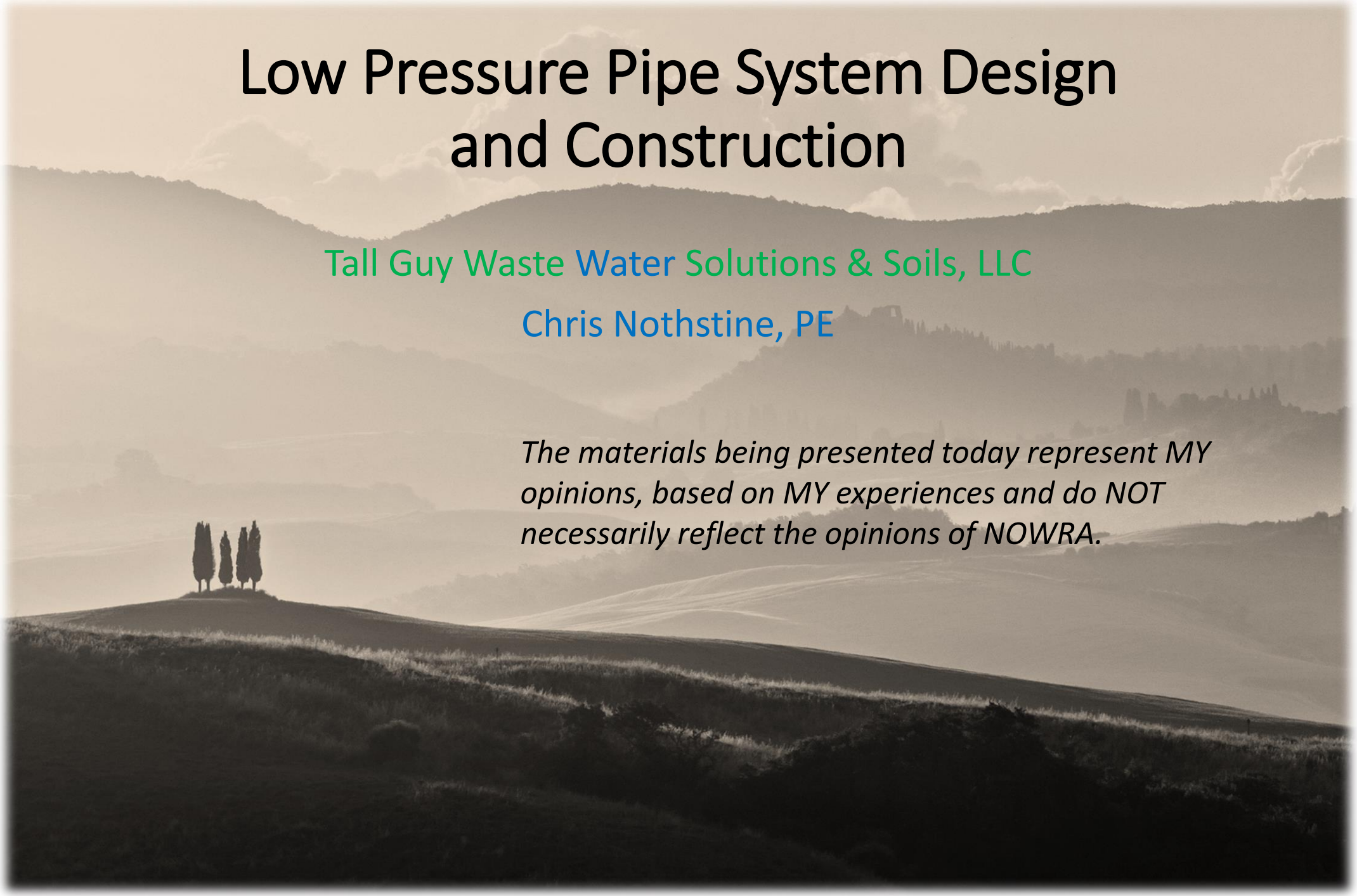
Low Pressure Pipe System Design and Construction

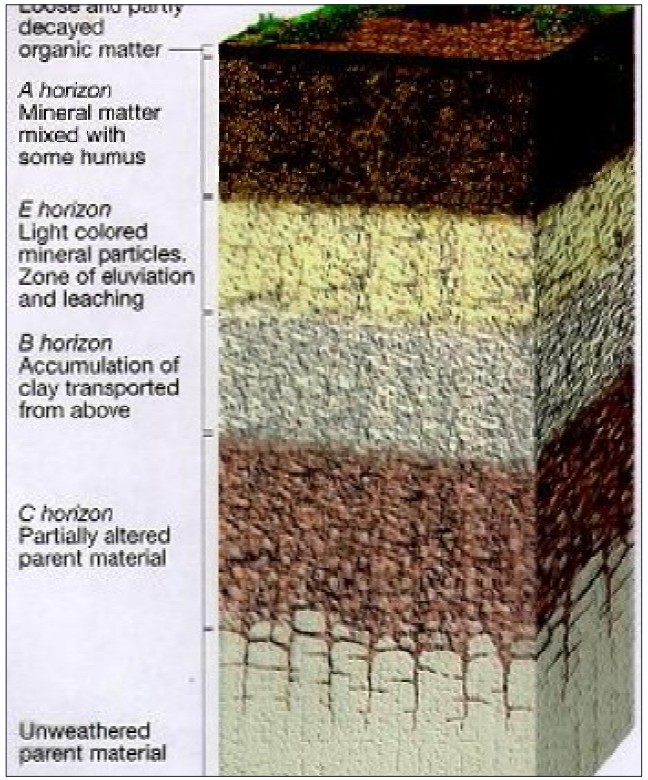
Tall Guy Waste Water Solutions & Soils, LLC

Chris Nothstine, PE

The materials being presented today represent MY opinions, based on MY experiences and do NOT necessarily reflect the opinions of NOWRA.



Soil morphology



Soil morphology is the field of observable attributes of the soil within the various soil horizons and the description of the kind and arrangement of the horizons. The observable attributes ordinarily described in the field include the composition (texture), soil structure and organization of the soil, color of the base soil and features such as mottling, distribution of roots and pores, evidence of translocated materials such as carbonates, iron, manganese, carbon and clay, and the consistence of the soil.

Onsite Wastewater Treatment

- Onsite Wastewater Treatment Systems
- Registration & Licensure Forms
- Information for Professionals
- Calendar of Events
- Onsite Wastewater Complaints
- CEU Tracking Information *NEW*
- Onsite Wastewater Courses
- Related Links
- Laws, Regulations & Manuals
- Frequently Asked Questions
- DHSS Construction Permit Process and Application

Operation and Maintenance Guidelines

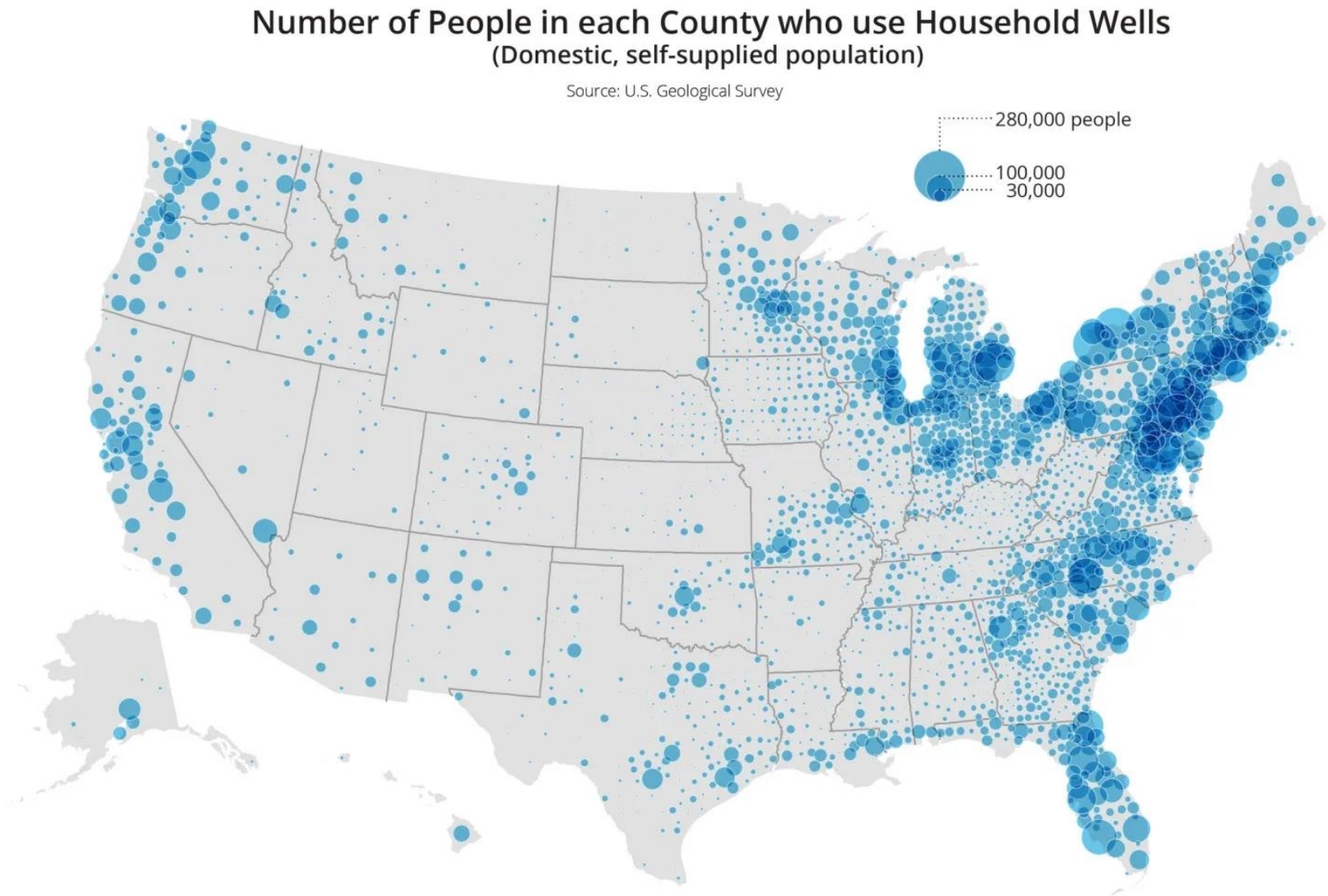
An estimated 25 percent of homes in Missouri rely on an onsite wastewater treatment system (OWTS) in areas where public sewers are not available. Onsite systems treat wastewater and disperse it on the property where it is generated. When functioning properly, onsite systems prevent human contact with sewage, and prevent contamination of surface and groundwater. Factors that affect the proper functioning of onsite systems include the site and soil conditions, design, installation, operation, and maintenance.

The Missouri Department of Health and Senior Services (DHSS) has set minimum state standards for OWTS. These standards cover new systems and major changes to existing systems. Some examples of major changes are replacing a sewage tank, and replacing or expanding an absorption field. These standards became effective in January 1996.

