USDA Natural Resources Conservation Service
Science and Technology

2015 Webinars

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06/24/2015	How to Implement Rotational Grazing in Equine Facilities
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07/21/2015	Overview of Tillage Implements for use in RUSLE2 Calculations: Focus on New Implements and Manure and Pesticide Incorporation
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SREF

Pumps and Waste Transfer and Evaluating System Pressures

CNTSC – WEBINAR
June 16, 2015

Natural Resources Conservation Service (NRCS)

Jerry D. Walker, P.E.

Agricultural Engineer (Water Management)
Central National Technology Support Center
Fort Worth, TX

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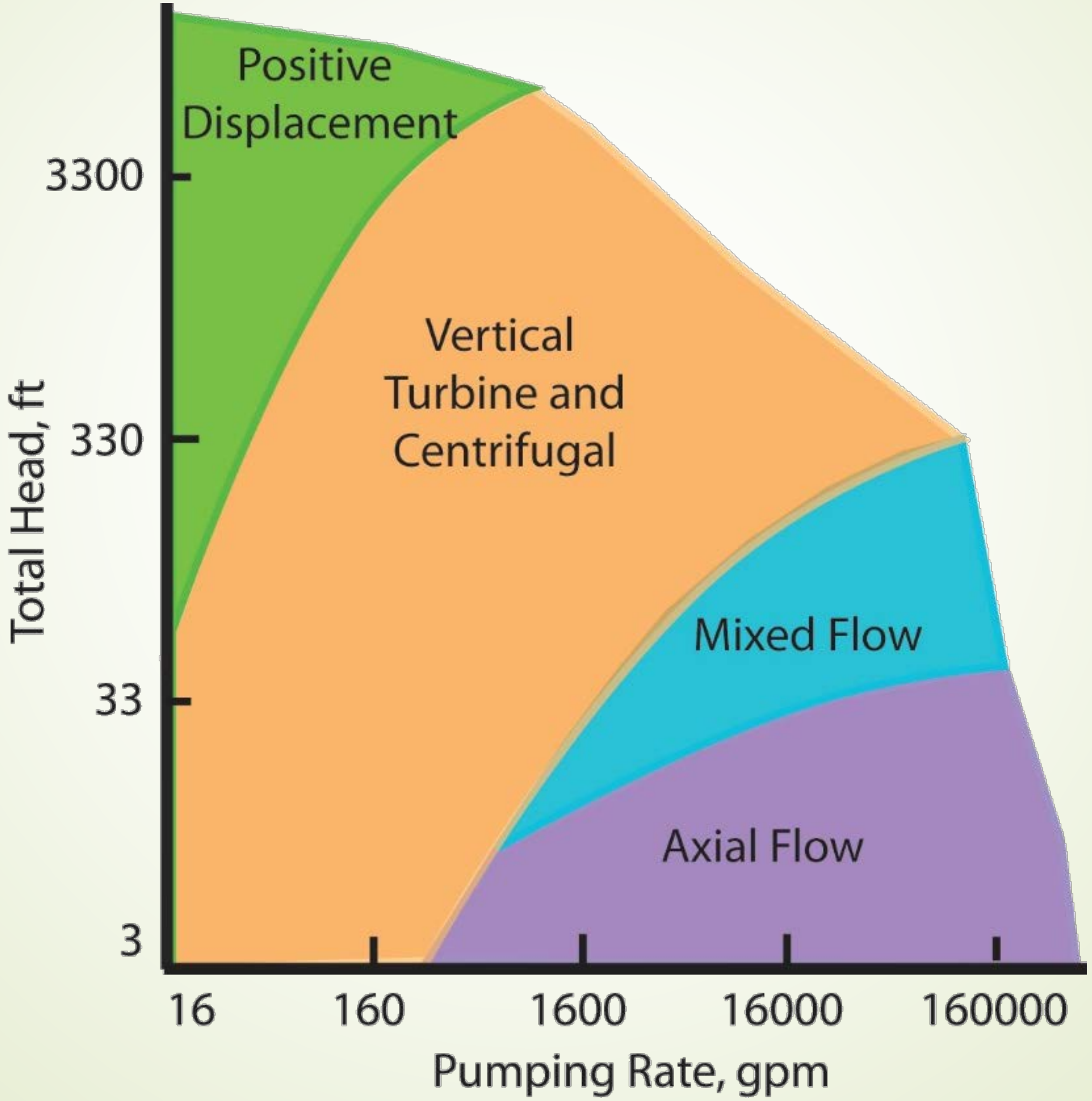
Training Focus and Objectives:

- Understanding of pump output requirements.
- Understanding of pumping plant efficiencies, output and input horsepower requirements and estimation of energy use.
- Appropriate pump types for some different applications.
- Discuss pump performance requirements and selection criteria for two specific examples relating to irrigation and animal waste.

Previous NRCS Pumping Plant Webinars

- Advances in Hi- and Lo-Tech Irrigation Systems
- Basics of Pump and Pipeline Design and Selection in Irrigation Systems
- Energy Conservation in Irrigation Systems
- Variable Frequency Drives

What type of pump do I use?



Safety

651.1303 Safety

Safety hazards are inherent to an agricultural waste management system. Some of these hazards lie hidden and await the unsuspecting. Others may be more obvious, but are just as formidable to the careless. For these reasons, attention to safety must always be given first consideration in the planning, design, construction, and operation of an AWMS.

by an AWMS include carbon dioxide, ammonia, hydrogen sulfide, and methane. Numerous odorous gases are produced by an AWMS. These gases fall into the general classification of amines, amides, mercaptans, sulfides, and disulfides.

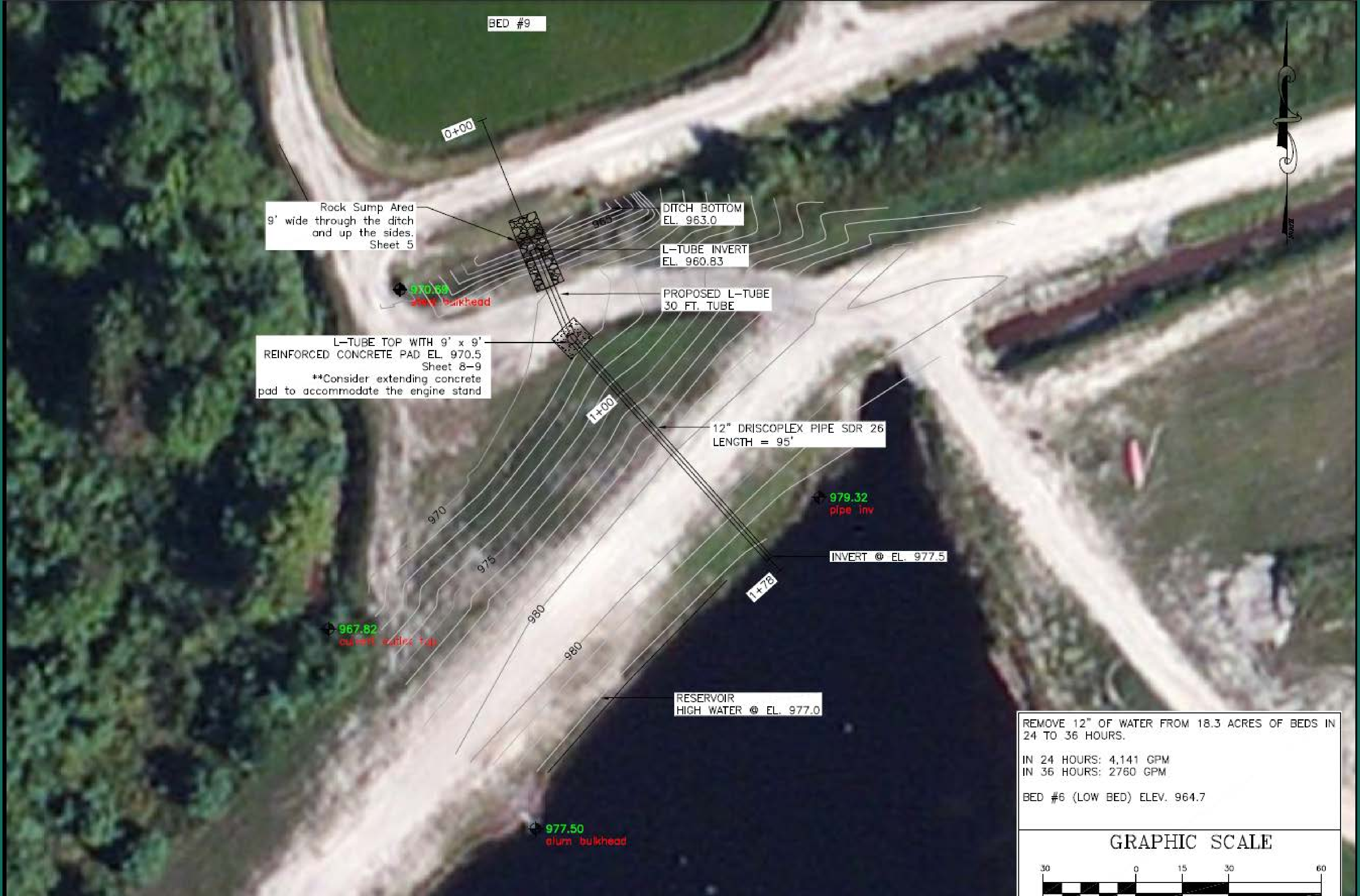
No direct tie between odors and safety problems has been found; however, odors can be a nuisance and cause complaints and even lawsuits. As such, they are an important consideration in the operation of an AWMS and must be minimized. AWMFH, Chapter 8, Siting Agricultural Waste Management Systems, de-

