NY-GEO 2024

APRIL 8-9 | ALBANY NY

To Vault, or Not to Vault:

When is a buried vault your best option?

Presenter: Joe Pejsa / Infra Pipe Solutions Ltd.

DESIGN TRACK - CEU CREDIT ELIGIBLE - 1:30 PM

Geothermal Valve Vaults

INTRODUCTION

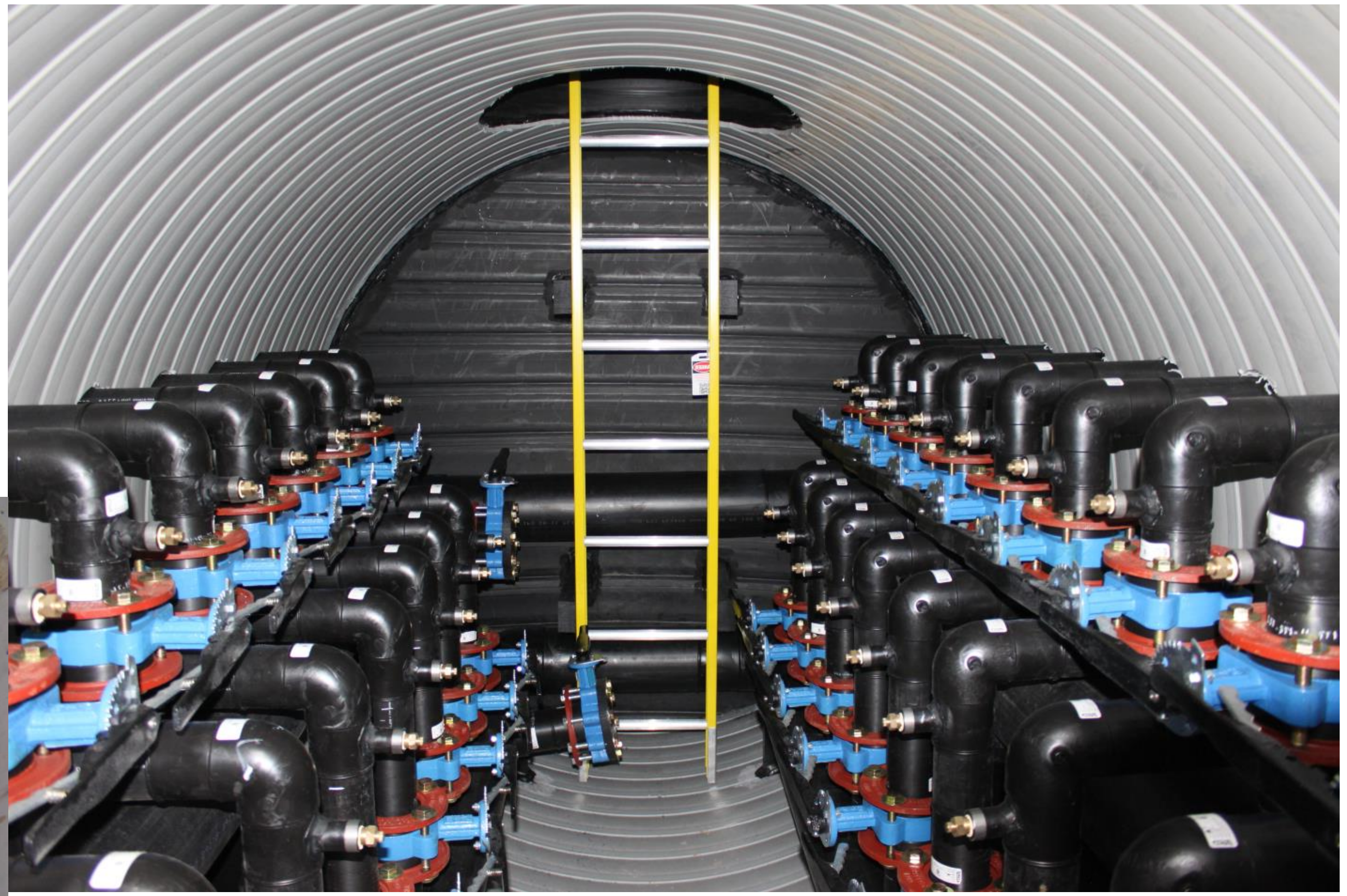
- Joe Pejsa
- Infra Pipe Solutions LTD
- Geothermal Vault Sales
- Infra Pipe Solutions (Formerly Uponor)
  - ISCO
  - GHP Systems
- 20 years working in the Ground Source Heat Pump industry. Primarily focused on Geothermal Valve Vaults/Well fields

WHAT IS A GEOTHERMAL VALVE VAULT

- An underground structure for locating the central manifold on a ground source heat pump project.

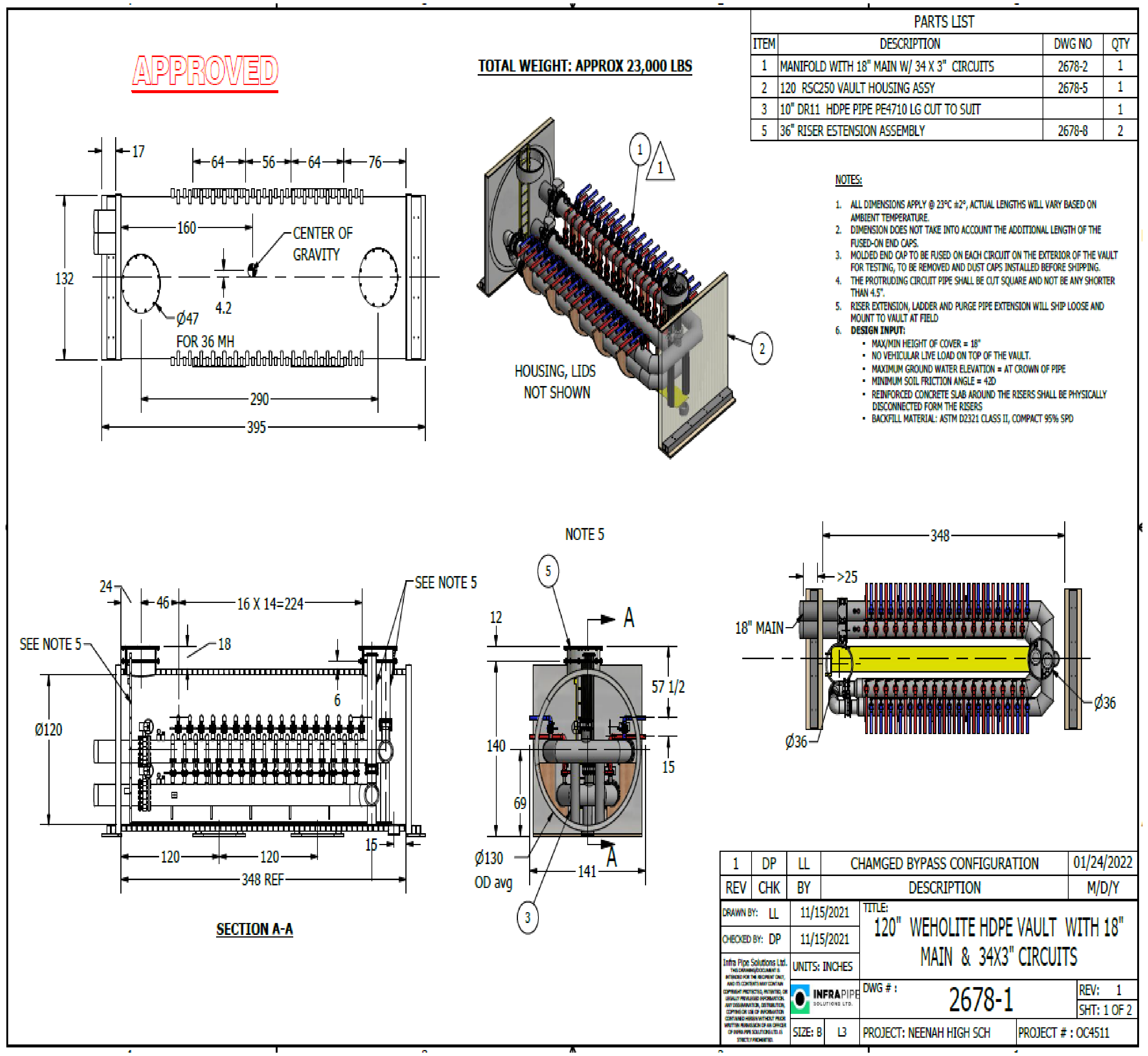
WHAT TYPES OF VALVE VAULTS ARE AVAILABLE?