Healthy Living

- Environmental Factors
- Chronic Diseases
- Communicable Diseases
- Healthy Families
- Organ/Tissue Donation and Registry
- Women, Infants & Children (WIC)
- Genetic Disease & Early Childhood
- Food Programs
- Wellness & Prevention
- Local Public Health Agencies
- Immunizations

from circle of blue WaterNews, October 1, 2018



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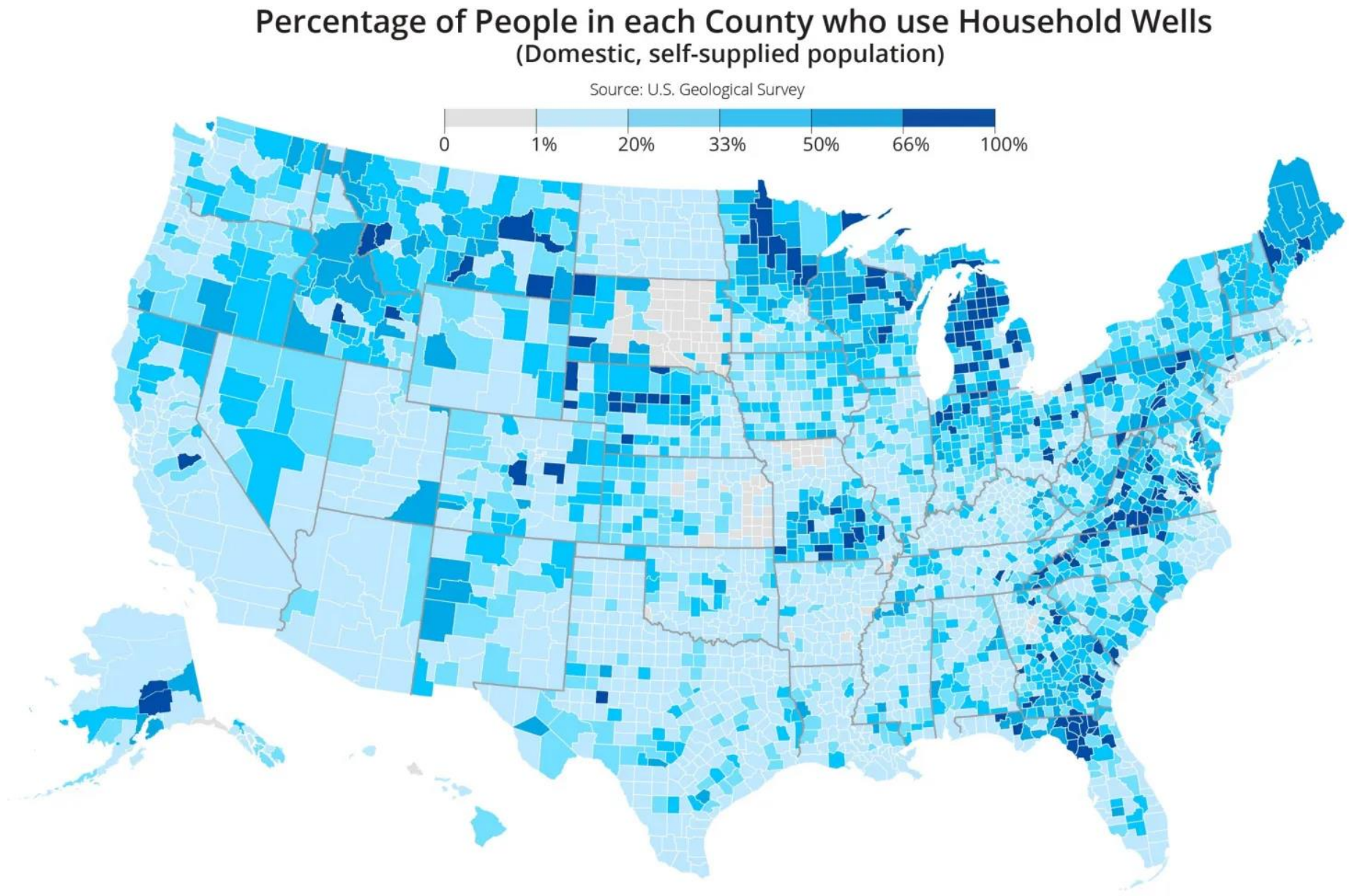
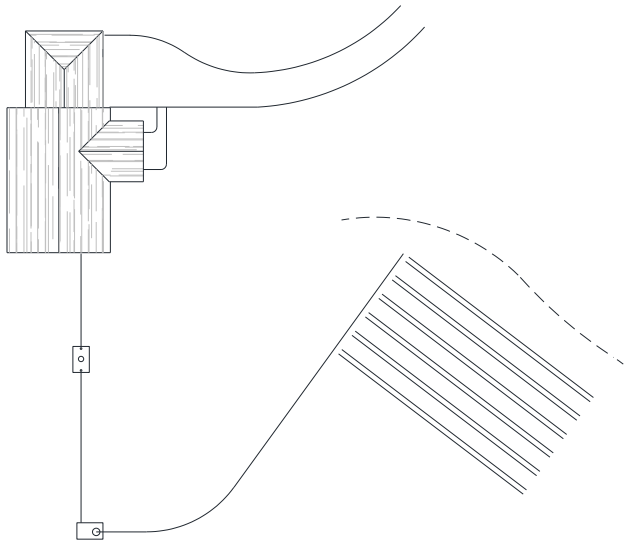
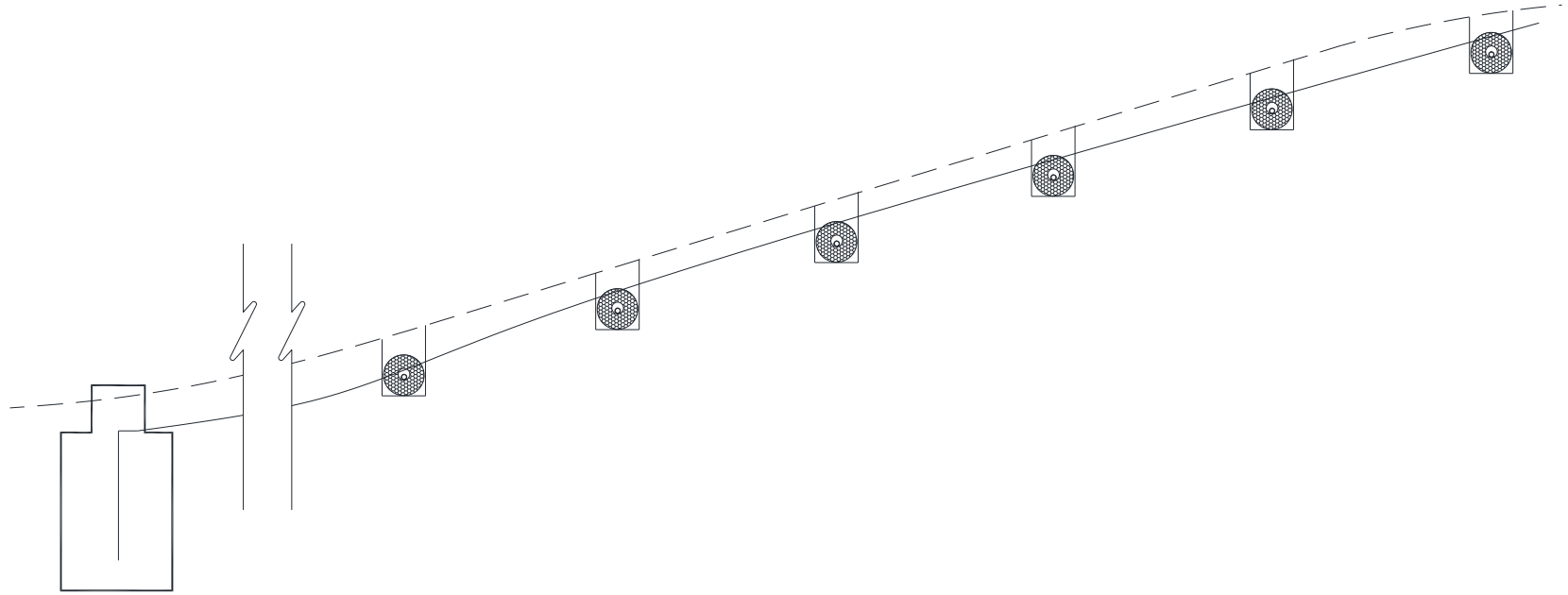