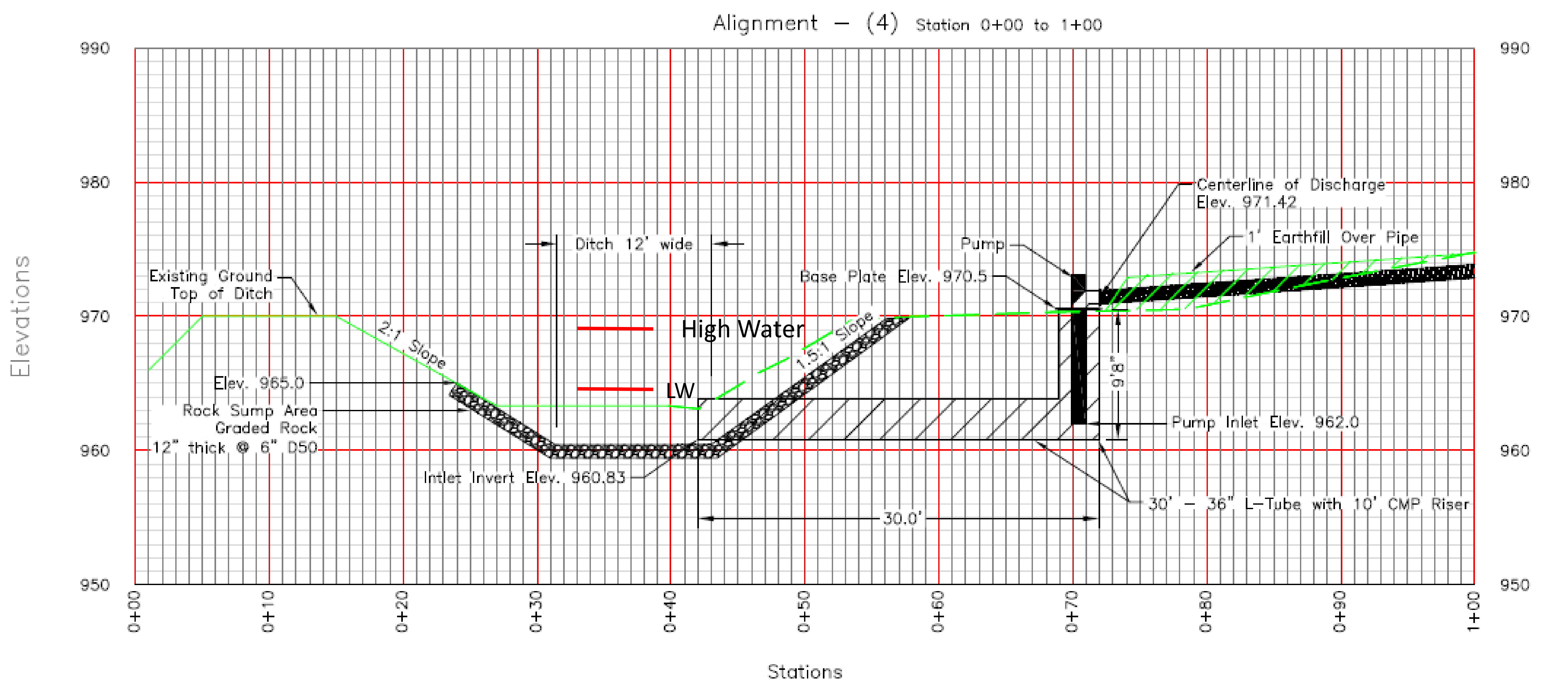
Irrigation Scenario
High Water Volume – Low Pressure Head

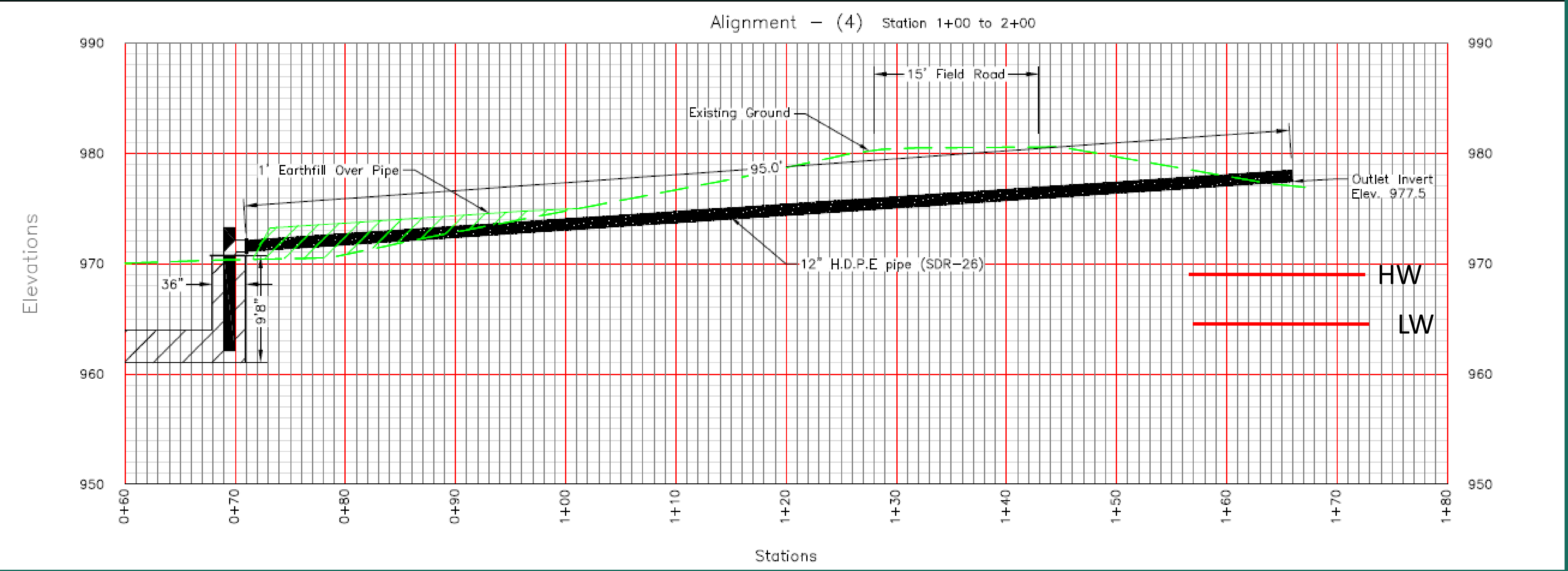
- Flood irrigation
- 18.3 acre cranberry marsh to be dewatered.
- Need to move 12" of flood water in 24 to 36 hours
- 1' x 18.3ac x 43,460sf/ac x 7.48 gal/cf = 5,962,667 gal
- In 24 hours => 4,141 GPM
- In 36 hours => 2,760 GPM