- Typically we see 2 types
  - HDPE
  - Concrete



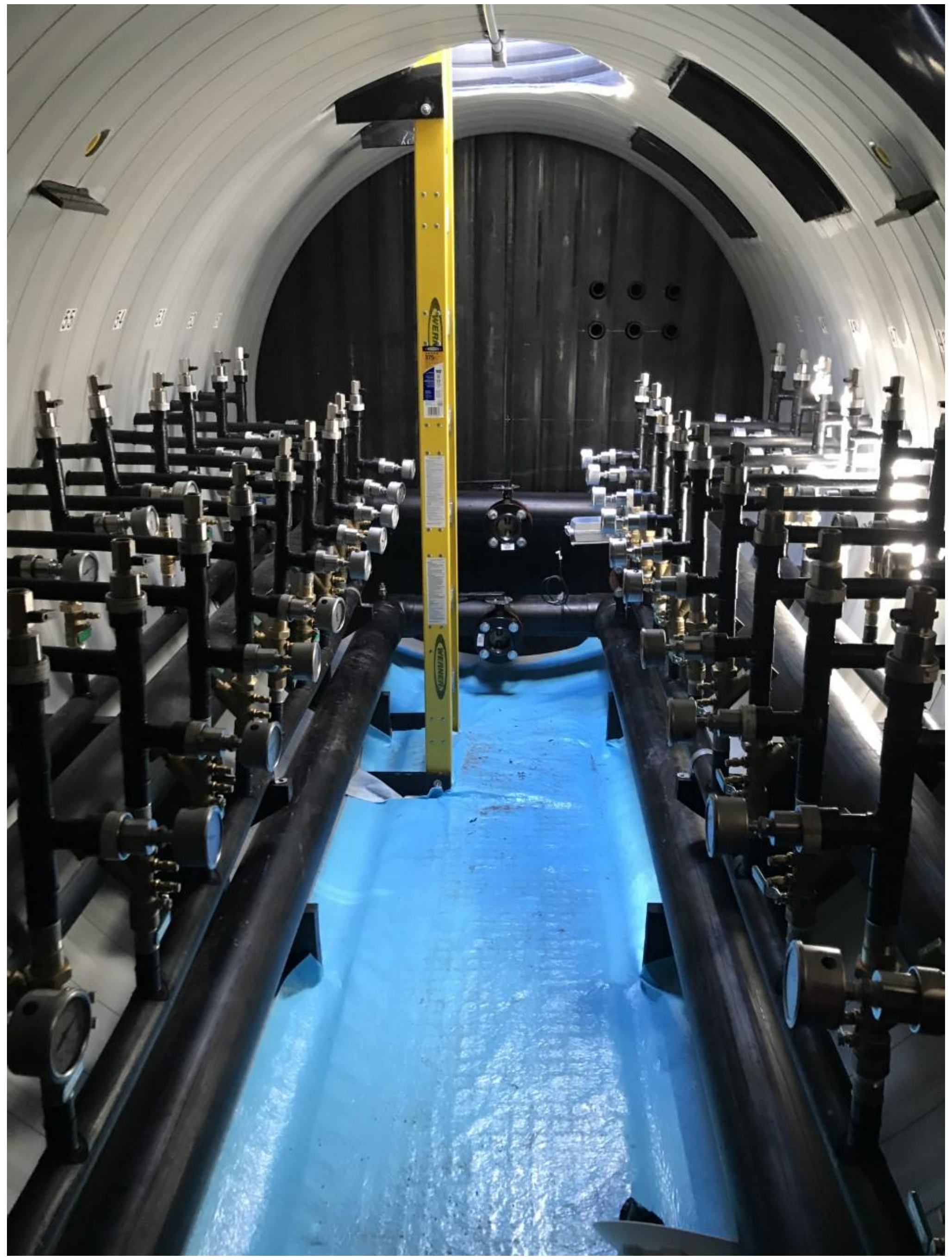
VAULT COMPONENTS

- Some common accessories
- Electric
  - –Lights
  - –Outlets
- Sump Pit with/without Pump
- Ventilation Fan
- OSHA Ladder
- Slip resistant grated floor
- Two manways
  - –One for flushing and purging



WHAT TO AVOID INSIDE A VALVE VAULT

- Keep it simple
  - –Put as many bores together as possible on circuit.
  - –The cost is extremely high when individual lines are brought into a vault.
  - –No internal heaters
  - –Ventilation fans need to be stored in the Maintenance room.
    - •Rust and OSHA

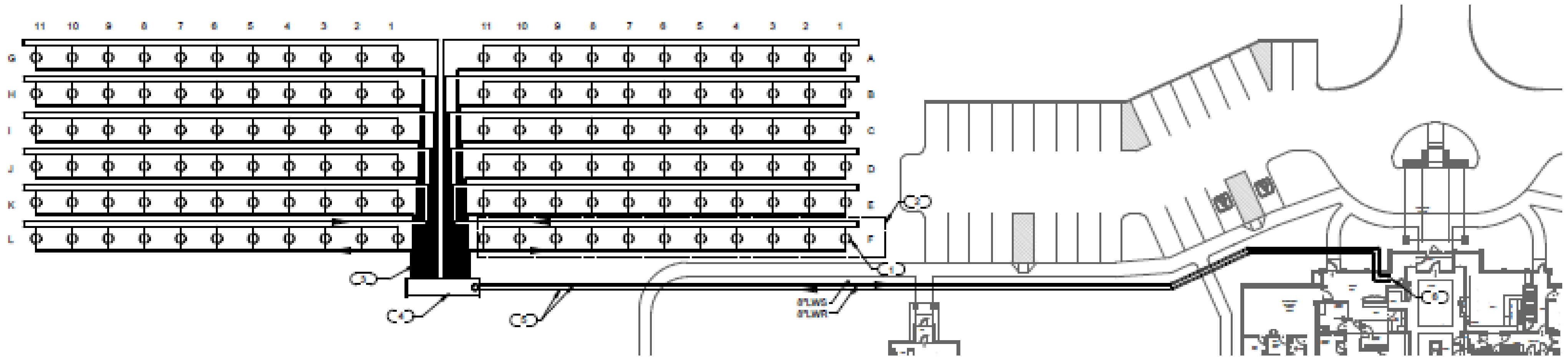


Topics for Discussion

- Where is the Location of the Geothermal Vault?
- Is there an issue with the Water Table?
- Are there Underground Utility issues?
- What are the savings?
- What is the expense?
- Does it Need to be H20 rated?