LPP design and construction

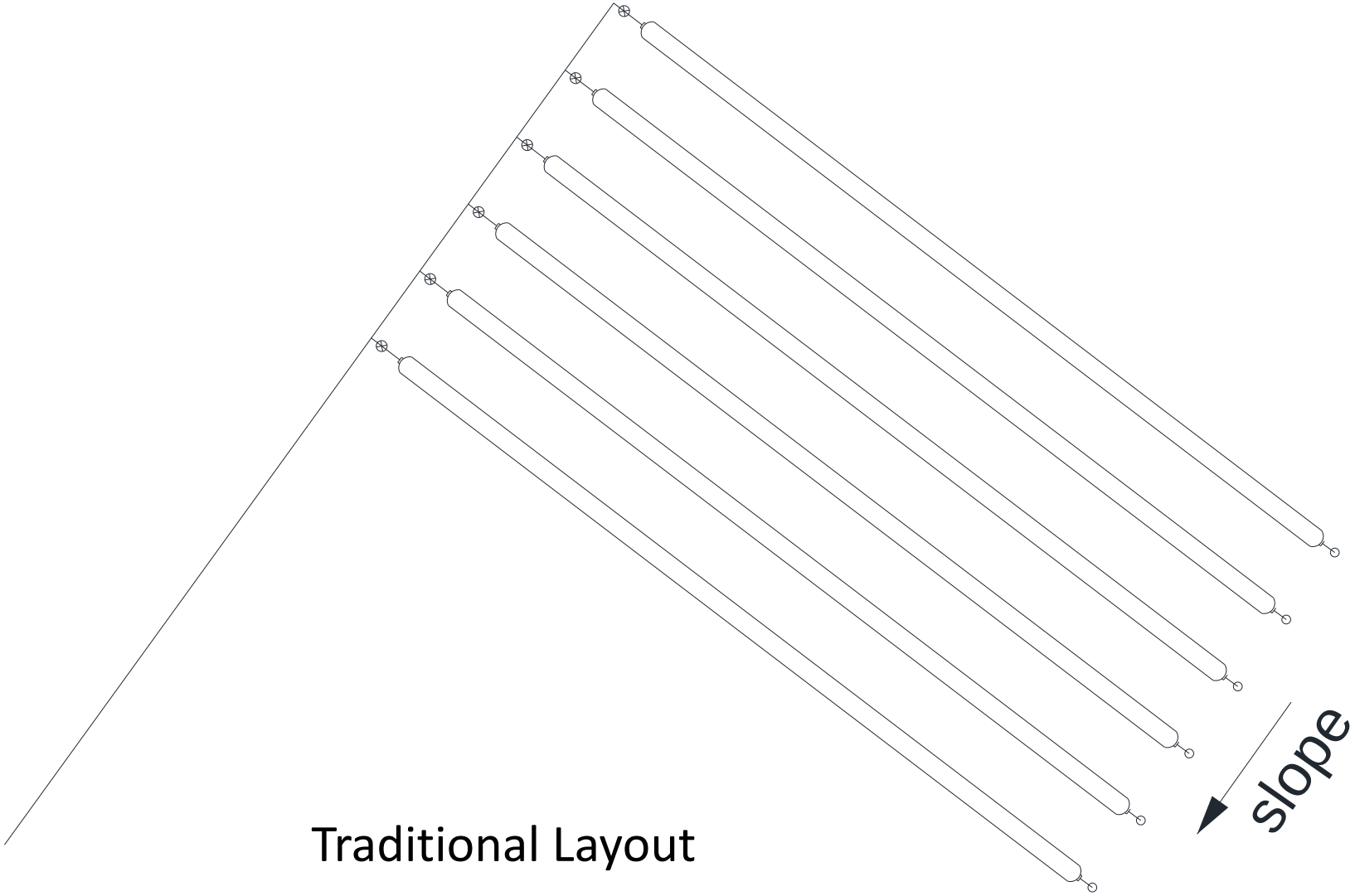


Plan View



Profile of tank and laterals

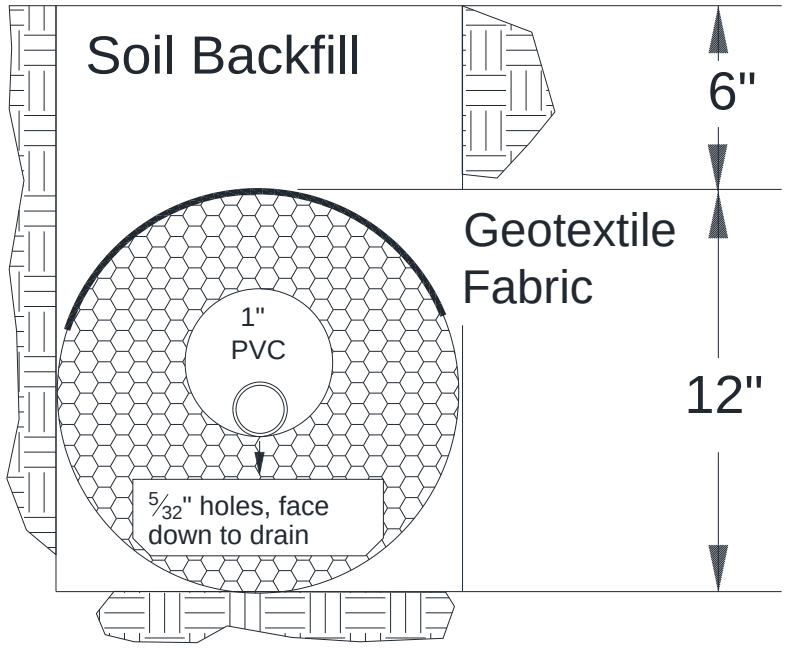
LPP design and construction



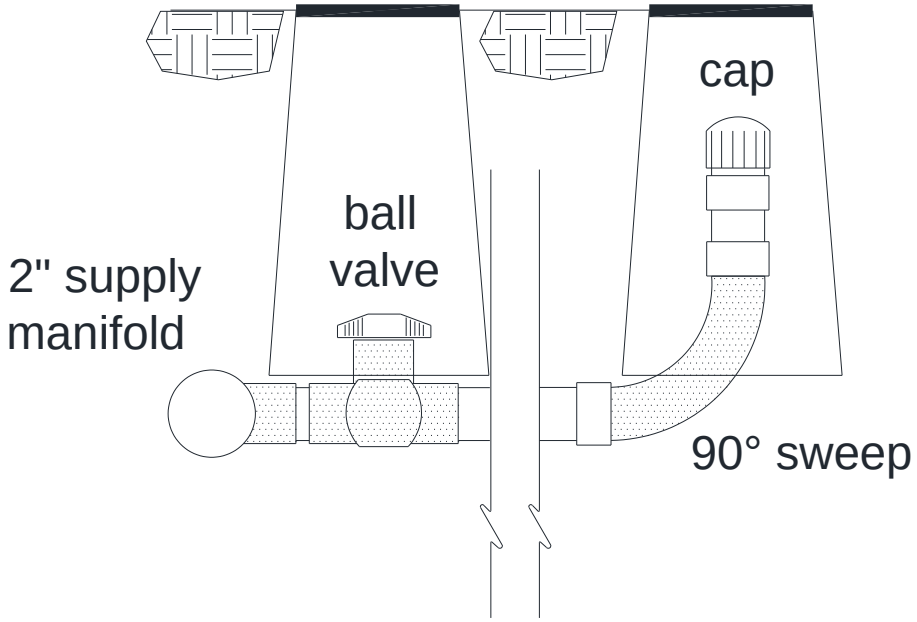
Traditional Layout

LPP design and construction

Typical Lateral (NTS)



Lateral Profile (NTS)



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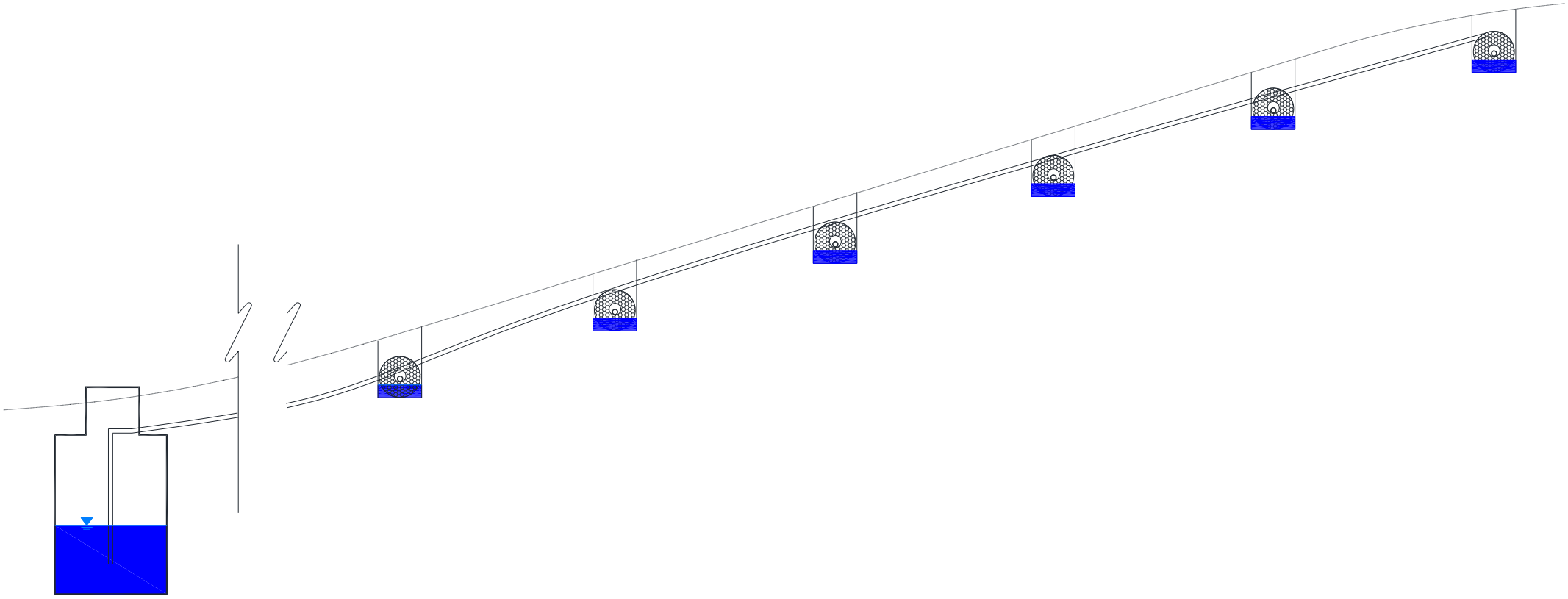