- Compare pumps
  - Lo-Lift Model 1210
  - Lo-Lift Model 1413

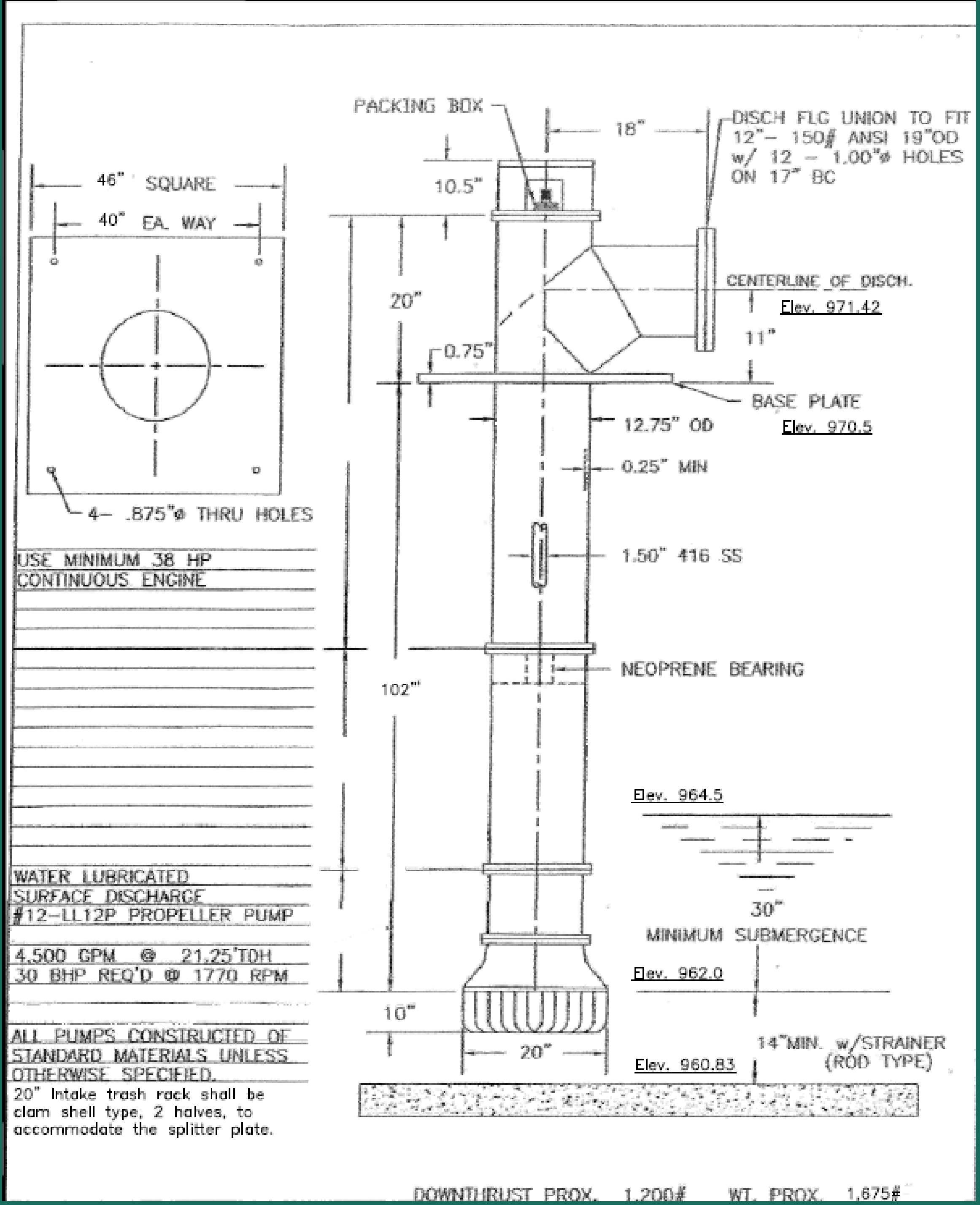
Question asked: Which is the best pump for this scenario?


BED #9
0+00
Rock Sump Area
9' wide through the ditch
and up the sides.
Sheet 5
DITCH BOTTOM
EL. 963.0
L–TUBE INVERT
EL. 960.83
PROPOSED L–TUBE
30 FT. TUBE
L–TUBE TOP WITH 9' x 9'
REINFORCED CONCRETE PAD EL. 970.5
Sheet 8–9
**Consider extending concrete
pad to accommodate the engine stand
1+00
12" DRISCOPLEX PIPE SDR 26
LENGTH = 95'
979.32
pipe inv
INVERT @ EL. 977.5
1+78
970
975
980
980
967.82
RESERVOIR
HIGH WATER @ EL. 977.0
977.50
alum bulkhead
REMOVE 12" OF WATER FROM 18.3 ACRES OF BEDS IN 24 TO 36 HOURS.
IN 24 HOURS: 4,141 GPM
IN 36 HOURS: 2760 GPM
BED #6 (LOW BED) ELEV. 964.7
GRAPHIC SCALE
30
0
15
30
60


Alignment – (4) Station 0+00 to 1+00
990
980
970
960
950
Elevations
Existing Ground
Top of Ditch
2:1 Slope
Ditch 12' wide
High Water
LW
1.5:1 Slope
Elev. 965.0
Rock Sump Area
Graded Rock
12" thick @ 6" D50
Intlet Invert Elev. 960.83
Pump
Base Plate Elev. 970.5
Centerline of Discharge
Elev. 971.42
1' Earthfill Over Pipe
9'8"
Pump Inlet Elev. 962.0
30' – 36" L-Tube with 10' CMP Riser
30.0'
0+00
0+10
0+20
0+30
0+40
0+50
0+60
0+70
0+80
0+90
1+00
Stations



Alignment – (4) Station 1+00 to 2+00
990
980
970
960
950
Elevations
15' Field Road
Existing Ground
95.0'
1' Earthfill Over Pipe
Outlet Invert
Elev. 977.5
12" H.D.P.E pipe (SDR-26)
36"
9'8"
HW
LW
0+60
0+70
0+80
0+90
1+00
1+10
1+20
1+30
1+40
1+50
1+60
1+70
1+80
Stations


PACKING BOX
18"
DISCH FLG UNION TO FIT 12"– 150# ANSI 19"OD w/ 12 – 1.00"ø HOLES ON 17" BC
46" SQUARE
40" EA. WAY
10.5"
20"
CENTERLINE OF DISCH.
Elev. 971.42
11"
0.75"
BASE PLATE
Elev. 970.5
12.75" OD
0.25" MIN
4– .875"ø THRU HOLES
1.50" 416 SS
USE MINIMUM 38 HP CONTINUOUS ENGINE
NEOPRENE BEARING
102"
Elev. 964.5
WATER LUBRICATED SURFACE DISCHARGE #12–LL12P PROPELLER PUMP
30" MINIMUM SUBMERGENCE
4,500 GPM @ 21.25'TDH
30 BHP REQ'D @ 1770 RPM
Elev. 962.0
10"
ALL PUMPS CONSTRUCTED OF STANDARD MATERIALS UNLESS OTHERWISE SPECIFIED.
20"
14"MIN. w/STRAINER (ROD TYPE)
Elev. 960.83
20" Intake trash rack shall be clam shell type, 2 halves, to accommodate the splitter plate.
DOWNTHRUST PROX. 1,200# WT. PROX. 1,675#

Pump Curves Provide an Operating Range of a Particular Pump, Impellor, with BHP Required, Pump Efficiency, Minimum Submergence or NPSHR. Etc.