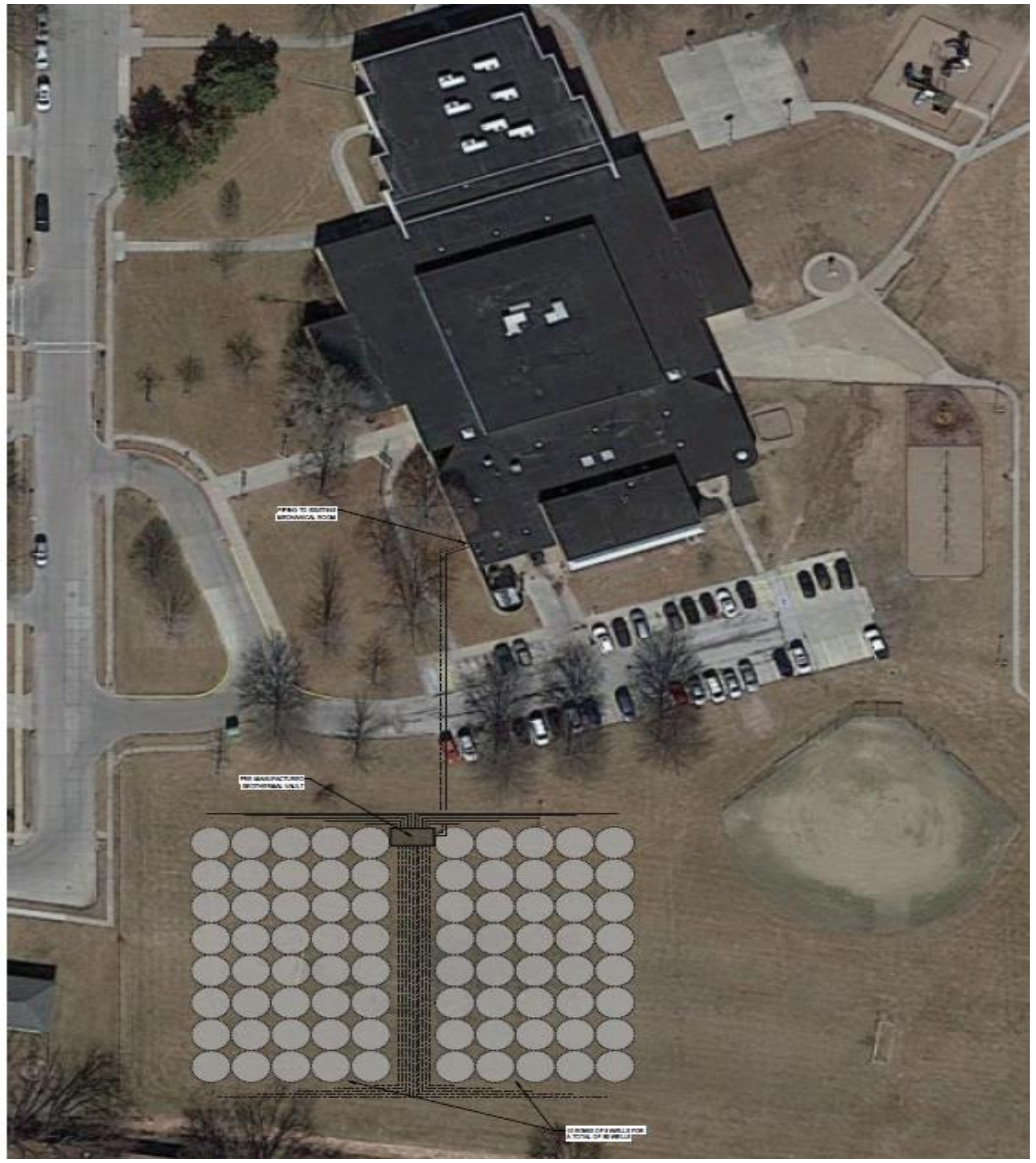
MOST COMMON QUESTION I RECEIVE

- HOW CAN I DETERMINE IF A VAULT IS NEEDED OR NOT?
- Answer, It depends on the project
  - –New build with lots of room
  - –Existing building with old boiler room
  - –Existing building with tons of utilities around the building
  - –Location of the well field
    - Distance to the building