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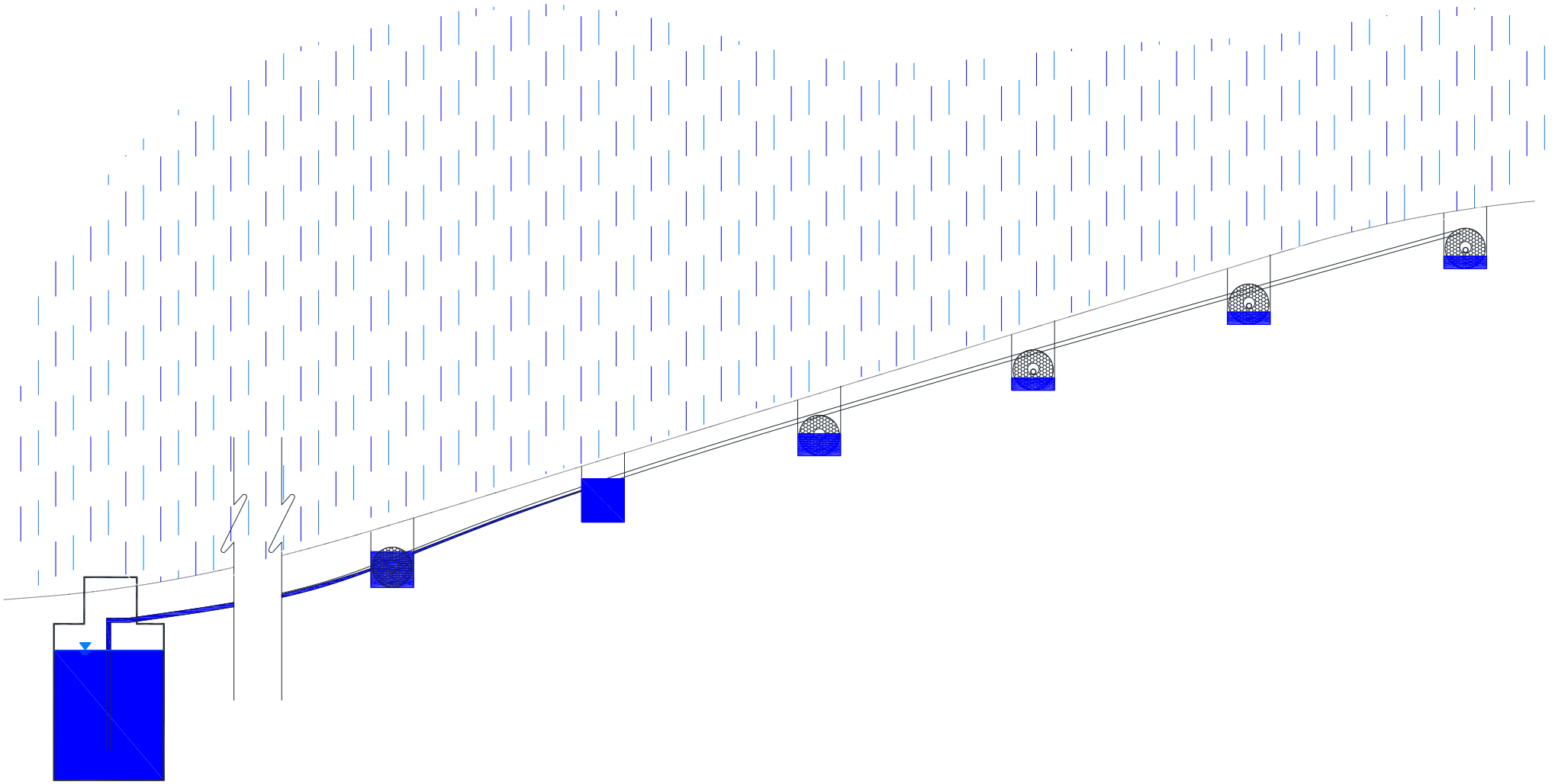
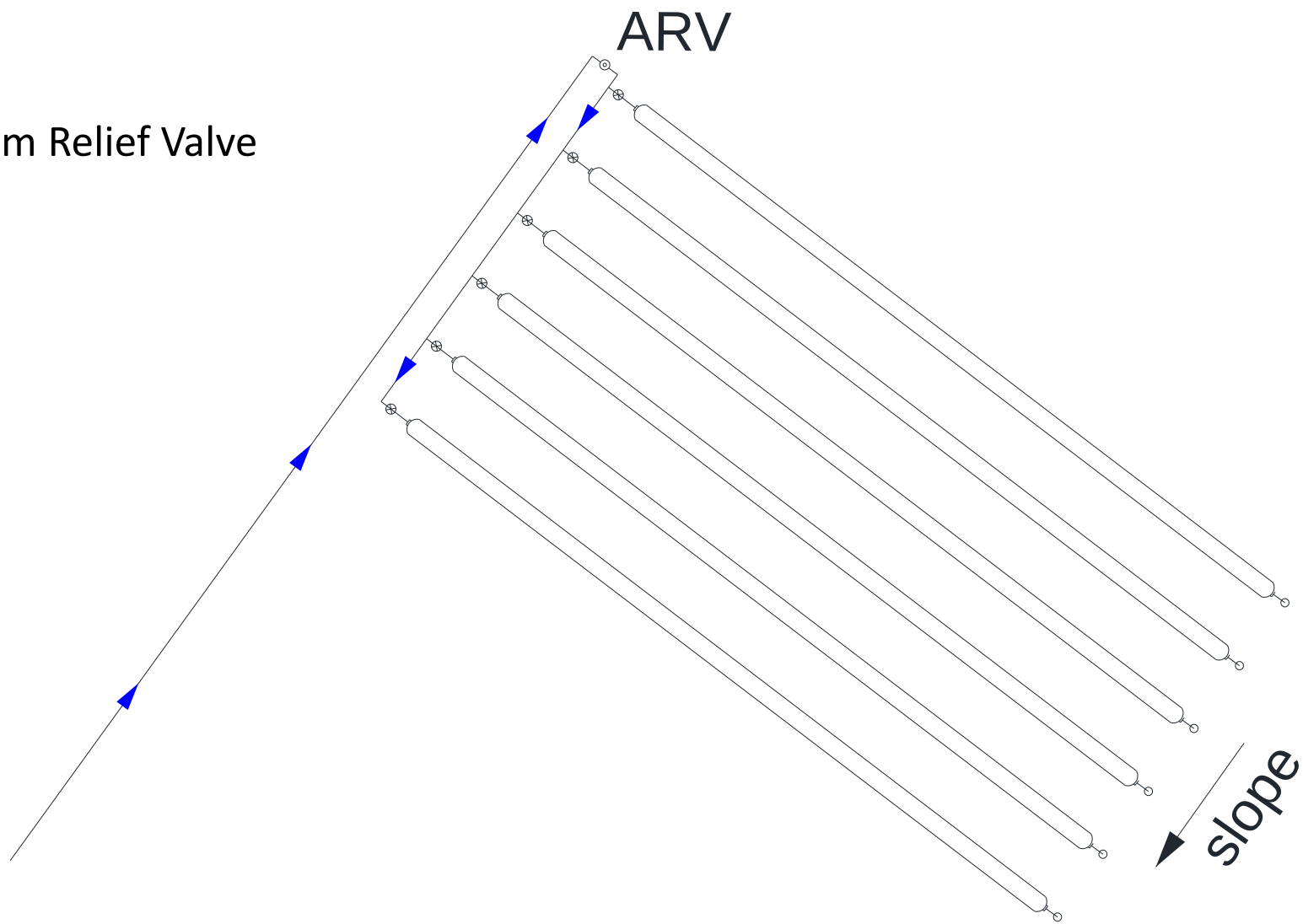
LPP design and construction



LPP design and construction

ARV=Air/Vacuum Relief Valve



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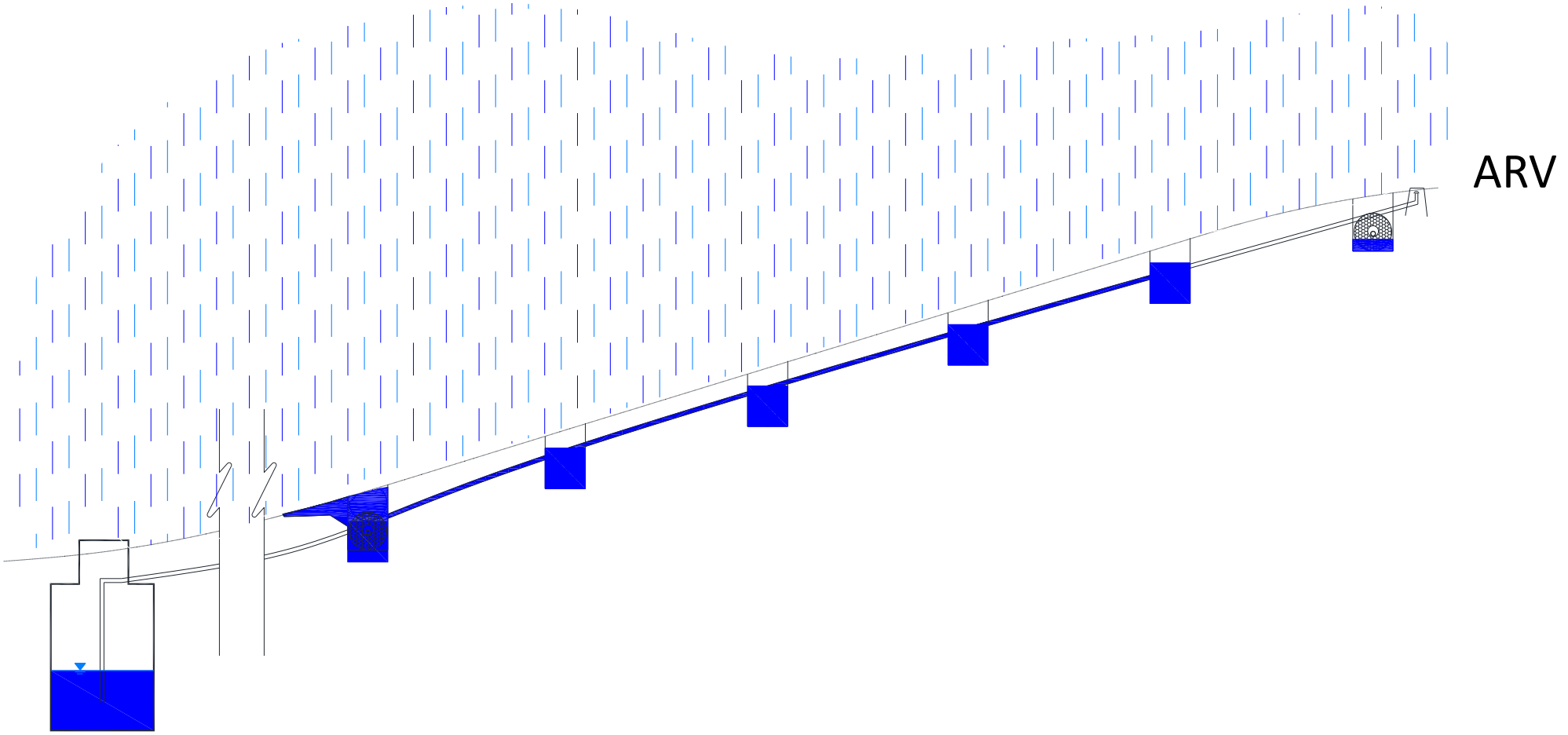

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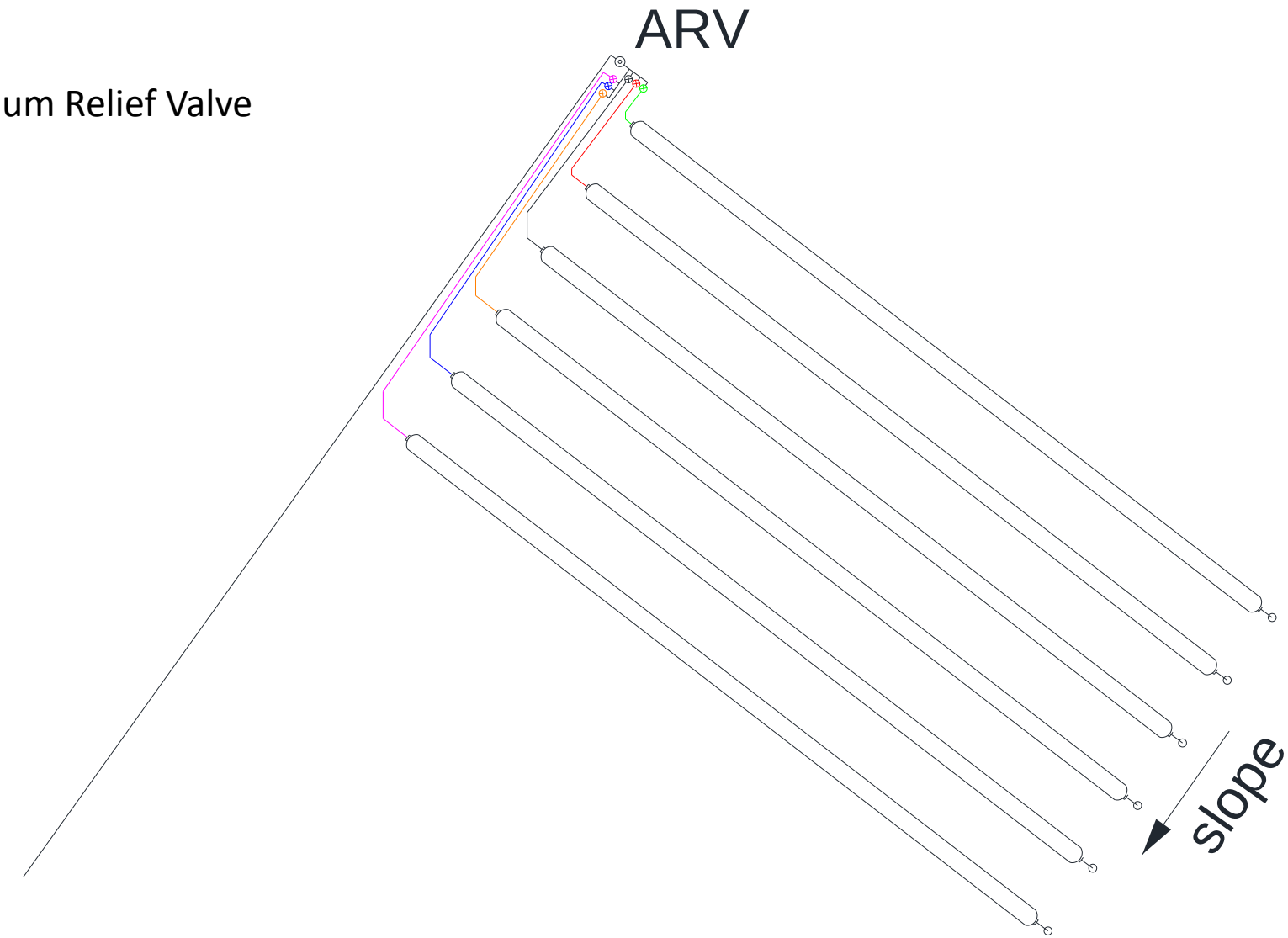