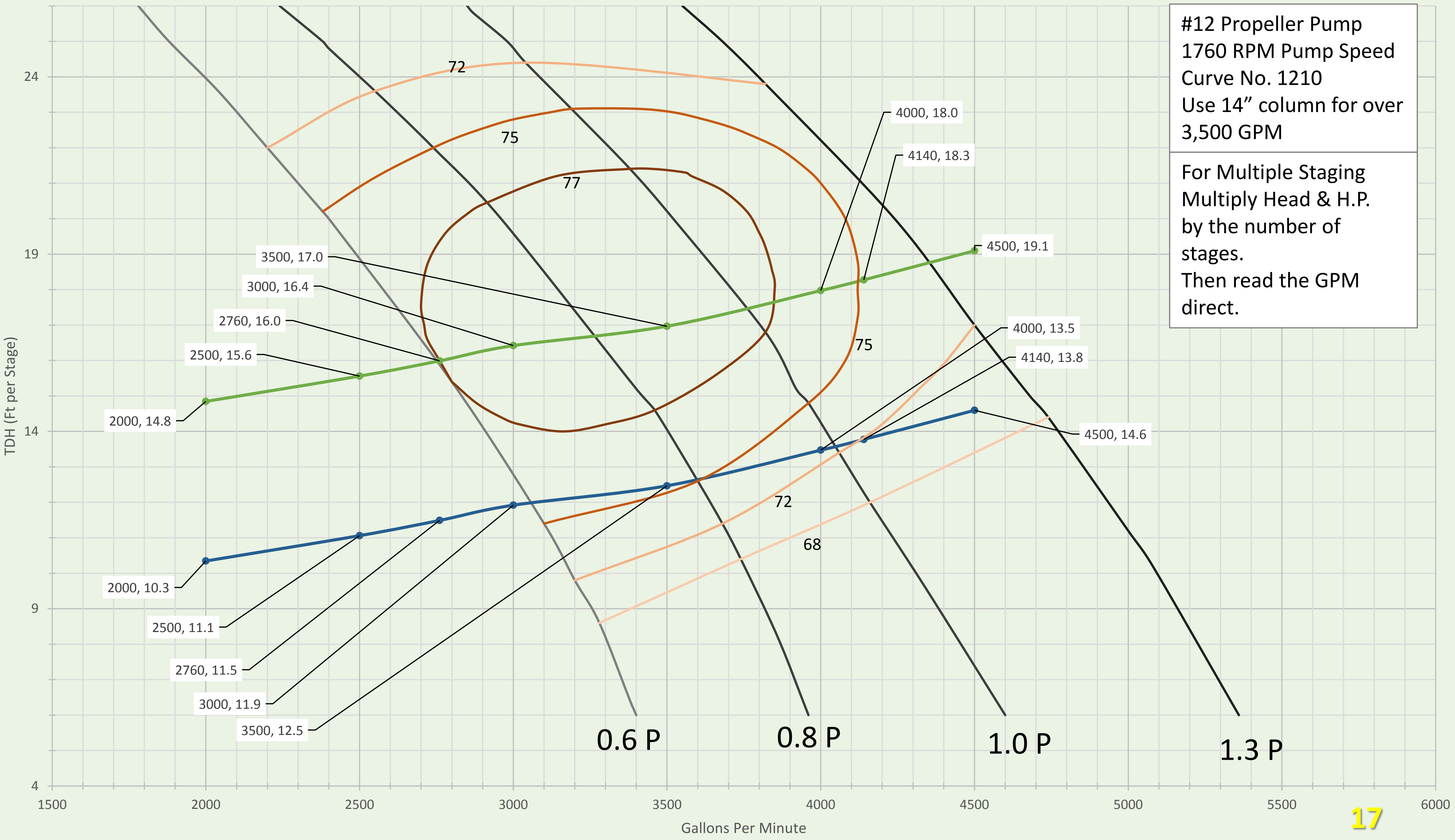
System curves provide a useful tool to aid a designer in assessing a pump for a particular field application. When plotted on a pump curve, actual pump operating points can be determined for particular sets of water surface elevation, pipeline size, material, length, and friction etc.

System curves are particularly beneficial when an application system like a gun sprinkler, center pivot or other pressure system are located at the system outlet.

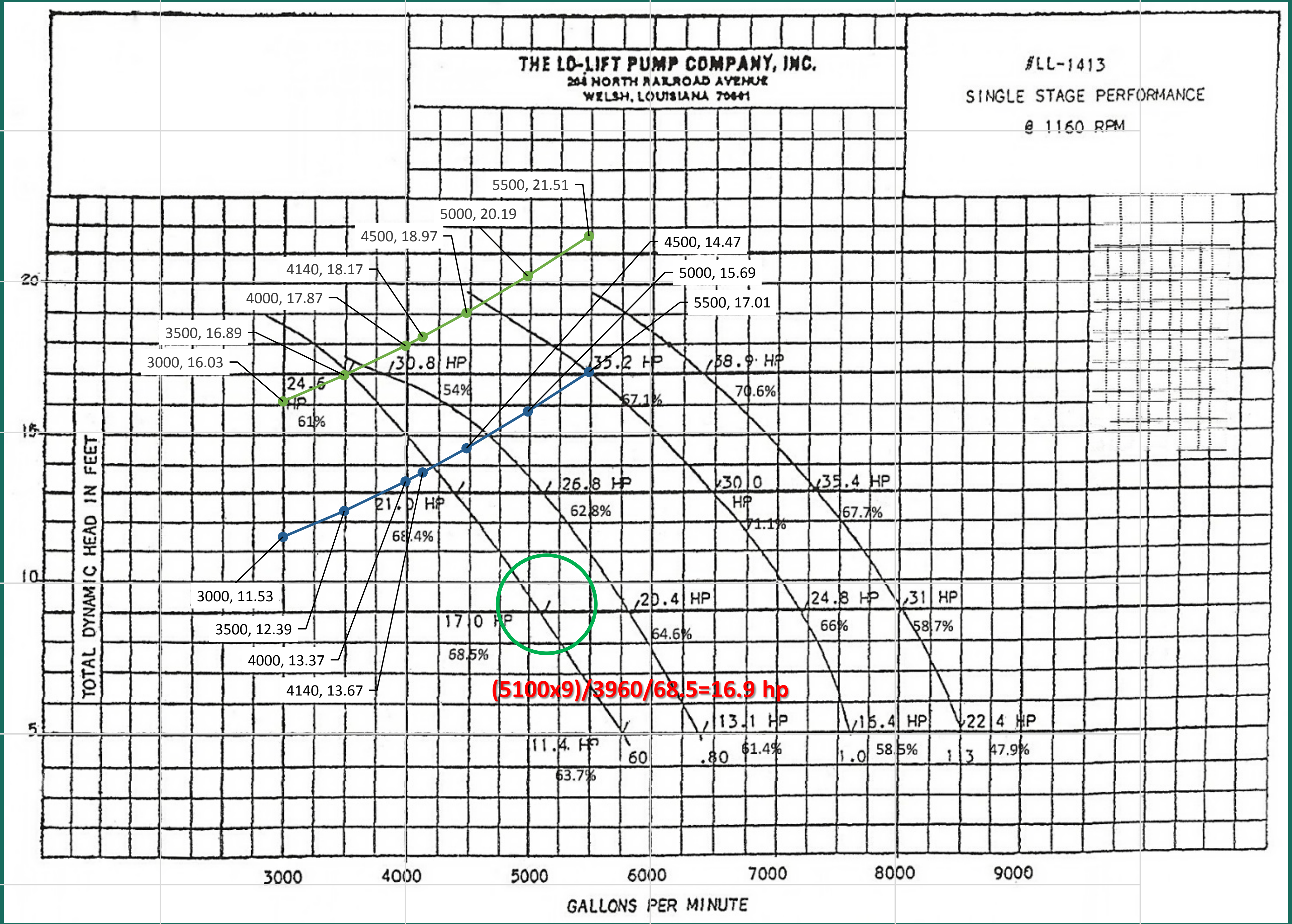
System Curve Spreadsheet Showing System Curve Data for P1210 and TDH and Q at intersection points for 0.8 P