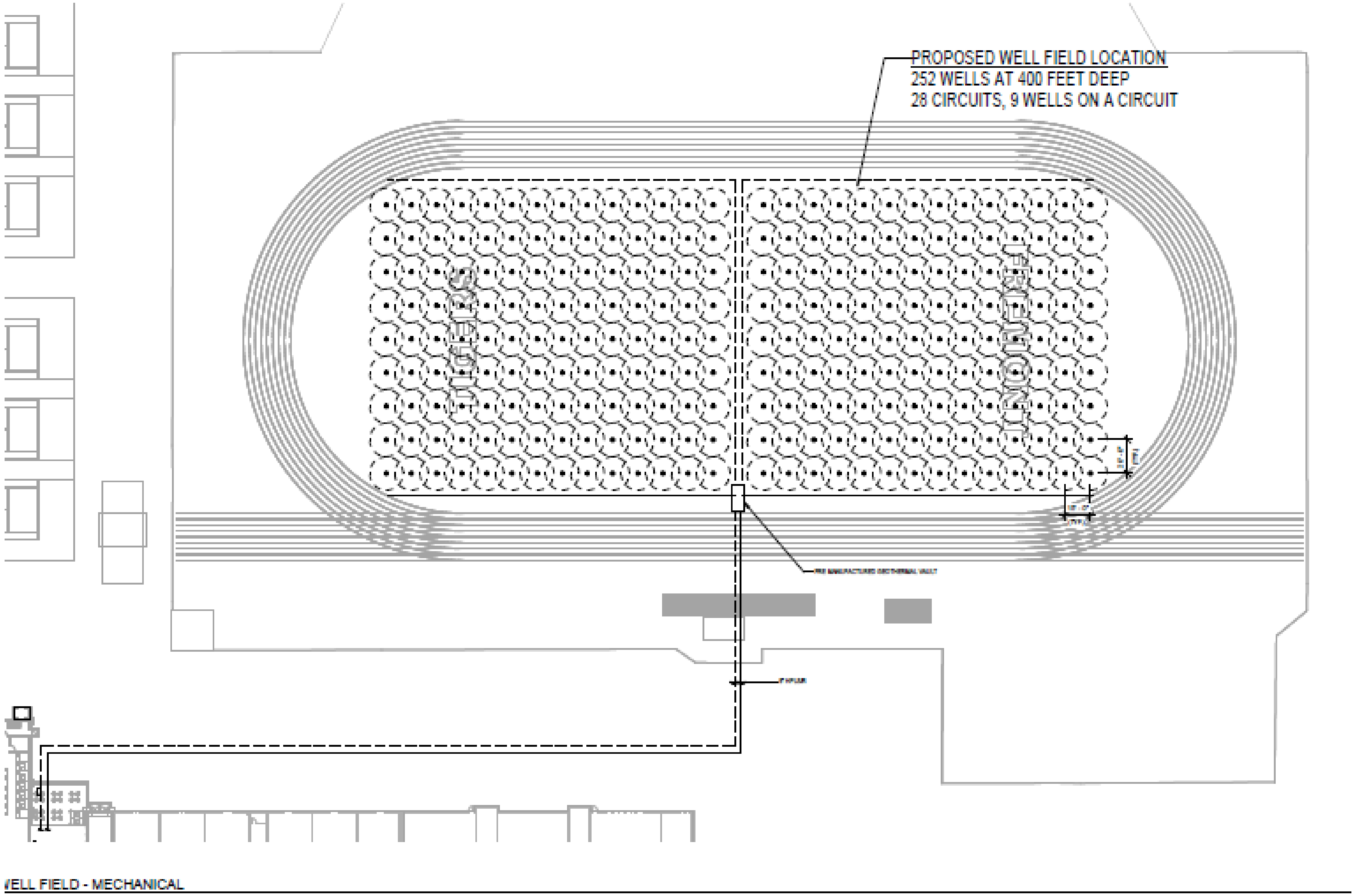


LOCATIONS FOR A VAULT

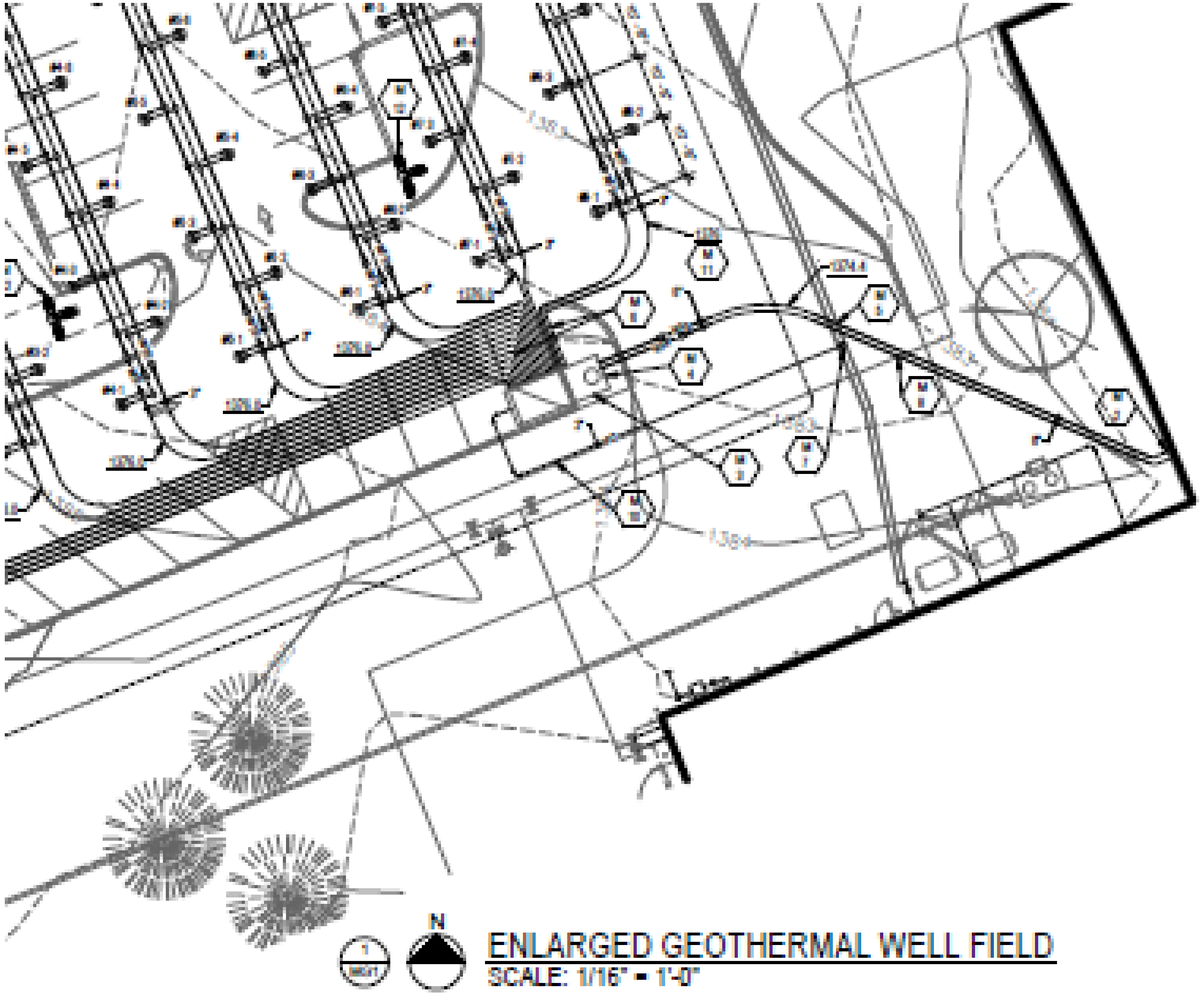
- –Parking lot
- –Grassy field
- –Athletic field
  - •Soccer
  - •Football
  - •Baseball



FOOTBALL/TRACK FIELD



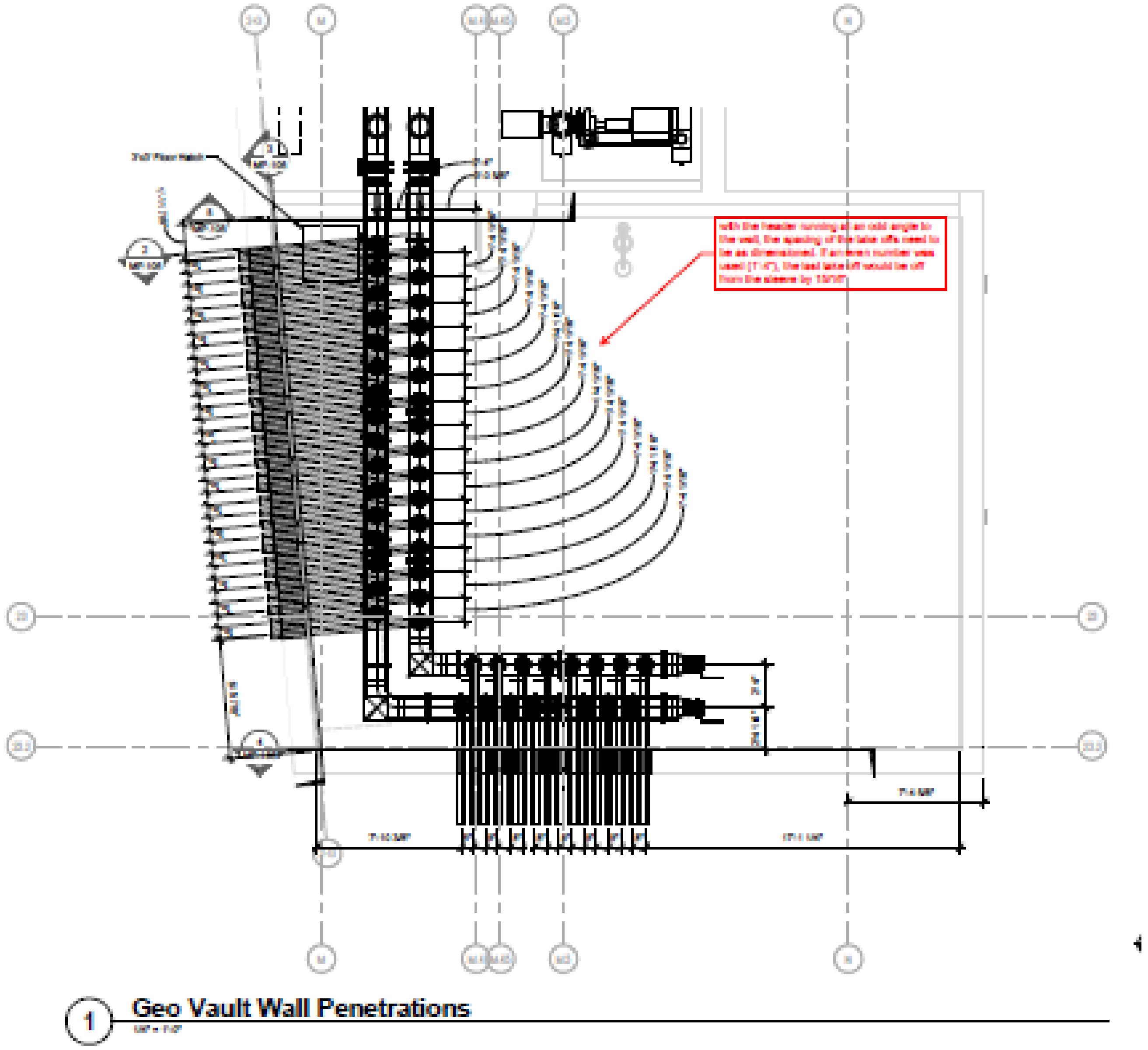
ISLAND LOCATION IN PARKING LOT



ENLARGED GEOTHERMAL WELL FIELD
SCALE: 1/16" = 1'-0"

MANIFOLD LOCATIONS

- Inside building, Crawl Space, or Separate Structure.
  - –How much space is available?



MANIFOLD LOCATIONS

- In the Parking Garage.

ANTI FLOATATION

- Is the water table high enough that we need to consider Anti-flotation?
- Is there a need for a sump pump and sump basin?

