Ninovan Creek Pumping
Design Calculations
June 11, 2016

Project: Several options have been discussed related to pumping water from the unnamed creek west of the Ninovan Lake Estates subdivision to supplement the lake level. Pumping using a 4" diesel trash pump and 4 inch lay flat hose was done in the spring and early winter of 2015 and using a 3" diesel trash pump in the spring of 2016. Indications are that the creek will support between 100 Gallons per Minute (GPM) to an excess of 800 GPM during peak creek flows. During dry periods the creek will reduce to no flow. Timing the pumping activities to occur during periods when the creek flow exists and sizing to match the available water is necessary.

Object: Calculations are necessary to evaluate and match pump sizes to the piping system. Evaluation of pipe resistance (Total Head = Static Head + Dynamic Head) to determine the effects of the pipe configurations is desired. Static Head has been measured from surveying work done on 2014 to evaluate the lake level verses the creek level. Dynamic Head is a result of the pipe or hose roughness, velocity and bends and varies on the pipe type and size used. Desired pumping rates are between 300 and 600 GPM.

Cases Evaluated

Case 1	4" Lay Flat	800 feet of 4 inch Lay flat hose
Case 2	6" PCV	6" PVC Schedule 40 Pipe with 4" Lay Flat hose from the pump to the Pipe
Case 3	Max Gravity	12" ADS N-12 Pipe pitch for gravity feed with 6" PVC Schedule 40 Feed
Case 4	Gravity Overflow	12" ADS N-12 Pipe with invert at lake overflow

Case 1
Pumping in 2015 and 2016 utilized a single 4" lay flat hose from the pump to the lake edge. 800 feet of hose was used to follow the edge of the farm field. A single 20 foot long 4 Inch suction was used from the creek to the pump with no suction strainer. A 6" ADS tee was placed in the creek bottom to prevent collection of sediment from the creek bottom.

Case 2
6 Inch PVC Schedule 40 is proposed to be ran from the edge of the lake towards the pump. Connection of the pump to the PVC Pipe would be via flexible lay flat hose. Suction hose would be sized for the pump selected.

Case 3
It is thought that a pipe with slope towards the lake can be ran for some of the distance to reduce the Total Head seen by the pump. Design and consideration of the pipe size, type and capacity is needed. Evaluation of this design indicates that the pipe will back flow towards the creek about 5 inches below the overflow. A check valve of some sort of back flow prevention device would be needed to maximize the lake level.

Case 4
Case 3 was evaluated to determine if a pipe could be installed with an invert at or above the lake overflow.

Calculations

Static Head

Field survey measurements on 2014 provide the following information:

Location	Elevation Feet	Distance
Lake overflow	0.00	450 feet east of proposed pipe discharge, Used as zero
Waters edge	-1.45	Used as zero
Top of Hill	8.65	Approximately 20 feet West
Property Line	1.67	66 Feet West
Fence Line	1.67	Fairly level for about 450 feet
Farm field		Sloping downward towards creek
Creek Level	-9.22	Approximately 800 feet due west of the lake edge

Based on these measurements the creek is 10.67 feet below the lake level.
Pushing the water over the hill at the surface is 17.87.
In 2015 the hose used had a high spot about 2 feet above the property line. Total head of about 13 feet.

Case 1:

800 feet of lay flat hose was surface run to connected to the pump with 20 feet of suction hose

At 300 GPM:
800 feet x 1.6 PSI / 100 Feet x 2.31 Ft/PSI = 29.57 Ft
At 500 GPM:
800 feet x 4 PSI / 100 Feet x 2.31 Ft/PSI = 73.92 Ft

Including the static head of 13 feet at suction line resistance of about 1 foot:

Total Head is 43 to 88 Feet

Evaluating this using the Kohler Pump information provided the estimated pump output is consistent with what was estimated from the spring 2016 lake level data at about 250 GPM.

Case 2:

6 Inch PVC is proposed to be buried through the hill and laid with a shallow pitch to provide about 1 foot to 4 feet of cover on the pipe along the fence line. A high point in the pipe with an air break will need to be created about the lake outlet to prevent siphoning of water to the creek. This will create a static head of about 9.22 feet.