	A	B	C	D	E	F	G	H	I	J	K
1	system curve when water at 964.5						system curve when water at 969				
2	INPUT:			INPUT:			INPUT:			INPUT:	
3	Pipe Diameter (in)	13.126		Pipe Diameter (in)	11.770		Pipe Diameter (in)	13.126		Pipe Diameter (in)	11.770
4	Flow Rate (gpm)	3300.000		Flow Rate (gpm)	3300.000		Flow Rate (gpm)	3600.000		Flow Rate (gpm)	3600.000
5	Hazen Williams Coefficient	140.000		Hazen Williams Coefficient	150.000		Hazen Williams Coefficient	140.000		Hazen Williams Coefficient	150.000
6	Pipe Length (ft.)	11.000		Pipe Length (ft.)	95.000		Pipe Length (ft.)	11.000		Pipe Length (ft.)	95.000
7											
8	OUTPUT:			OUTPUT:			OUTPUT:			OUTPUT:	
9	Q (cfs)	7.3520		Q (cfs)	7.3520		Q (cfs)	8.0203		Q (cfs)	8.0203
10	Area (ft^2)	0.9397		Area (ft^2)	0.7556		Area (ft^2)	0.9397		Area (ft^2)	0.7556
11	Velocity (ft/s)	7.8237		Velocity (ft/s)	9.7302		Velocity (ft/s)	8.5349		Velocity (ft/s)	10.6148
12	Wetted Perimeter	3.4364		Wetted Perimeter	3.0814		Wetted Perimeter	3.4364		Wetted Perimeter	3.0814
13	Hydraulic Radius (ft)	0.2735		Hydraulic Radius (ft)	0.2452		Hydraulic Radius (ft)	0.2735		Hydraulic Radius (ft)	0.2452
14	Friction Loss (ft.)	0.1448		Friction Loss (ft.)	1.8723		Friction Loss (ft.)	0.1701		Friction Loss (ft.)	2.1993
15											
16	misc losses						misc losses				
17	bell entrance k .04	0.0400					bell entrance k .04	0.0400			
18	12 inch strainer k 0.6	0.6000					12 inch strainer k 0.6	0.6000			
19	90 degree miter K 0.5	0.5000	head				90 degree miter K 0.5	0.5000	head		
20	sum K values	1.1400	1.083529				sum K values	1.1400	1.289489		
21											
22	below 3500 gpm col = 12.25 in	Q	TDH				below 3500 gpm col = 12.25 in	Q	TDH		
23	TDH = (978 - 964.5) + fric+minor losses	2000.00	14.85				TDH = (978 - 969) + fric+minor losses	2000.00	10.35		
24	16.6007	2500.00	15.56				12.6589	2500.00	11.06		
25		2760.00	15.99					2760.00	11.49		
26		3000.00	16.42					3000.00	11.92		
27	at 3500 gpm col = 13.126	3500.00	16.97				**at 3500 gpm col = 13.126**	3500.00	12.47		
28		4000.00	17.97					4000.00	13.47		
29		4140.00	18.27					4140.00	13.77		
30		4500.00	19.10					4500.00	14.60		
31											

If using 0.8 P for on this Installation should use 14” column



#12 Propeller Pump
1760 RPM Pump Speed
Curve No. 1210
Use 14” column for over 3,500 GPM
For Multiple Staging Multiply Head & H.P. by the number of stages.
Then read the GPM direct.
TDH (Ft per Stage)
Gallons Per Minute
24
19
14
9
4
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
72
75
77
75
72
68
0.6 P
0.8 P
1.0 P
1.3 P
2000, 14.8
2500, 15.6
2760, 16.0
3000, 16.4
3500, 17.0
4000, 18.0
4140, 18.3
4500, 19.1
2000, 10.3
2500, 11.1
2760, 11.5
3000, 11.9
3500, 12.5
4000, 13.5
4140, 13.8
4500, 14.6


THE LO-LIFT PUMP COMPANY, INC.
204 NORTH RAILROAD AVENUE
WELSH, LOUISIANA 70591
#LL-1413
SINGLE STAGE PERFORMANCE
@ 1160 RPM
TOTAL DYNAMIC HEAD IN FEET
GALLONS PER MINUTE
3000
4000
5000
6000
7000
8000
9000
5
10
15
20
5500, 21.51
5000, 20.19
4500, 18.97
4140, 18.17
4000, 17.87
3500, 16.89
3000, 16.03
4500, 14.47
5000, 15.69
5500, 17.01
3000, 11.53
3500, 12.39
4000, 13.37
4140, 13.67
24.6 HP
61%
30.8 HP
54%
35.2 HP
67.1%
38.9 HP
70.6%
21.0 HP
68.4%
26.8 HP
62.8%
30.0 HP
71.1%
35.4 HP
67.7%
17.0 HP
68.5%
20.4 HP
64.6%
24.8 HP
66%
31 HP
58.7%
11.4 HP
63.7%
13.1 HP
61.4%
15.4 HP
58.5%
22.4 HP
47.9%
.60
.80
1.0
1.3
(5100x9)/3960/68.5=16.9 hp

Energy Use Spreadsheet

- **P1210 0.8 P**
  - **Low Water Level 964.5**
  - **Outlet Elev 978**
  - **Q gpm – 3300**
  - **Total TDH -16.6**
  - **Cost-Elec $1.48/hr; Diesel $2.93/hr**

  - **High Water Level 969**
  - **Outlet Elev 978**
  - **Q gpm 3600**
  - **Total TDH 12.7**
  - **Cost-Elec $1.28/hr; Diesel $2.53/hr**

Assumed Electricity at $0.10/kwh and diesel at $2.75/gal

System and Field Information

INPUT: (Type input values in green cells. Use pulldown values in blue cells)

Measured Flow Rate	2810.00	gpm
Annual Hours of operation	700.00	hr
Fuel/Power Type	Electric	kwh/hr
Fuel/Power Cost ($/fuel unit)	0.10	$/khw
Pumping Plant Discharge Pressure	0.00	psi
Pumping Lift (Vertical Lift including Drawdown)	15.30	feet

Tool for Estimating Typical Potential Pumping Plant Efficiency

Select System Decriptions from Pulldown (Blue) Boxes Below

Power Unit Type	Component Efficiency %
Electrical Motor, Vertical Hollow Shaft, 10 - 100 hp rating	90
Drive Type	
Direct Drive	100
Pump Type	
User enter pump efficiency	77
EST. POTENTIAL OVERALL PUMPING PLANT EFF	69.3
USE EST. POT. OVERALL PP EFF	
Clear current content of cell C34	

OUTPUT

Horsepower Out (Based on Flow Rate and Head)	10.86	HP
OVERALL PUMPING PLANT EFF. (%)	69.30	%
Horsepower In (Based on Fuel/Power Used/Time)	15.67	HP
Fuel Use rate	11.69	kwh/hr
Current Energy Cost/hr	1.17	$/hr
Current Energy Cost/Season (excluding maintenance)	$818	$/Season

Questions?