Assumptions

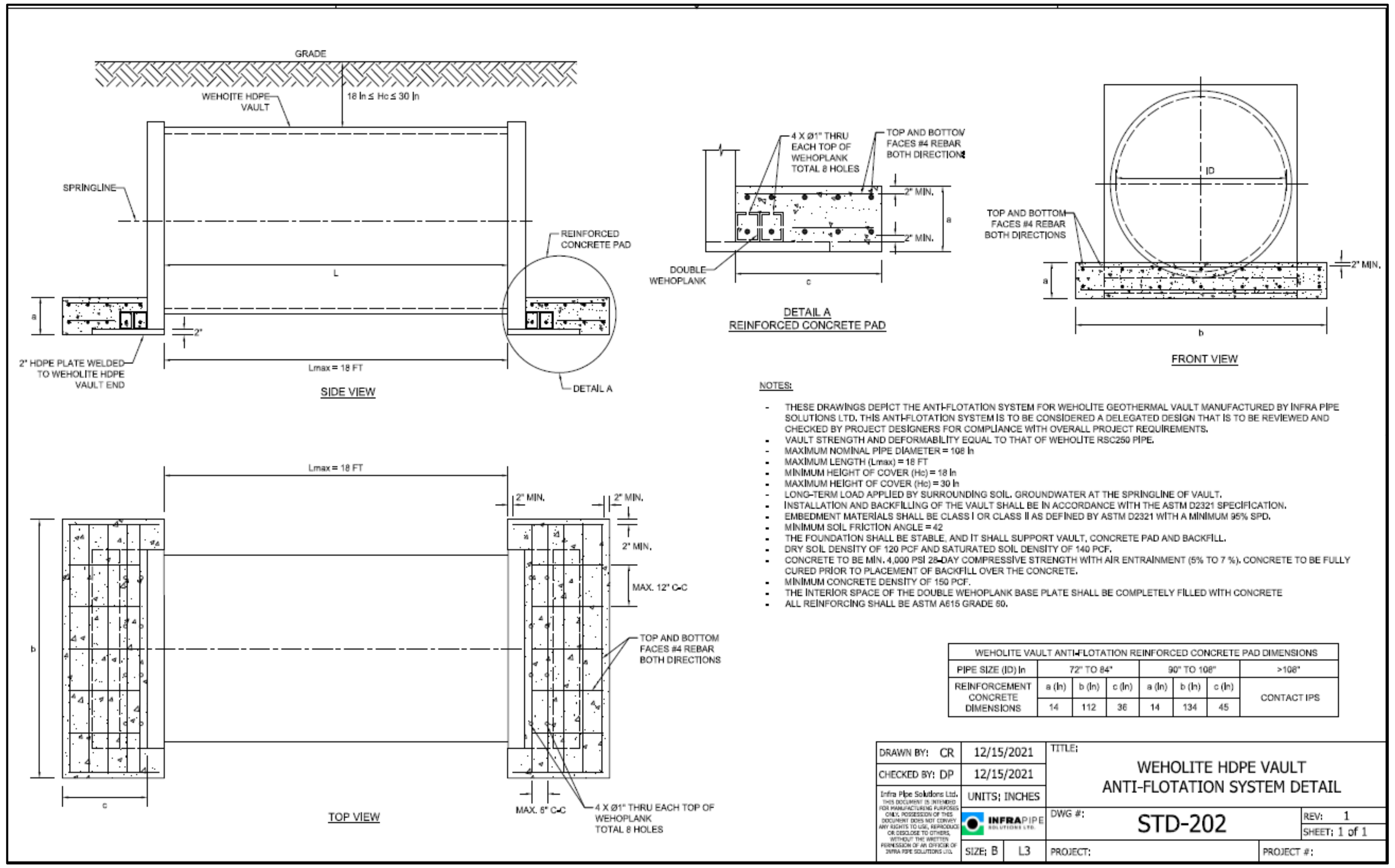
Size = 120" RSC250
length = 30 ft
Height of cover = 30"
Maximum ground water elevation = at crown of pipe
γ_w= Density of water = 62.4 lb/ft^3
γ_d= Density of dry soil = 120 lb/ ft^3
γ_s= Density of saturated soil = 140 lb/ ft^3
γ_{sb}= Density of submerged soil = 77.6 lb/ ft^3
γ_c= Density of concrete = 150 lb/ ft^3
γ_{cb}= Density of submerged concrete = 87.6 lb/ ft^3

Buoyancy Check of the Vessel

Pipe Key	=	66		
L	=	30	ft	Vessel Length
Hc	=	2.50	ft	Height of cover above structure
Hw	=	2.50	ft	Depth of water table below grade
ID	=	120	in	Pipe ID
RSC	=	250		Ring Stiffness Constant
OD	=	130.24	in	Pipe OD
OD	=	10.85	ft	
A'	=	0.00	ft^2	Non-submerged area
ρ d	=	120	lbs/cuft	Density of dry soil
ρ s	=	140	lbs/cuft	Density of saturated soil
ρ g	=	62.4	lbs/cuft	Density of the groundwater
Fb	=	173200.57	lbs	Buoyant force on structure (Up)
Wp	=	8141.80	lbs	Weight of structure
Wd	=	97683.07	lbs	Weight of dry soil above structure
Ws	=	29426.59	lbs	Weight of counteracting saturated soil
		216551.47	lbs	Total Force (Down)
		81300	lbs	Extra weight required to achieve a SF of 1.25
N'	=	1.25		Safety factor against flotation

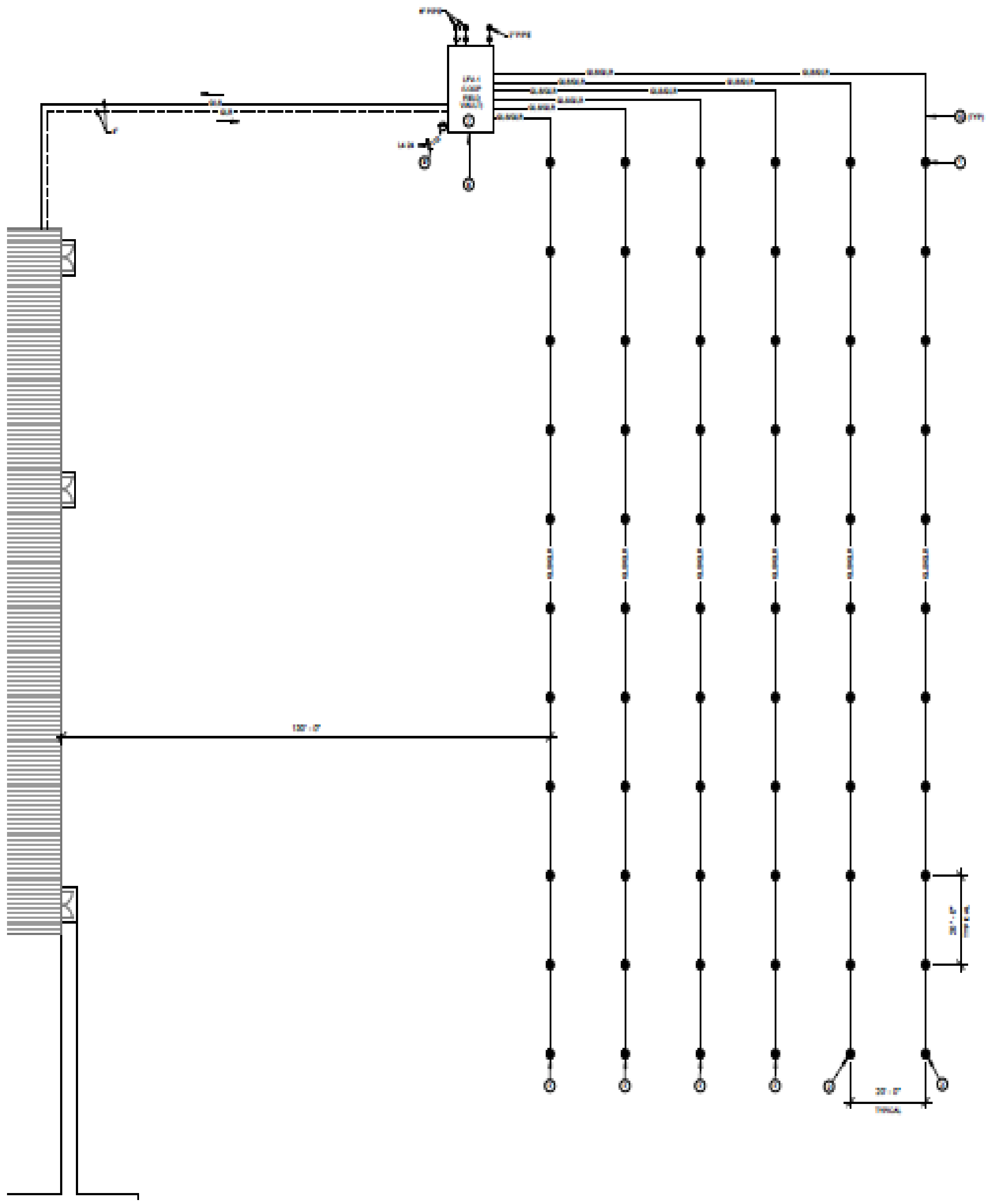
Note:

