.4	0.4	-2.0
	Canal	10:00	-1.0					3.6		5.7	5.2	4.8	4.2	3.6	3.1	2.7	1.9	1.6	1.3	0.4	
	Canal	14:00	-1.5				4.2	3.3		5.6	5.1	4.7	4.1	3.5	3.1	2.6	1.8	1.5	1.2	0.4	
	Canal	18:00	-2.9				4.0	3.3		5.5	5.0	4.5	4.0	3.5	3.0	2.5	1.7	1.5	1.2	-0.3	
	Canal	22:00	-3.8				4.0	3.1		5.5	5.0	4.5	3.9	3.4	3.0	2.3	1.7	1.4	1.1	-1.1	
	Tide	2:00																			
	Tide	6:00																			
	Tide	10:00																			
	Tide	14:00																			
	Tide	18:00																			
	Tide	22:00																			

Readings were extracted from Operatings Logs aquired by IPET Task 8 for each pump station where available.