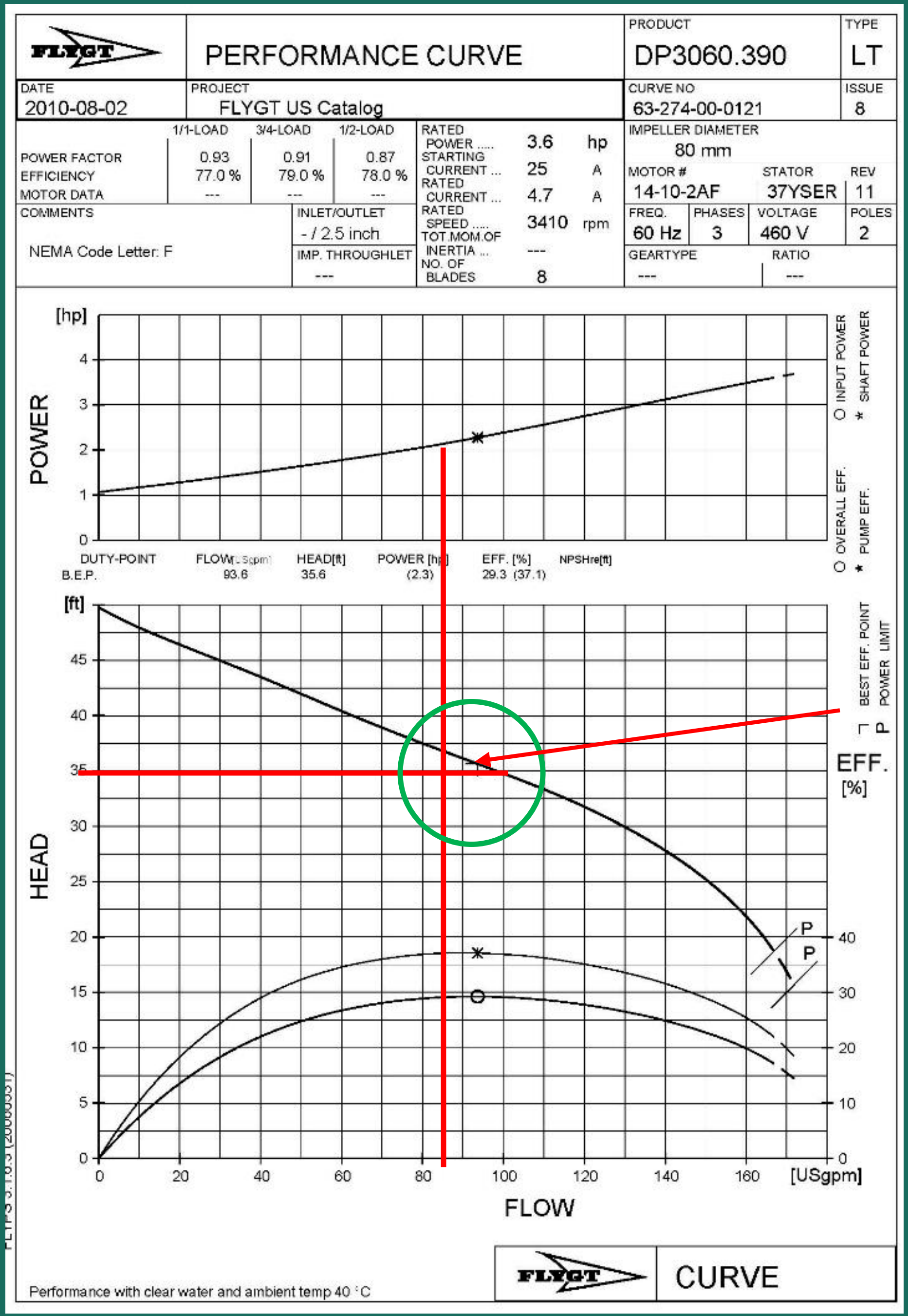
Waste Water Scenario
Pump From Parlor to Waste Storage Structure

285 feet from parlor to waste storage structure

- 2 – 45 deg elbows in transfer line
- Need 85 GPM at 34 feet TDH

- Candidate pump
  - Flygt 3060 Model 274 (3.7 HP)

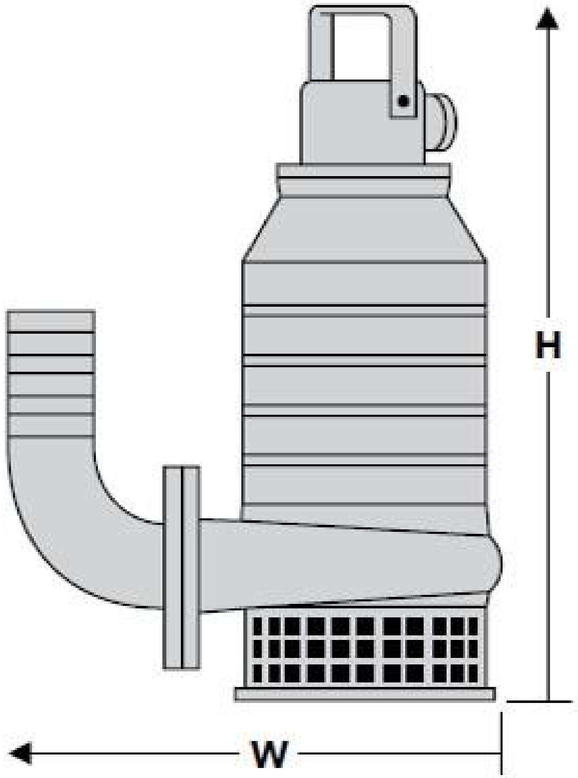
85 GPM @ 34 TDH



Xylem Inc. - Flygt Pumps

Stainless Steel 3000 Series Sludge Sewage Pumps

CS/DS 3060 (SS)



Model number:	3060.390
Motor rating:	1ø: 2.5 HP @ 3400 RPM 3ø: 3.7 HP @ 3300 RPM
Voltage (1ø):	230V
Full load amps:	11A
Voltage (3ø):	200V, 230V, 460V, 575V
Full load amps:	10.8A, 9.4A, 4.7A, 3.8A
Versions:	CS: 3″ Standard Imp. Code 226 (1ø), 222 (3ø) DS: 3″ Vortex Imp. Code 276 (1ø), 274 (3ø)
Hose connection:	Slip-on
Pump dimensions:	$16^1/_2$″ W (max.) x $23^1/_2$″ H (max.)
Max. weight (lbs.):	95
Description:	CS/DS: Stainless steel construction; rests on bottom strainer. CS: Open impeller, with diffuser. DS: Vortex type impeller.

Xylem Inc. - Flygt Pumps

Interpreting Data From Pump Curves

GEA - Houle Pumps

Interpreting Data From Pump Curves

3″ High Pressure Pump*

Hog Manure	Dairy Waste Water
Maximum consistency	
1/8" (3 mm)	