- Total extra weight required to achieve a safety factor of 1.25 = 81300 lb
- Middle reinforced concrete base contribution = 29810 lbs
- End Cap Anti-Flotation system contribution = 51490 lbs



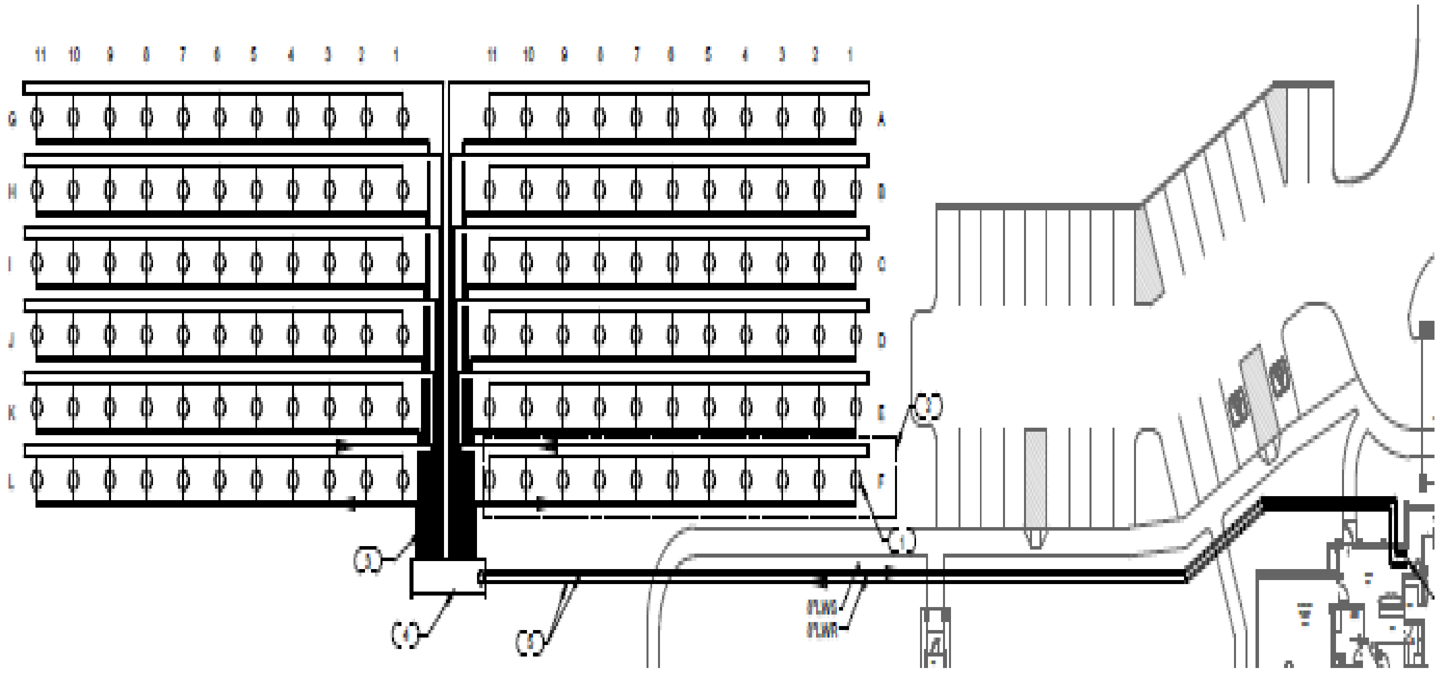
LOOKING AT THE DESIGN

- Is the design optimal?
- Does design make sense?
- How much diversity are we after?
- Options
  - –3 circuits of 22 bores?
  - –6” main with 3-3”?
  - –Does this now fit in the mechanical room



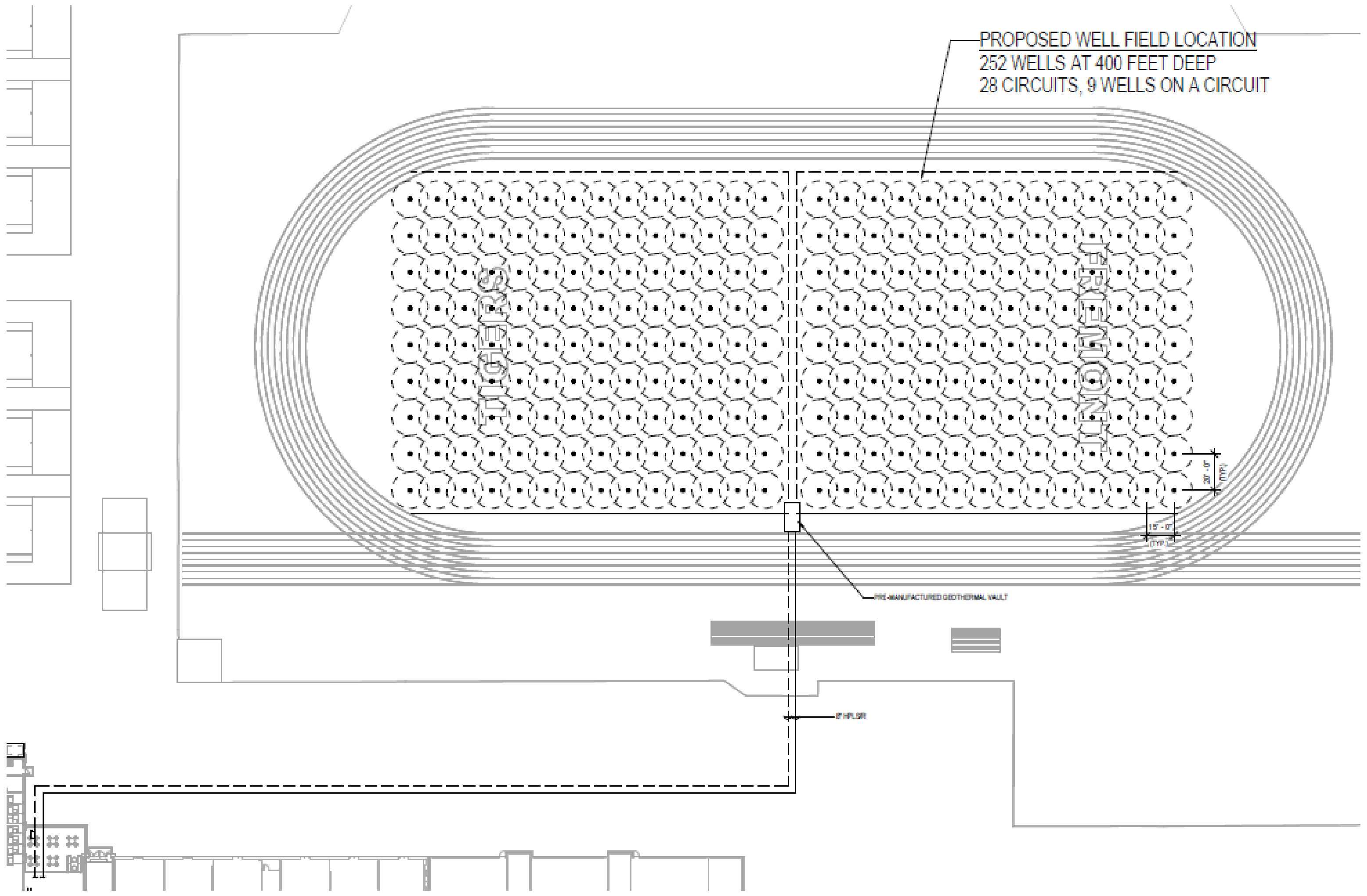
LOOKING AT THE DISTANCE

- How far to the building? 420’ on this one.
- Is it still feasible to do an interior manifold?
  - –840’ of 8” DR 15.5
  - –Volume 1900 gallons
  - –10080’ of 2” DR 11
  - –Volume 1550 gallons
  - –Labor to install
  - –Size of trench
  - –Price of glycol