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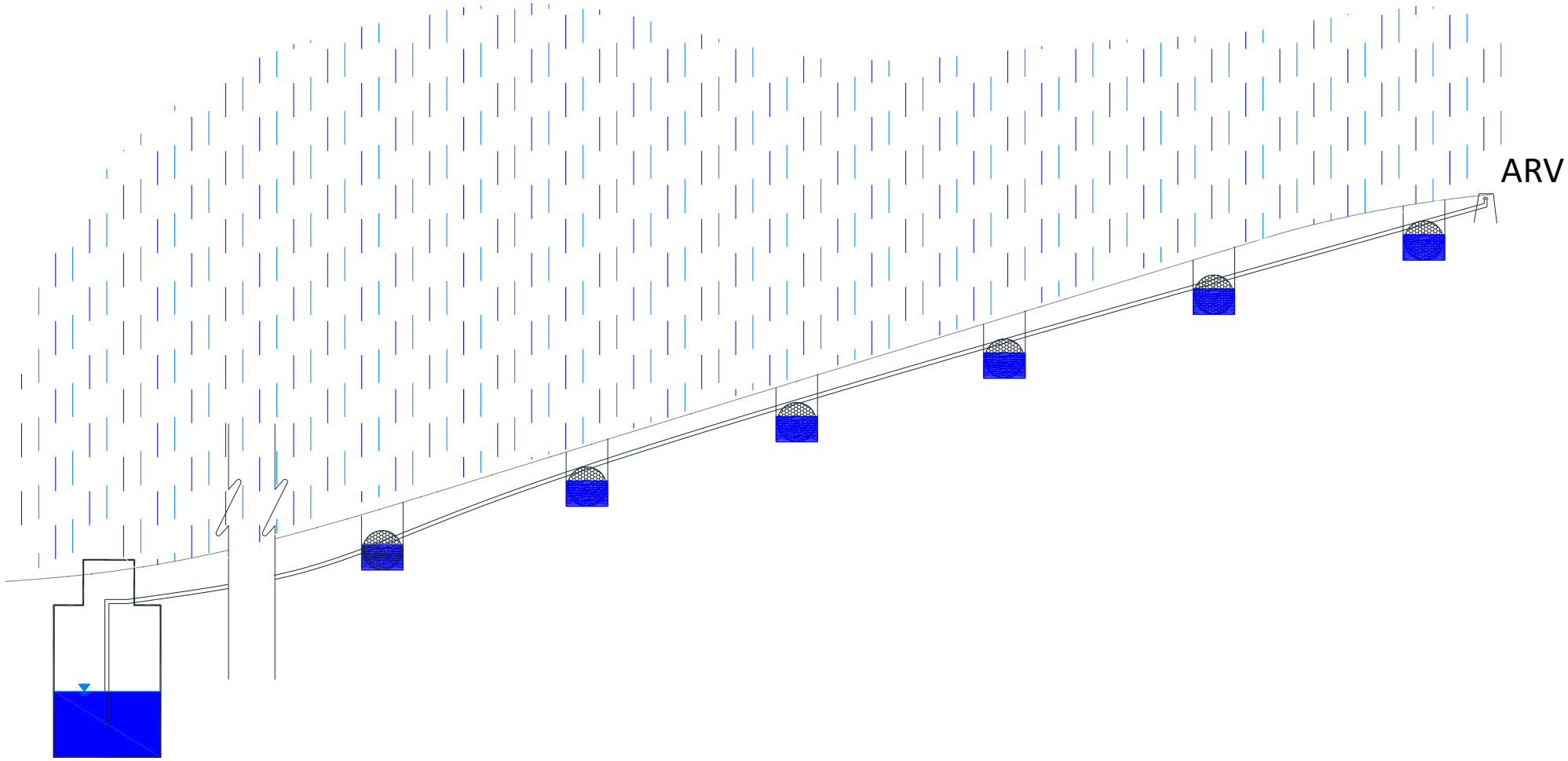


LPP design and construction

SIZING INFORMATION

TABLE 4: DISCHARGE RATES IN GALLONS PER MINUTE FROM ORIFICES[1]

Pressure (ft)	Orifice Diameter (in)			
	1/8	5/32	3/16	1/4
2.5	NP	NP	0.66	1.17
3	NP	NP	0.72	1.28
3.5	NP	0.54	0.78	1.38
4	NP	0.58	0.83	1.47
4.5	NP	0.61	0.88	1.56
5	0.41	0.64	0.93	1.65
5.5	0.43	0.68	0.97	1.73
6	0.45	0.71	1.02	1.80
6.5	0.47	0.73	1.06	1.88
7	0.49	0.76	1.10	1.95
7.5	0.50	0.79	1.14	2.02
8	0.52	0.81	1.17	2.08
8.5	0.54	0.84	1.21	2.15
9	0.55	0.86	1.24	2.21
9.5	0.57	0.89	1.28	2.27
10	0.58	0.91	1.31	2.33

NOTE: [1]Table is based on discharge in GPM = 11.79 x Orifice Diameter[2] in Inches x (Pressure in Feet)$^{1/2}$. NP means Not Permitted.
Source: *Pressure Distribution Network Design* by James C. Converse, January 2000.

Prepared for you by 10/19/2022

Pump Selection for Pressurized System

Orifice Size	0.156	inches	
Residual Head at Last Orifice	4.00	feet	
Lateral Length	60	feet	
Total Number of Laterals per Cell	6		
Orifice Spacing	5.00	feet	
Distributing Valve Model (# of Zones)	1		None used
Lift to Manifold	13	feet	
Discharge Assembly Size	1.50	inches	
Transport Line Size	1.50	inches	
Pipe Class/Schedule	40		
Transport Length	130	feet	
Manifold Size	2.00	inches	
Pipe Class/Schedule	40		
Length of Distribution Header	5.00	feet	
Lateral Size	1.25	inches	
Pipe Class/Schedule	40		
Flow Meter	none		None used
'Add-on' Friction Losses	5.00	feet	

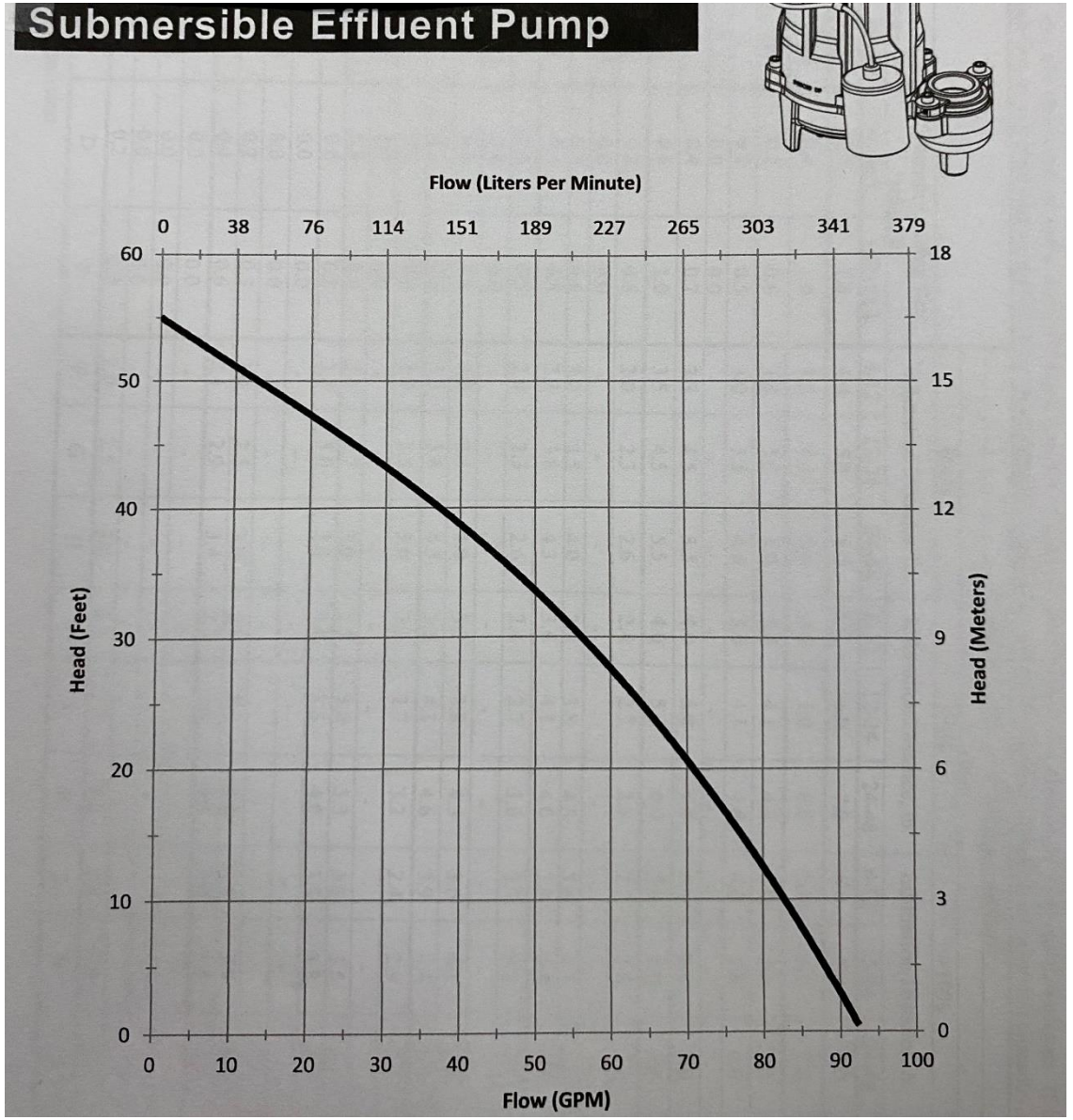
Input

Calculation

Minimum Flow Rate per Orifice	0.60 gpm	
Number of Orifices per Zone	72	
Total Actual Flow Rate	43.6 gpm	
Number of Laterals per Zone	6	
Total Dynamic Head:		
Lift to Manifold	13.0 feet	
Residual Head at Last Orifice	4.0 feet	
Frictional Head Losses:		
Head Loss in Transport Pipe	13.7 feet	
ad Loss through Discharge Assembly	5.7 feet	
Head Loss in Distribution Header	0.0 feet	
Head Loss in Laterals	0.2 feet	
'Add-on' Friction Losses	5.0 feet	
Head Loss through Distributing Valve	0.0 feet	None Used
Head Loss through Flow Meter	0.0 feet	None Used
Size Pump for:		
TOTAL FLOW RATE	**43.6 gpm**	
	@	
TOTAL DYNAMIC HEAD	**41.7 feet**	

Output

LPP design and construction



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Calculation		
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Number of Orifices per Zone	72	
Total Actual Flow Rate	43.6 gpm	
Number of Laterals per Zone	6	
Total Dynamic Head:		
Lift to Manifold	13.0 feet	
Residual Head at Last Orifice	4.0 feet	
Frictional Head Losses:		
Head Loss in Transport Pipe	4.1 feet	
ad Loss through Discharge Assembly	5.7 feet	
Head Loss in Distribution Header	0.0 feet	
Head Loss in Laterals	0.2 feet	
'Add-on' Friction Losses	5.0 feet	
Head Loss through Distributing Valve	0.0 feet	None Used
Head Loss through Flow Meter	0.0 feet	None Used
Size Pump for:		
TOTAL FLOW RATE	**43.6 gpm**	
	@	
TOTAL DYNAMIC HEAD	**32.0 feet**	

LPP design and construction

When designing low-pressure pipe systems, we need to consider Linear Loading Rate.