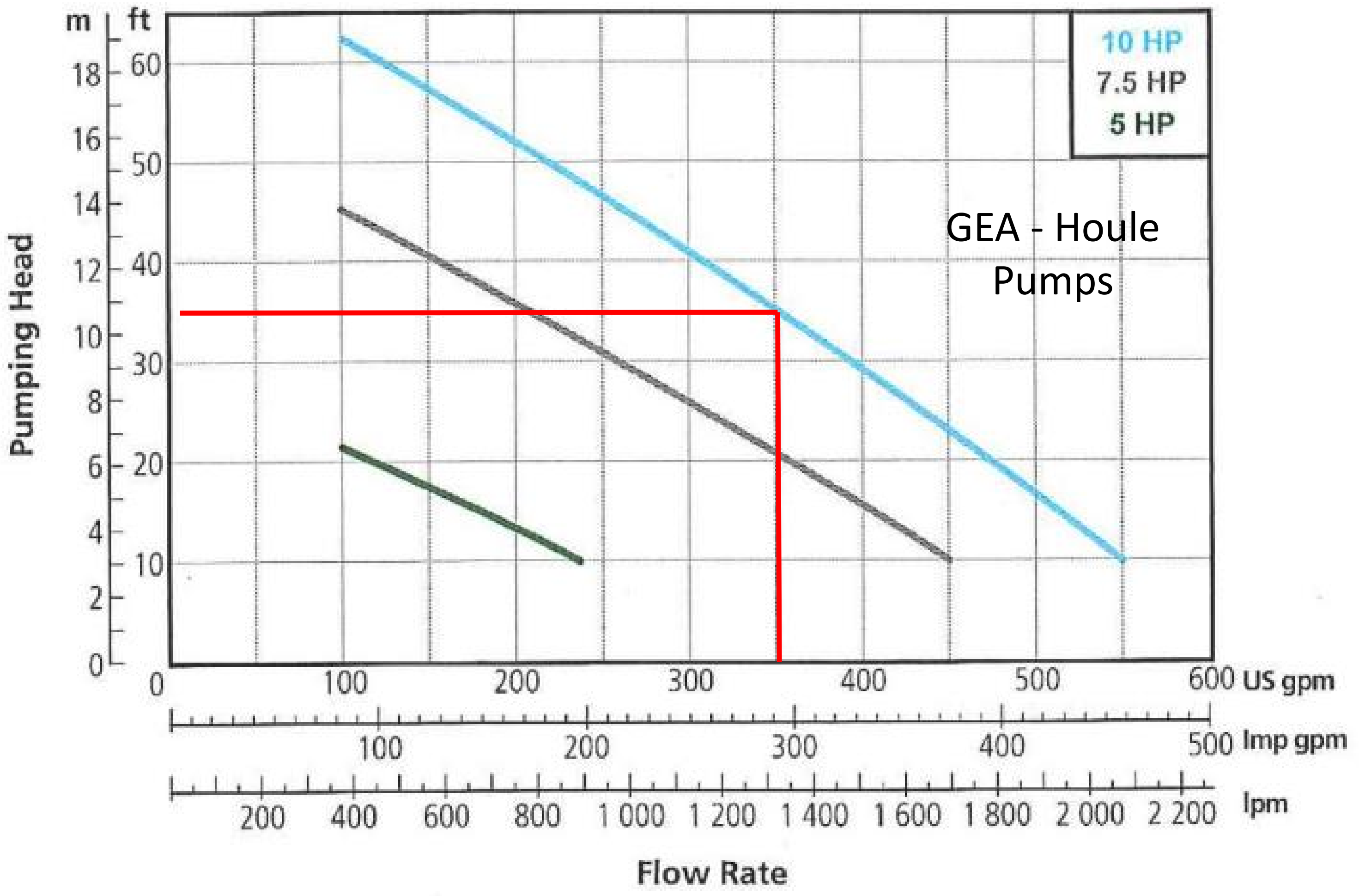
Typical Application

Used to transfer hog manure from the reception pit to the main storage when high head pressure is present. The 3″ High Pressure Pump can transfer liquid on relatively long distances.

Impeller and Housing

- *Impeller with 3 curved blades made of ductile cast iron;*
- *4 1/2″ (114 mm) intake.*

3″ High Pressure Pump with 1760 rpm Motor (60 Hz)



GEA - Houle
Pumps

Estimate of Pump Efficiency on Previous Pump Curve

- Look at 10 hp pump : 350 gpm – 35 ft head
- WHP = (350 gpm x 35 ft)/3960 = 3.1 HP produced by the pump
- HP shown on pump curves is normally BHP or HP delivered to the pump by the motor.
- The maximum HP will be produced near the center of the pump curve where the pump is most efficient.
- So an estimate of pump efficiency with a 10 hp motor would be
- 3.1 hp/10 hp x 100 = 31%; this is a reasonable efficiency for a manure pump.
- If check WHP at ends of curve will see what is expected pump operates less efficiently at edges of its curve.

Read this Standard if you are involved in planning, design or approval of waste storage, treatment or transfer structures or appurtenances.

Also recommend Chapters 11 and 12 and maybe 4 and 9 of the NEH 651, Agricultural Waste Management Field (AWMFH).

NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

WASTE TRANSFER

(Number)

CODE 634

DEFINITION

A system using structures, pipes or conduits installed to convey wastes or waste byproducts from the agricultural production site to storage/treatment or application.

PURPOSE

To transfer agricultural waste material associated with production, processing, and harvesting to:

- a storage facility,
- a treatment facility,
- a handling or loading area,
- agricultural land for agronomic application.

CONDITIONS WHERE PRACTICE APPLIES

The waste transfer system is included as an element of the agricultural production area, storage/treatment facility and/or land application areas of the agricultural operation.

The practice applies where it is necessary to transfer waste material generated by livestock production or agricultural product processing from:

- the generation site to the application area,
- the generation site to a storage/treatment facility,
- the storage/treatment facility to land for agronomic application.

This practice does not apply to hauling waste material with equipment or vehicles.

CRITERIA

General Criteria Applicable to All Purposes

Permits. Notify landowner and/or contractor of responsibility to locate all buried utilities in the project area, including drainage tile and other structural measures. The landowner is also required to obtain all necessary permits for project installation prior to construction.

Structures. Structures including concrete pits, tanks, hoppers, manholes, and channels used for waste transfer, prefabricated or cast in place, must meet the criteria in NRCS Conservation Practice Standard (CPS) *Waste Storage Facility* (Code 313) for liquid tightness and structural strength, regardless of materials used for construction.

Design all structures, including those that provide a work area around pumps to withstand the design static and dynamic loading. Design structures to withstand earth and hydrostatic loading as specified for comparable structural criteria in NRCS CPS Waste *Storage Facility* (Code 313).

In locating structures, utilize existing topography to the greatest extent possible to generate head on effluent flow and reduce pumping requirements.

Investigate the subsurface conditions (i.e., depth to bedrock, soil classification, water table, etc.) when locating and designing structures.

Size reception pits (areas established to temporarily accumulate effluent flow) to contain a minimum volume of one full day's waste production. Provide additional storage for reception pits receiving stormwater runoff to contain the volume of precipitation and runoff from the 25-year, 24-hour storm plus any required freeboard and emergency storage.

Additional Considerations During Animal Waste Transfer Pump Selection

- Special pump and or attachment options available to address solids content of waste and consistency of waste
- Types of material that will need to be suspended during pumping and sand bedding impact on product selection
- Additional pressure requirements due to application systems (i.e. Big Gun Sprinkler)
- Operation and Maintenance Requirements and tradeoffs depending on options selected.
- How all these items will impact pump selection, and horsepower requirements.

651.1101 Waste consistency

Wastes are classified in four categories according to their consistency—solid, semisolid, slurry, and liquid. Ruminants tend to produce manure that is of semisolid consistency when excreted; swine excrete manure as slurry; and poultry excrete manure that is a more solid manure. This clearly points out the need to be knowledgeable of waste consistency in terms of total solids (TS) to properly select waste management system components. Chapter 9 of this handbook presents information about how the consistency of the waste controls how the waste is handled and how the TS content in the waste controls consistency. The consistency of manure when it is applied to the land affects the type of equipment used and the amount applied. Chapter 4 of this handbook gives the moisture content of manure (feces and urine) as excreted; however, changes in consistency as moisture is added or removed must be taken into account in planning a waste management system.