At 350 GPM the dynamic head for the PVC is 0.8 Ft/100 Feet.

900 Feet x 0.8 Ft / 100 Feet = 7.2 Ft
100 Feet of Discharge = 4.16 Ft
20 Feet of Suction = 0.83 Ft
9.22 Ft of static Head

Total Head = 21.44 Ft

At 500 GPM the dynamic head for the PVC is 1.5 Ft/100 Feet.

900 Feet x 1.5 Ft / 100 Feet = 13.5 Ft
100 Feet of Discharge = 9.24 Ft
20 Feet of Suction = 1.85 Ft
9.22 Ft of static Head

Total Head = 33.81 Ft

Case 3:

To maximize the gravity effect, a design of a shallow pitch pipe from the lake edge to a point where it has about 1 foot of cover was reviewed. In this design 12 inch ADS N-12 pipe was chosen to provide as it would provide 614 gallons per minute of capacity if laid at 0.125% slope. 6 Inch PVC would be connected to it at the high point to provide pressure rated pipe from the pump to the high point.

460 feet of 12" Pipe could be laid with a balance of the 900 feet as 6" PVC Schedule 40. The pipe would have a minimum cover of 11 inches. The high point in the pipe would be 0.38 feet below the overflow for a total static head of 8.84 Ft. Since the 12" Pipe is not flowing at full capacity and gravity fed there is no dynamic head from the gravity portion of the pipe.

At 400 GPM the dynamic head for the PVC is 1.0 Ft/100 Feet.

440 Feet x 0.6 Ft / 100 Feet = 4.4 Ft
100 Feet of Discharge = 4.16 Ft
20 Feet of Suction = 0.83 Ft
8.84 Ft of static Head

Total Head = 18.23 Ft

Note: The friction loss of a check valve would need to be added to this calculation.

At 18.23 feet of head the Kohler Pump is estimated to provide 390 gallons per minute

Case 4:

This case modified case 3 to find a point where the pipe would not back flow to the creek below the lake overflow. In this design 10 inch ADS N-12 pipe was chosen to provide as it would provide 754 gallons per minute of capacity if laid at 0.5% slope. 6 Inch PVC would be connected to it at the high point to provide pressure rated pipe from the pump to the high point.

160 feet of 10" Pipe could be laid with a balance of the 900 feet as 6" PVC Schedule 40. The pipe would have a minimum cover of 9 inches. The high point in the pipe would be at the lake overflow for a total static head of 9.22 Ft. Like the 12" pipe the 10" Pipe is not flowing at full capacity and gravity fed so there is no dynamic head from the gravity portion of the pipe.

At 400 GPM the dynamic head for the PVC is 1.0 Ft/100 Feet.

740 Feet x 0.6 Ft / 100 Feet = 7.4 Ft
100 Feet of Discharge = 4.16 Ft
20 Feet of Suction = 0.83 Ft
9.22 Ft of static Head

Total Head = 21.61 Ft

At 21.61 feet of head the Kohler Pump is estimated to provide about 370 gallons per minute

Summary

Case	Description	Head @ Calc Flow	GPM	Fuel
1a	4” Trailer Pump, 4” Hose, 2015 Pumping	63 Ft @ 400	378	1 Gal/Hr
1b	4” Small Frame Pump (Subaru), 4” Hose, 2016 Spring	43 Ft @ 300	225	~.4 Gal/ Hr
2a	6” PVC Schedule 40 Pipe (No pump evaluated)	21.44 @ 350	350	
2b	6” PVC Schedule 40 Pipe (No pump evaluated)	33.81 @ 500	500	
3	12” ADS with 6” PVC, Kohler 4” Pump (Need check valve)	18.23 @ 400	390	.44 Gal/Hr
4	10” ADS with 6” PVC, Kohler 4” Pump	21.61 @ 400	370	.44 Gal/Hr
Quick Calculations				
4	With dual 4” Pumps	30 Ft @ 600	600	.88 Gal/Hr

Notes:

- The dynamic head of a 6” PVC begins to increase more rapidly above 5 feet per second which equates to about 500 GPM. Dual 4 Inch pumps will produce 550 GPM to 600 GPM due to the increased head pressure.
- Reducing the length of the discharge hose is recommended to reduce the dynamic head from this connection. Currently calculated at 4.16 Ft for 100 feet. Reducing this to 50 or 25 feet would reduce this to 2 Ft or 1 Ft respectively. About a 15 Gallon per Minute increase could be expected with the Kohler pump.
- Increasing the size of the hose from the pump to the PVC from 4 inch to 6 inch would cut the head generated by this connection to 30%. i.e. 100 foot 4” hose to 50 feet of 6” hose would reduce head on this connection from 4.16 Ft to 0.5 Ft. For the Kohler pump, this will increase flow by about 25 Gallons per Minute

Reference Information

Lay Flat Hose Friction

Suction Hose

Fire Hose Friction Loss Calculator

Instructions

Enter the hose diameter, the gallons per minute (GPM), and the length, into the Friction Loss Calculator and then press the submit button.

Friction Loss Calculator	
Select Diameter From the list	4 inch
Enter GPM (Gallons Per Minute)	300
Enter Hose Length (in feet)	20
Submit	
Friction Loss (PSI)	0.36
The Friction Loss for this 20 foot section of 4 inch hose or pipe with 300 GPM is 0.36 PSI (pounds per square inch)	

Discharge Hose

Fire Hose Friction Loss Calculator

Instructions

Enter the hose diameter, the gallons per minute (GPM), and the length, into the Friction Loss Calculator and then press the submit button.

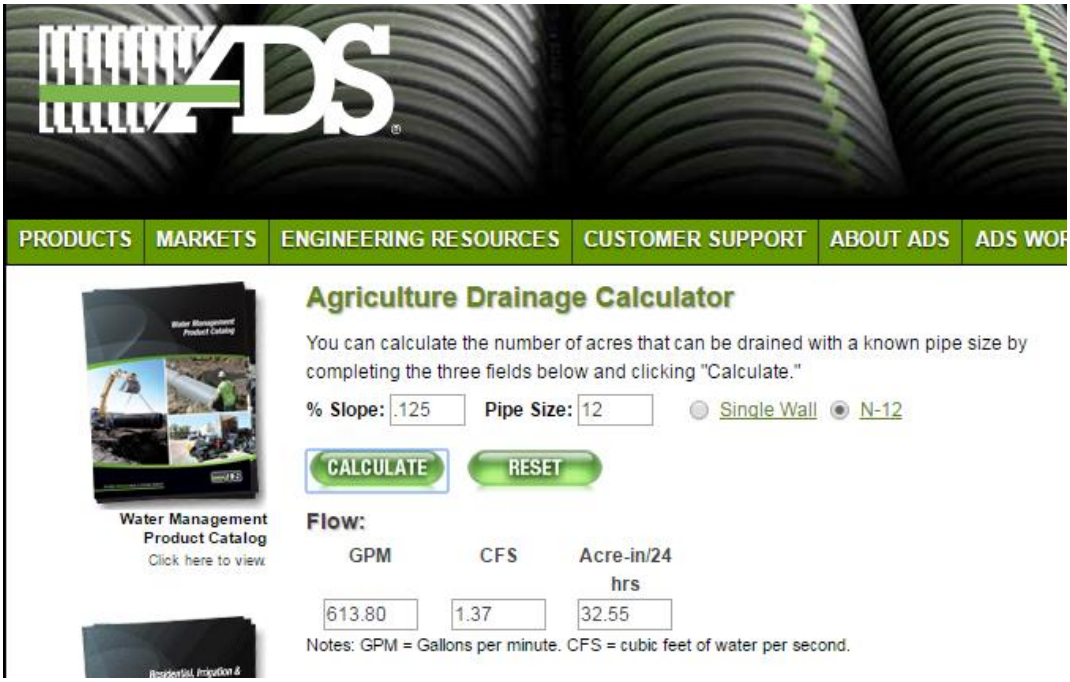
Friction Loss Calculator	
Select Diameter From the list	4 inch
Enter GPM (Gallons Per Minute)	300
Enter Hose Length (in feet)	100
Submit	
Friction Loss (PSI)	1.8
The Friction Loss for this 100 foot section of 4 inch hose or pipe with 300 GPM is 1.8 PSI (pounds per square inch)	