LLR – Amount of wastewater applied daily along the landscape contour. It is expressed in gallons per day per lineal foot along the contour.

J.C. Converse, 1998

LPP design and construction

Depth of Class III soil (inches)	Maximum recommended LLR
18-24	4 gpd/LF
12-18	3 gpd/LF
6-12	1 gpd/LF

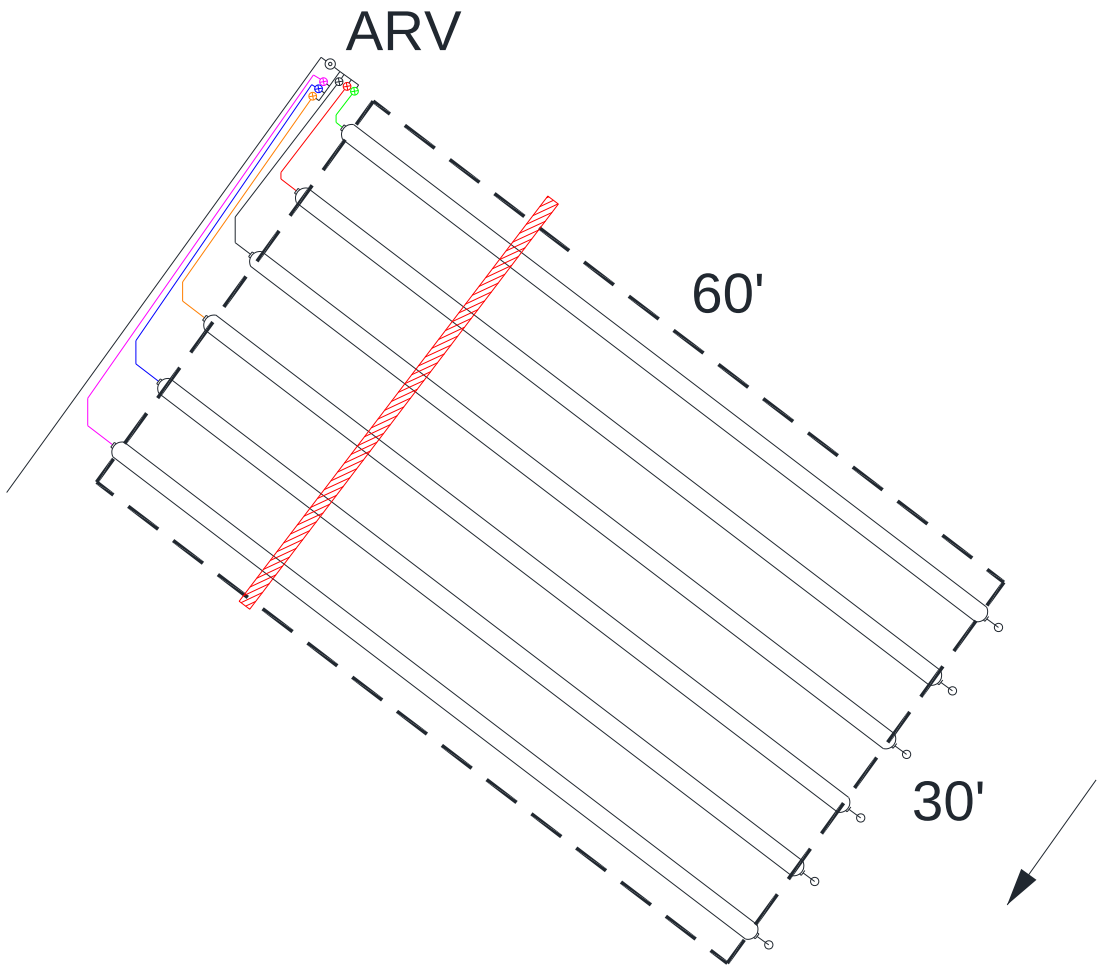
J.C. Converse

LPP design and construction

Table 1. Infiltration rates in gal/da/ft^2 for wastewater of >30 mg L^{-1} or wastewater of <30 mg L^{-1} and hydraulic linear loading rates in gal/da/ft for soil characteristics of texture and structure and site conditions of slope and infiltration distance. Values assume wastewater volume of >150 gal/da/bedroom. If horizon consistence is stronger than firm or any cemented class or the clay mineralogy is smectitic, the horizon is limiting regardless of other soil characteristics

					Hydraulic Linear Loading Rate, gal/da/ft									
					Slope									
					0-4%			5-9%			>10%			
Soil Characteristics			Infiltration Loading Rate, gal/da/ft^2		Infiltration Distance, in.			Infiltration Distance, in.			Infiltration Distance, in.			
Texture	Structure													
	Shape	Grade	>30 mg/L	<30 mg/L	8-12	12-24	24-48	8-12	12-24	24-48	8-12	12-24	24-48	Row
COS, S, LCOS, LS	--	0SG	0.8	1.6	4.0	5.0	6.0	5.0	6.0	7.0	6.0	7.0	8.0	1
FS, VFS,LFS,LVFS	--	0SG	0.4	1.0	3.5	4.5	5.5	4.0	5.0	6.0	5.0	6.0	7.0	2
CSL, SL	--	0M	0.2	0.6	3.0	3.5	4.0	3.6	4.1	4.6	5.0	6.0	7.0	3
	PL	1	0.2	0.5	3.0	3.5	4.0	3.6	4.1	4.6	4.0	5.0	6.0	4
		2, 3	0.0	0.0	-	-	-	-	-	-	-	-	-	5
	PR/BK /GR	1	0.4	0.7	3.5	4.5	5.5	4.0	5.0	6.0	5.0	6.0	7.0	6
		2,3	0.6	1.0	3.5	4.5	5.5	4.0	5.0	6.0	5.0	6.0	7.0	7
FSL, VFSL	--	0M	0.2	0.5	2.0	2.3	2.6	2.4	2.7	3.0	2.7	3.2	3.7	8
	PL	1,2,3	0.0	0.0	-	-	-	-	-	-	-	-	-	9
	PR/BK /GR	1	0.2	0.6	3.0	3.5	4.0	3.3	3.8	4.3	3.6	4.1	4.6	10
		2,3	0.4	0.8	3.3	3.8	4.3	3.6	4.1	4.6	3.9	4.4	4.9	11
L	--	0M	0.2	0.5	2.0	2.3	2.6	2.4	2.7	3.0	2.7	3.2	3.7	12
	PL	1,2, 3	0.0	0.0	-	-	-	-	-	-	-	-	-	13
	PR/BK /GR	1	0.4	0.6	3.0	3.5	4.0	3.3	3.8	4.3	3.6	4.1	4.6	14
		2, 3	0.6	0.8	3.3	3.8	4.3	3.6	4.1	4.6	3.9	4.4	4.9	15
SIL	--	0M	0.0	0.2	2.0	2.5	3.0	2.2	2.7	3.2	2.4	2.9	3.4	16
	PL	1,2,3	0.0	0.0	-	-	-	-	-	-	-	-	-	17
	PR/BK /GR	1	0.4	0.6	2.4	2.7	3.0	2.7	3.0	3.3	3.0	3.5	4.0	18
		2,3	0.6	0.8	2.7	3.0	3.3	3.0	3.5	4.0	3.3	3.8	4.3	19
SCL,CL SICL	--	0M	0.0	0.0	-	-	-	-	-	-	-	-	-	20
	PL	1,2,3	0.0	0.0	-	-	-	-	-	-	-	-	-	21
	PR/BK /GR	1	0.2	0.3	2.0	2.5	3.0	2.2	2.7	3.2	2.4	2.9	3.4	22
		2,3	0.4	0.6	2.4	2.9	3.4	2.7	3.0	3.3	3.0	3.5	4.0	23
SC, C, SIC	--	0M	0.0	0.0	-	-	-	-	-	-	-	-	-	24
	PL	1,2,3	0.0	0.0	-	-	-	-	-	-	-	-	-	25
	PR/BK /GR	1	0.0	0.0	-	-	-	-	-	-	-	-	-	26
		2,3	0.2	0.3	2.0	2.5	3.0	2.2	2.7	3.2	2.4	2.9	3.4	27
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O

LPP design and construction



Area Requirement

1,800 SF x 0.2 gpd/SF = 360 gpd

Linear Loading Rate (LLR)

60 gpd / 60LF = 1.0 gpd/LF

(LLR)

1 gpd/LF x 6 = 6 gpd/LF

6 gpd/LF > 4 gpd/LF (not adviseable)