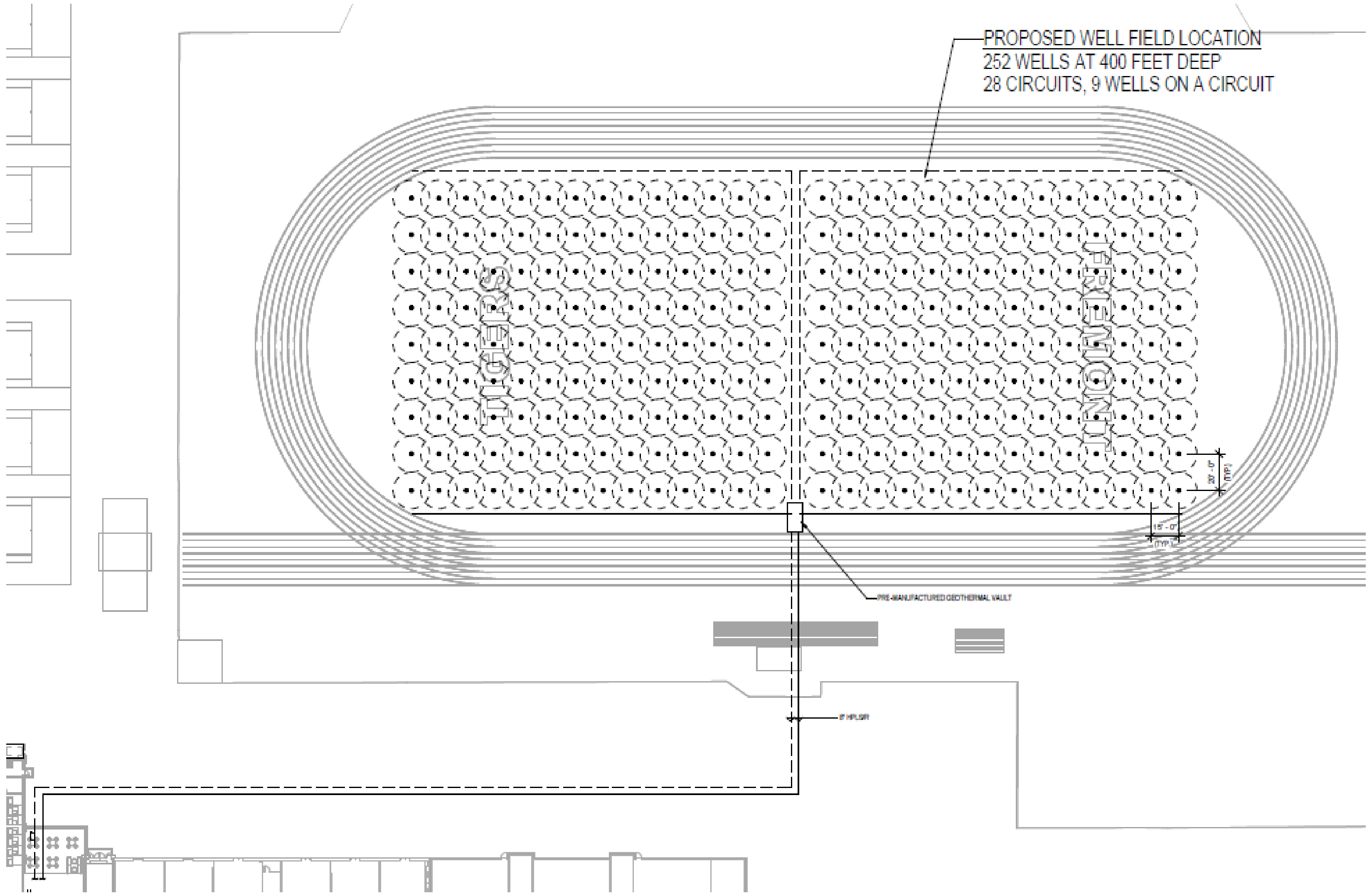
LOOKING AT THE DISTANCE

- How far to the building? 650’ on this one
- Is it still feasible to do an interior manifold?
  - –1300’ of 8” DR 15.5
  - –Volume 2650 gallons
  - –36400’ of 2” DR 11
  - –Volume 5600 gallons
  - –Labor to install
  - –Size of trench
  - –Price of glycol