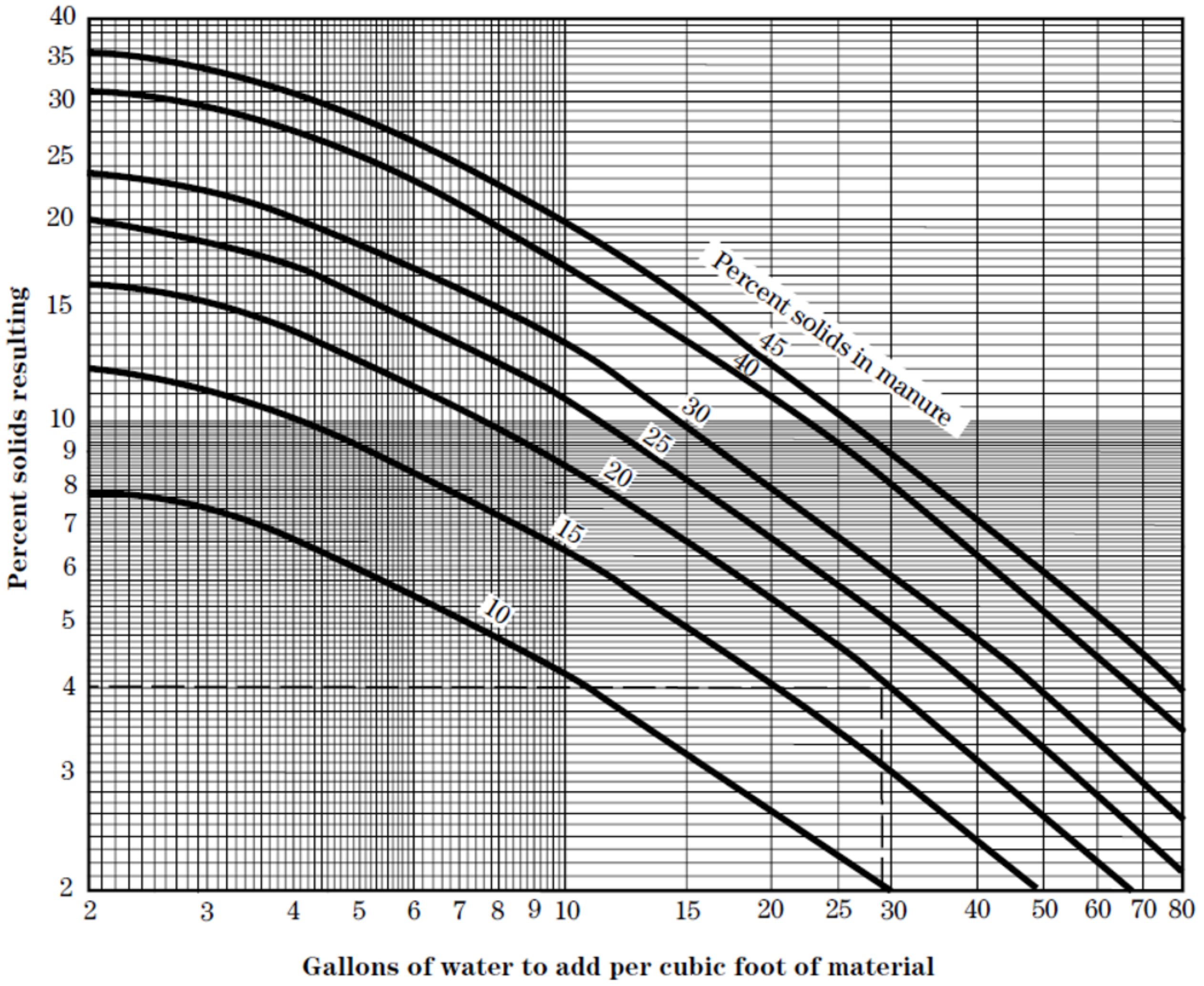
Table 11–1 Friction loss ratio, slurries versus clean water (asphalt-dipped circular iron pipe, 6- to 10-in diameter)

Velocity ft/s	Percent solids					
	4	5	6	7	8	10
1.0	1.1	1.5	2.1	2.9	3.4	5.3
1.5	1.0	1.2	1.5	2.1	2.5	4.0
2.0	1.0	1.0	1.0	1.6	1.9	3.3
2.5	1.0	1.0	1.0	1.3	1.6	2.9
3.0	1.0	1.0	1.0	1.2	1.5	2.7
3.5	1.0	1.0	1.0	1.1	1.3	2.5
4.0	1.0	1.0	1.0	1.0	1.0	2.4
4.5	1.0	1.0	1.0	1.0	1.0	2.3
5.0	1.0	1.0	1.0	1.0	1.0	2.2
5.5	1.0	1.0	1.0	1.0	1.0	2.1
6.0	1.0	1.0	1.0	1.0	1.0	2.0
6.5	1.0	1.0	1.0	1.0	1.0	2.0
7.0	1.0	1.0	1.0	1.0	1.0	2.0

Source: Adapted from Colt Industries Hydraulic Handbook, figure 44, Fairbanks Morse Pump Div., 11th Ed.

See Example 11–1, on page 11-8, National Engineering Handbook, Part 651, Ag Waste Management Field Manual, Chapter 11, Waste Utilization, for example application of this assessment.

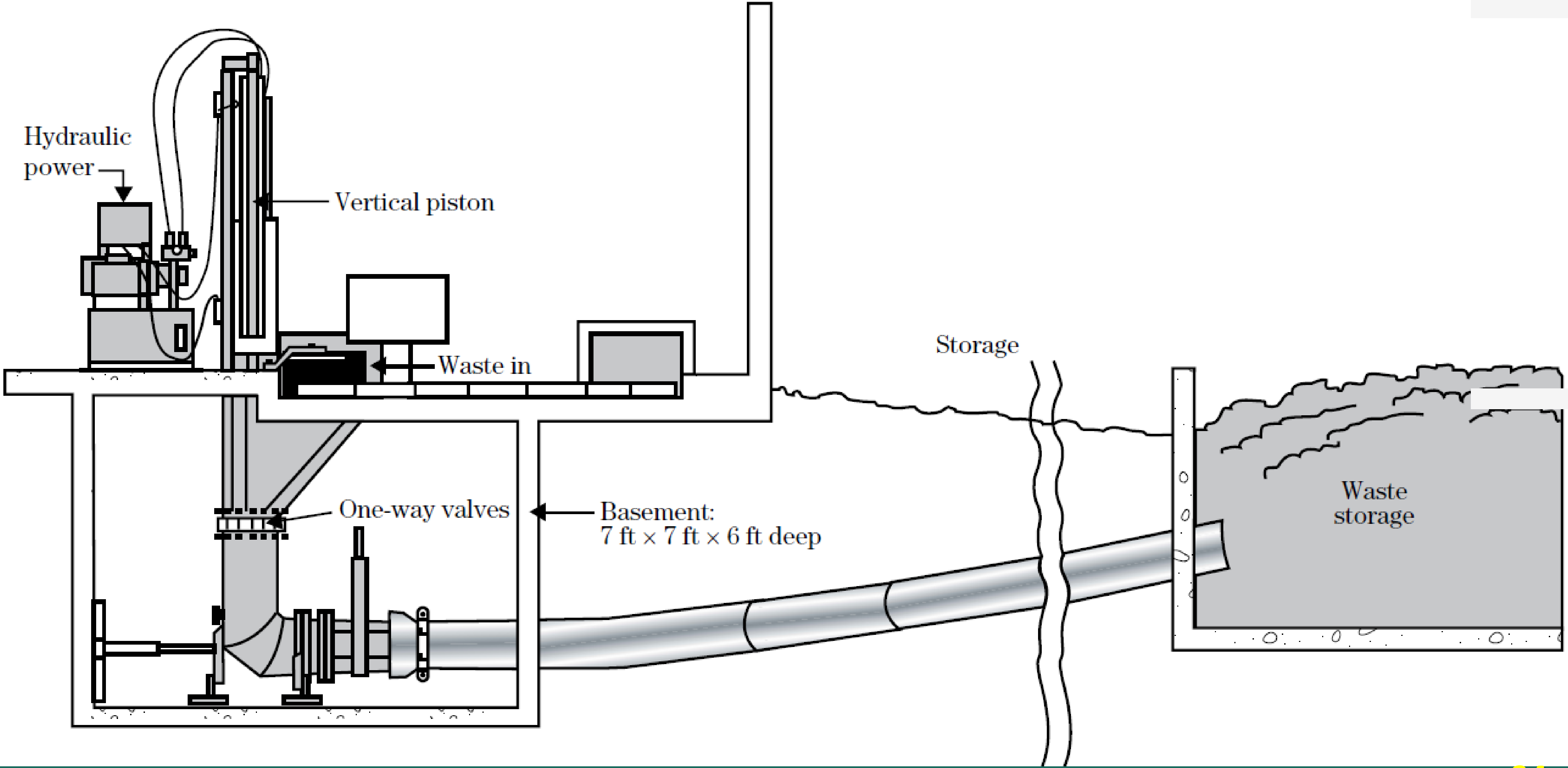
Figure 11–2 Gallons of water required per cubic foot of material for dilution to pumping consistency



Hydraulic Manure Pump

PATZ Corp. Hydraulic Manure Pump

Figure 12–40 Vertical piston plunger waste pump with a pipe anchor (*Drawing courtesy of Berg Equipment Co.*)



Questions??