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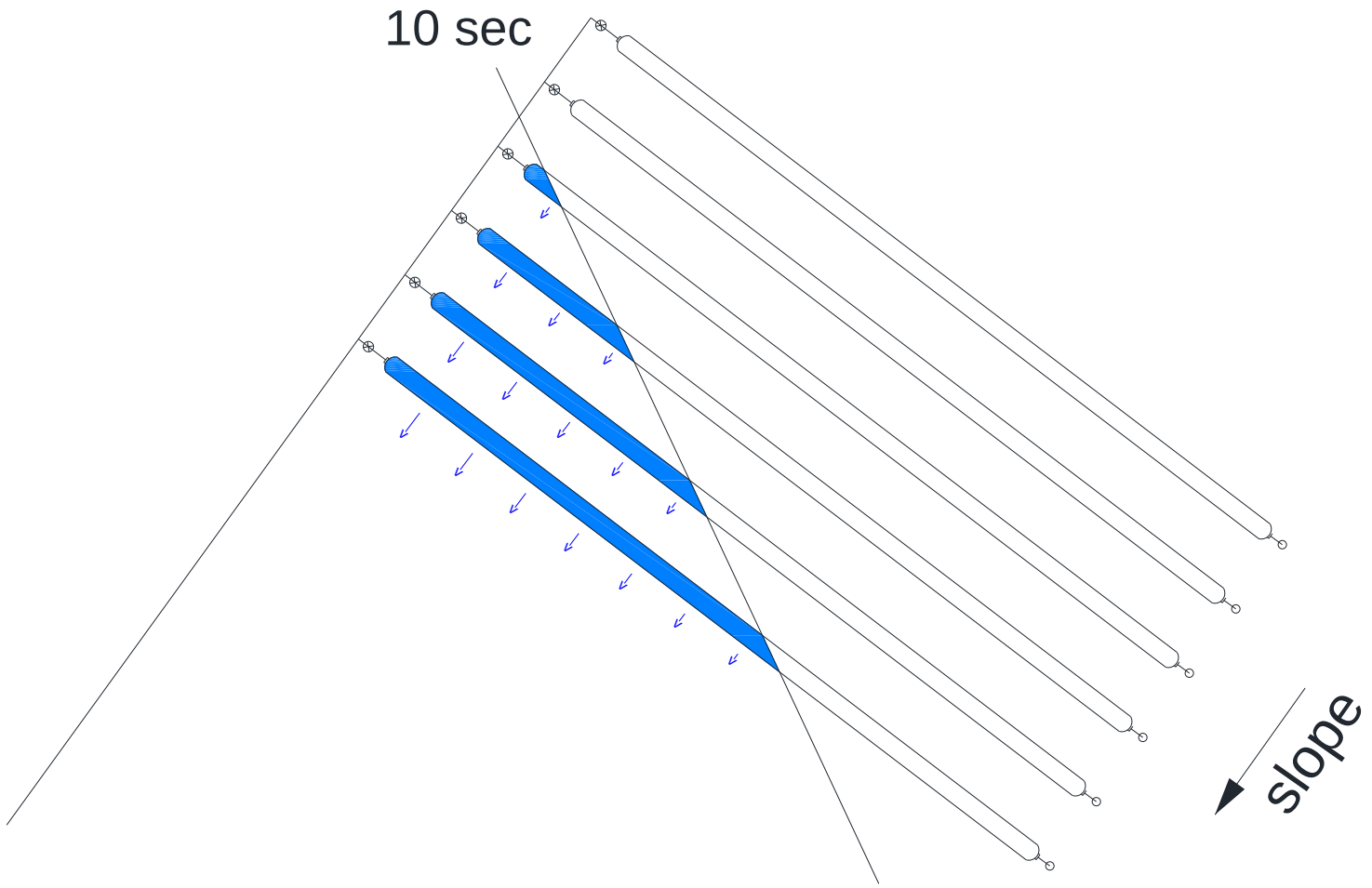

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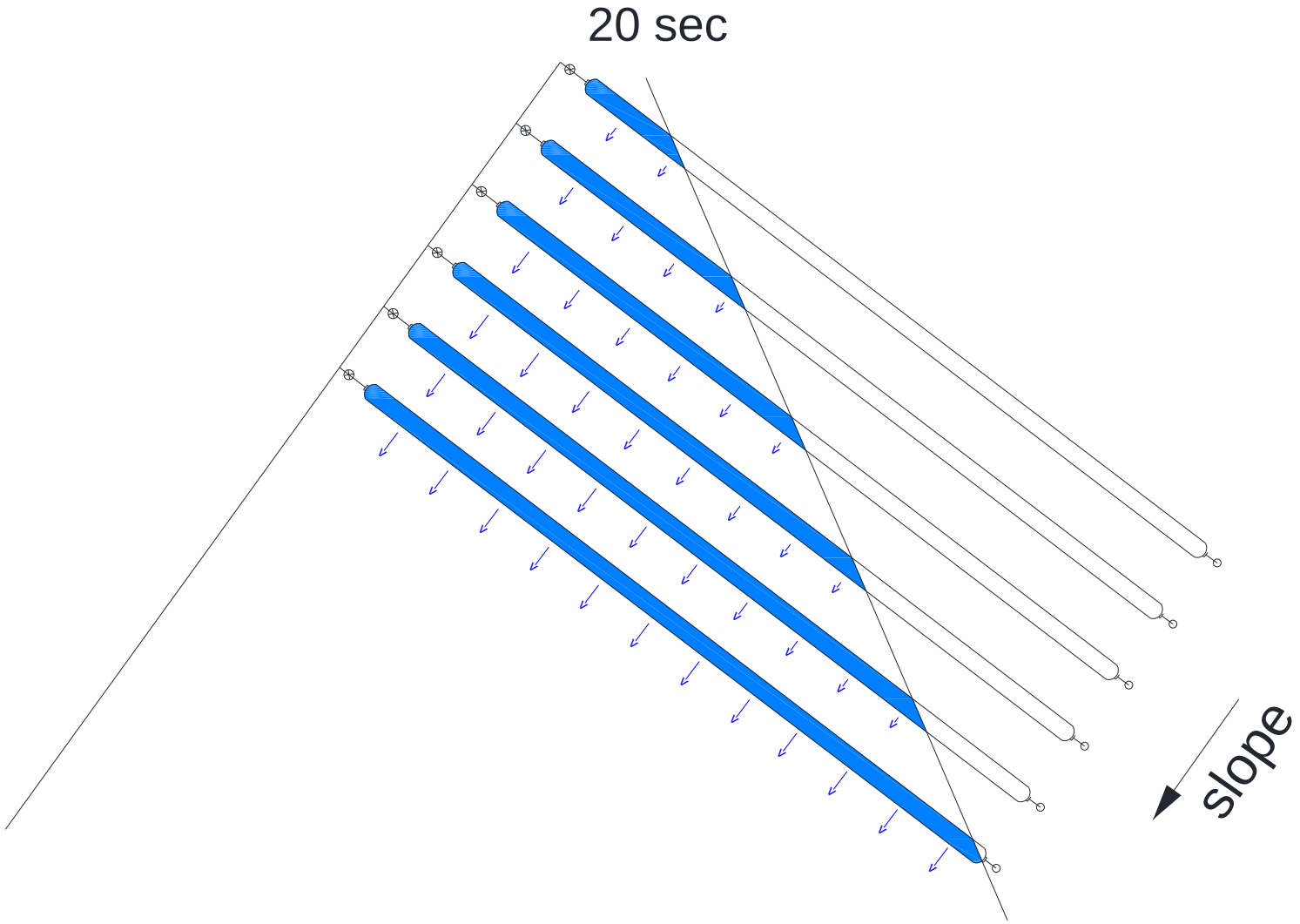

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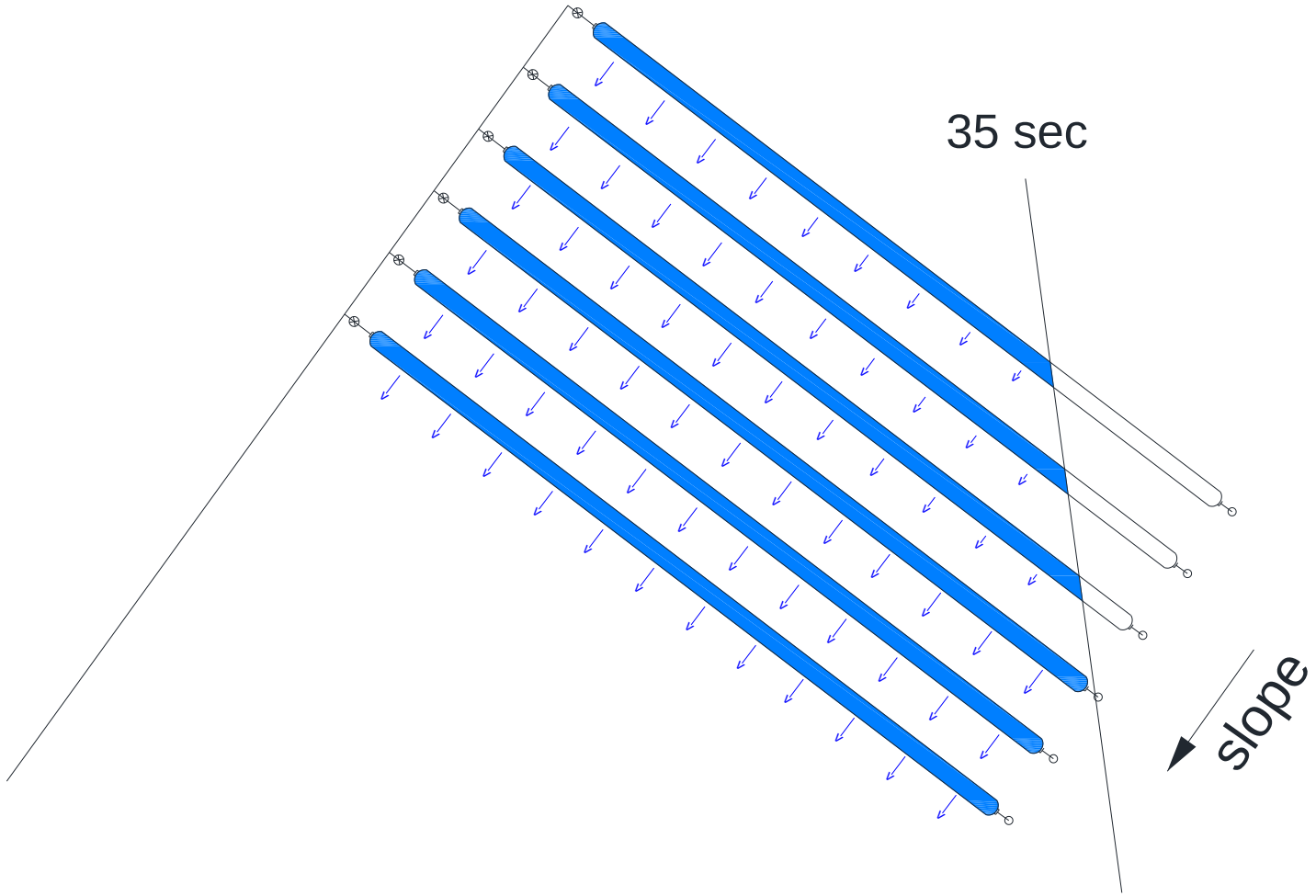