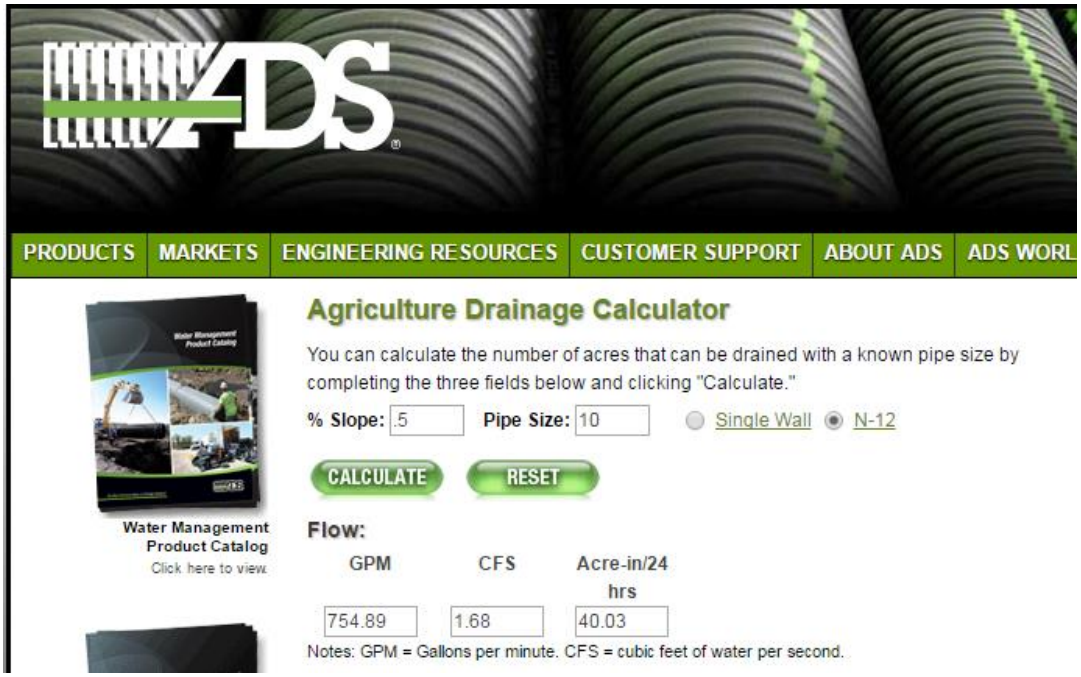
VINYLFLOW® / IRONSIDES® Friction Loss per 100 Ft. (PSI)

GPM	1.5"	2"	2.5"	3"	4"	6"	8"	10"	12"	14"	16"
20	1.2										
30	2.4										
40	5.1	1.1									
50	6.0										
60		2.4	1.4								
80		4.1	1.9	1.0							
90	17.0										
100		6.0	2.8	1.2							
120				1.8							
140				2.2							
160				2.6	0.6						
180				3.3	0.7						
200		22	7		0.8						
220					1.0						
240					1.1		0.2				
250				5							
260					1.3	0.2					
280					1.4	0.2					
300					1.6	0.2					
340						0.3					
350			22								
380						0.4					
420						0.5					
460						0.6					
500					4	0.7					
540						0.8					
580				22		0.9					
620						1.0					
660						1.1					
1,200						3.0					
1,250					22						
1,800							1.5				
2,500								1.0			
3,500									0.8		
3,630						22					
5,000							11			0.6	
6,000											0.4
8,000								8			
12,000									8		
15,000										5	
16,000											30