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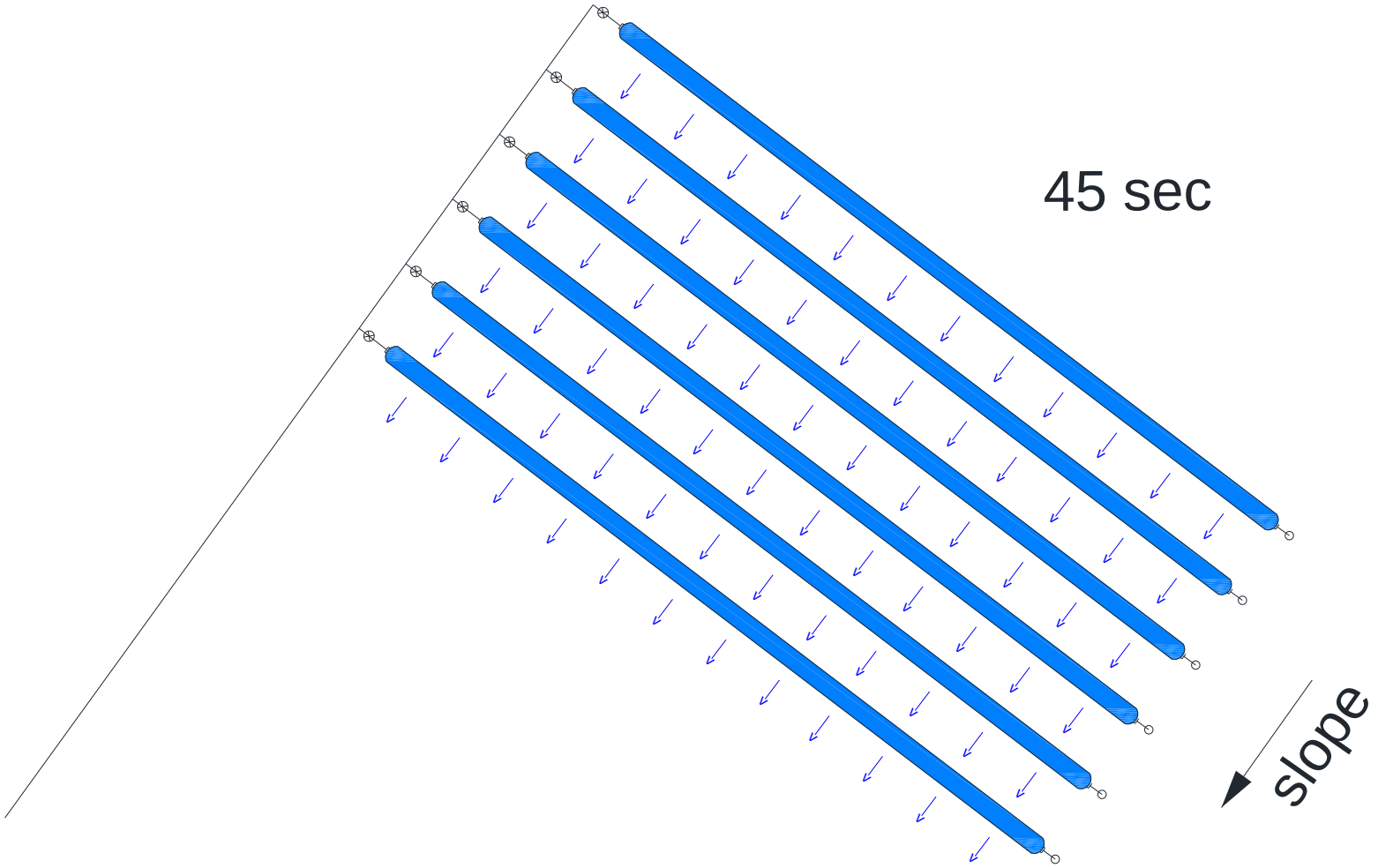

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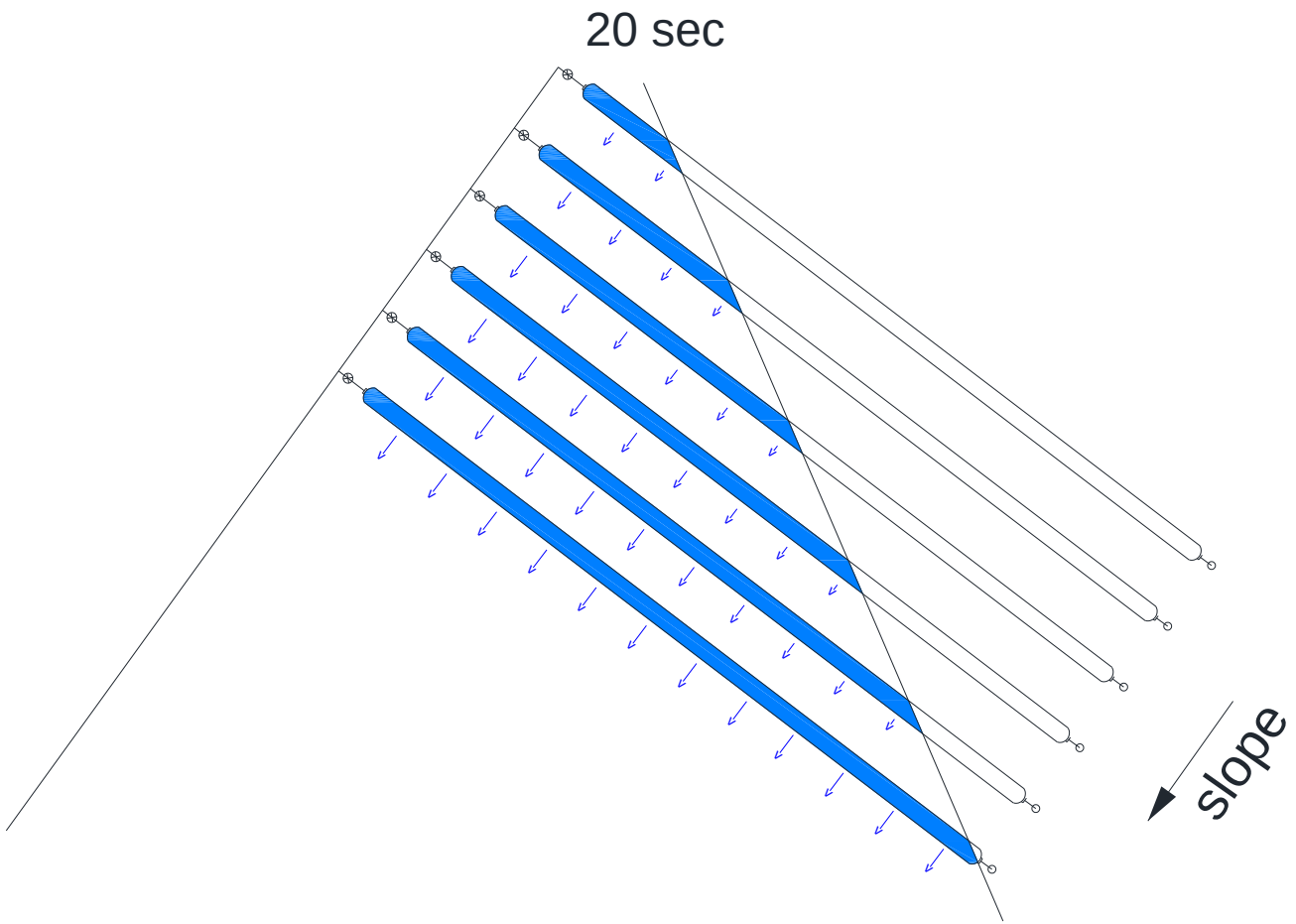
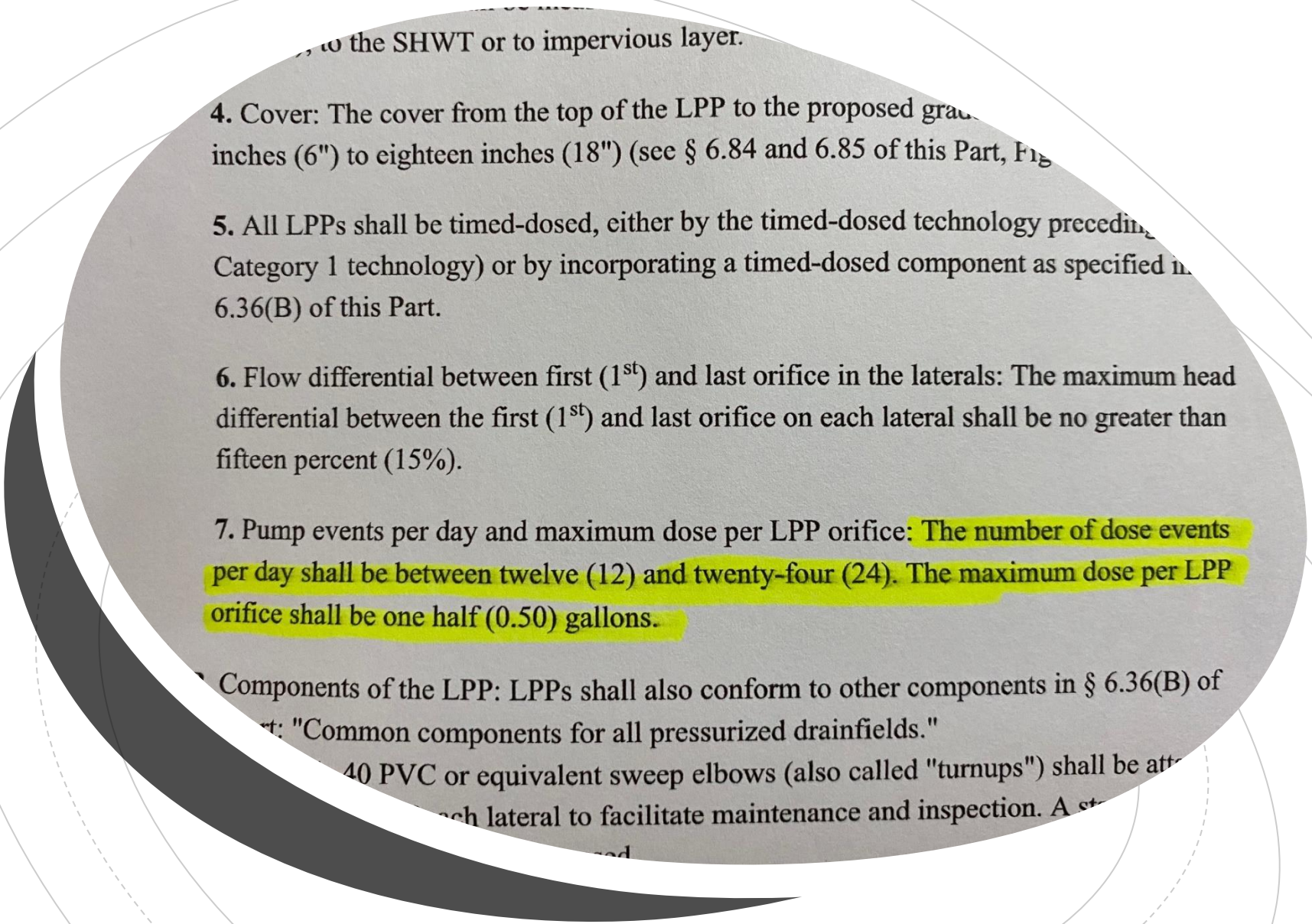


Q(gallons) @ time(minutes)

Line	1.0 min	2.0 min	3.0 min
1	2.0	8.7	15.4
2	2.3	9.0	15.7
3	2.8	9.5	16.2
4	3.6	10.3	17.0
5	4.6	11.3	18.0
6	5.8	12.5	19.2
Total	21.1	61.3	101.5
$\frac{Q_6 - Q_1}{Q_1}$	190%	44%	25%



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