Note: 1 PSI = 2.31 Foot of water

ADS N-12 Pipe Capacity





6 Inch PVC Schedule 40 PVC Friction

6 inches				
Volume Flow *(gal/min)*	Volume Flow *(gal/hr)*	Velocity *(ft/sec)*	Friction Head *(ft/100 ft)*	Friction Loss *(psi/100 ft)*
50	3000	0.6	0.02	0.01
60	3600	0.7	0.03	0.01
70	4200	0.8	0.04	0.02
75	4500	0.8	0.05	0.02
80	4800	0.9	0.05	0.02
90	5400	1.0	0.06	0.03
100	6000	1.1	0.08	0.04
125	7500	1.4	0.1	0.05
150	9000	1.7	0.2	0.07
175	10500	2.0	0.2	0.1
200	12000	2.3	0.3	0.1
250	15000	2.8	0.4	0.2
300	18000	3.4	0.6	0.3
350	21000	3.9	0.8	0.3
400	24000	4.5	1.0	0.4
450	27000	5.1	1.3	0.6
500	30000	5.6	1.5	0.7
750	45000	8.4	3.3	1.4
1000	60000	11.2	5.5	2.4

Kohler Pump Data

Model: TP4.0D

KOHLER®

Portable Pump

ISO 9001
KOHLER POWER SYSTEMS
NATIONALLY REGISTERED

The KOHLER Advantage

- **Built to Last Since 1920**
  For over 90 years, hospitals, airports and military bases around the world have depended on KOHLER generators.
- **Premium Warranty**
  You get our premium 3-year limited warranty backed by a network of more than 10,000 dealers.
- **Custom Kits**
  Legs, handles, wheels, lifting kits - whatever you want, any way you want it.
- **Free Loaner Program***
  If your KOHLER generator ever goes down, just swing by one of our select dealers. We'll provide a free loaner unit for warranty repairs exceeding 24 hours.

Standard Features

- **Long-Life**
  No aluminum here – the volute & impeller are made of robust cast iron.
- **Protective Frame**
  A 360-degree roll cage design.
- **Pro-Grade Engine**
  Powered by a KOHLER® diesel engine, designed for professional-grade power.
- **Extra Engine Protection**
  Oil Sentry™ automatically shuts engine down in low-oil conditions.

Available Options

- Mobility Kit (2 Wheels, 4 Handles, Leg and Hardware)

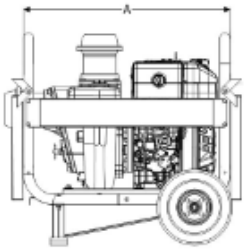
KOHLER CO., Kohler, Wisconsin 53044 USA
Phone 920-457-4441, Fax 920-459-1646
For the nearest sales and service outlet in the
US and Canada, Phone 1-800-544-2444
KOHLERPower.com

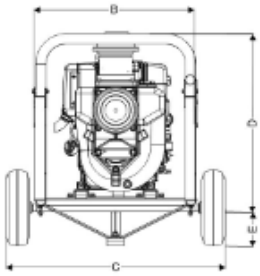
Specifications

Model Name	TP4.0D
Pump Type	4 inch Diesel Trash Pump
Kohler Pump Spec	PA-TP40D-3001
Compliance	3001 (CARB/EPA/CSA)
Engine cc	349
Oil-Sentry™ (Low oil protection)	Yes
Suction Diameter in (mm)	4" NPT (101.6)
Suction Head Height ft (m)	26(8)
Total Head Height ft (m)	56 (17)
Flow Rate gal (L) per minute	476 (1800)
Impeller	Cast Iron
Seals	Silicone Carbide
Fuel Type	Diesel
Fuel Capacity	1.1gal (4.3L)
Run Time (hours)	4.3
Warranty-Commercial/ Industrial Use	3 Years
Warranty-Consumer/ Recreational Use	3 Years

Dimensions and Weights

A mm (in.)	729 (28.7)
B mm (in.)	579 (22.8)
C mm (in.)	757 (29.8)
D mm (in.)	594 (23.3)
E mm (in.)	140 (5.5)
Dry Weight, lbs (kg)	198 (89.8)
Carton Length mm (in.)	754 (29.7)
Carton Width mm (in.)	604 (23.8)
Carton Height mm (in.)	632 (24.9)
Packaged Weight lbs (kg)	225 (102)





Performance