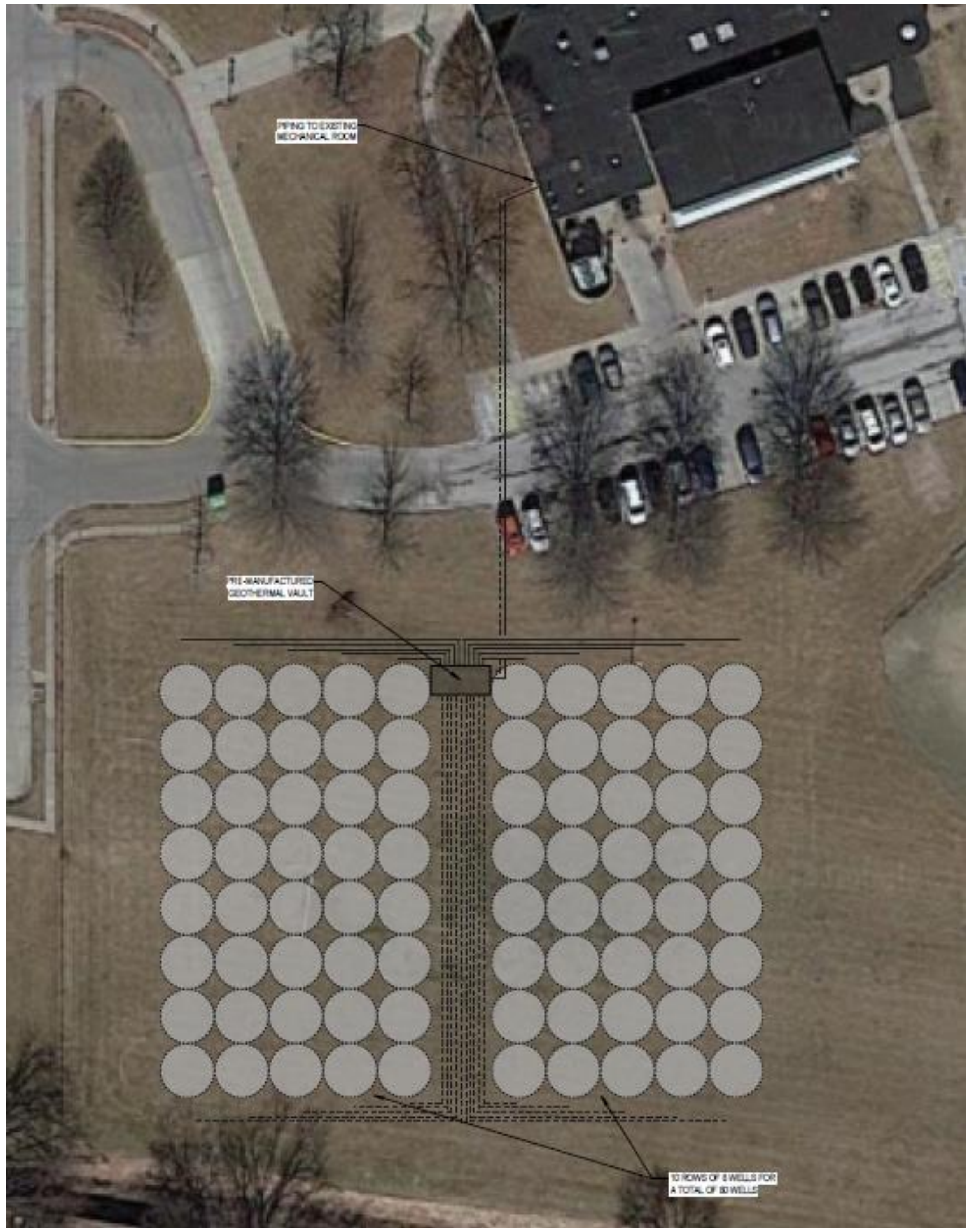
LOOKING AT POSSIBLITIES

- 14 – 3" CIRCUITS 18 – 1" LOOPS
- What does that change?
  - –1300' of 8" DR 15.5
  - –Volume 2650 gallons
  - –18200' of 3" DR 15.5
  - –Volume 6900 gallons
  - –Cost of the Vault



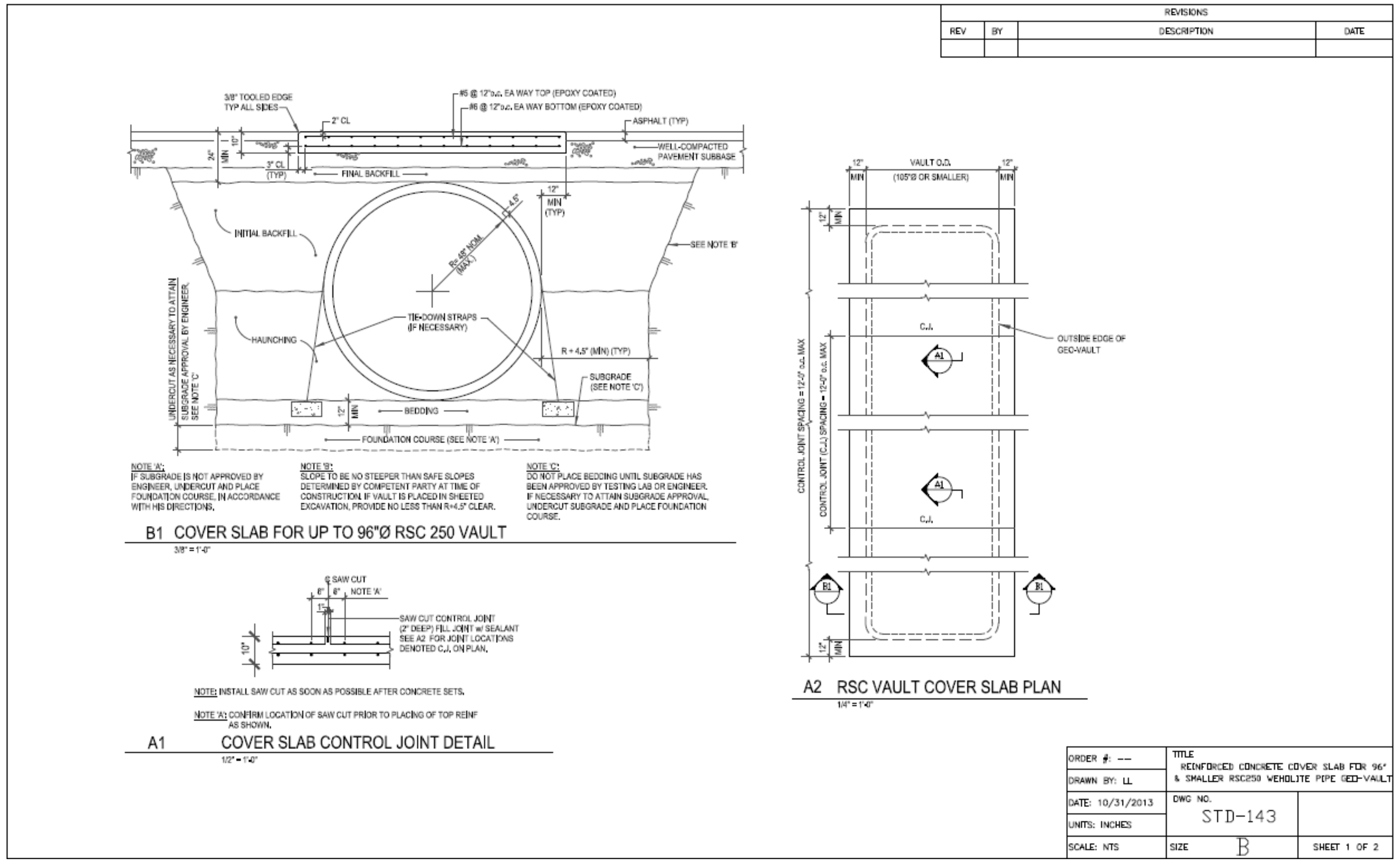
EXISTING BUILDING

- What are the constraints?
  - –Size of the existing mechanical room
  - –Number of utilities outside the mechanical room
  - –Crawl space before you get to mechanical room



H20 LOAD RATING

- Can HDPE be load rated?
  - –Yes
  - –Depending on Burial Depth
    - •30 inches
    - •Concrete pad for shallow cover 18 inches or less.



AASHTO LFRD CALCULATOR

INFRAPIPE

AASHTO LRFD CALCULATOR FOR WEHOLITE PROFILE-WALL HDPE PIPE, VERSION 1.1

In the absence of detailed site and installation conditions, IPS makes assumptions about the loading and support conditions. The reviewer (EOR, Design Engineer, Consulting Engineer etc.) shall examine the analysis to ensure that IPS assumptions are reasonable and applicable to particular project.

PROJECT: 84in RSC250
OC#: OC 4011
DATE: 11/23/2021
COMPUTED BY: AT

INPUTS

ID =	84	in	ID of Weholite profile-wall HDPE pipe.
RSC =	250		Ring stiffness class.
Hc =	1.7	ft.	Depth of fill over top of pipe (used for dead load calculations)
Hw =	3.8	ft.	Depth of water over springline (centerline of the pipe = 0).
Yw =	62	lb/ft^3	Unit weight of water.
Ys =	120	lb/ft^3	Ave wet soil density.
v=	0.3		Poisson's ratio of soil.

Soil type and compaction level to calculate the secant constrained modulus of elasticity (Ms). AASHTO LRFD Table 12.12.3.5-1

Class II, Gravelly Sand (GW, GP, SW, SP), 95%

Ms=	2127	psi	Infra Pipe Solutions calculator assumes the native material is at least as strong as the intended backfill material. Soil classification is in accordance to ASTM D2321.

Backfill and compaction level to calculate the shape factor Df . AASHTO LRFD Table 12.12.3.10.2b-1

Gravel, GW, GP, GW-GC, GW-GM,GP-GC and GP-GM per ASTM D2487 (includes crushed rock) Moderate to High (>=85% SPD)

Df=	5.07		
Es=	110000	psi	Short term modulus of pipe material . AASHTO LRFD Table 12.12.3.3-1
El =	21000	psi	Long term modulus of pipe material. AASHTO LRFD Table 12.12.3.3-1, ASTM F894, 335434C Cell Class
εyc=	0.041		Factored compression strain limit of the pipe wall material as specified in Table 12.12.3.3-1 , 4.1%
εyt=	0.05		Service long term tension strain limit of the pipe wall material as specified in T 12.12.3.3-1 , 5%
YEV =	1.30		Earth load factor (see table 3.4.1-2 LRFD)
YWA =	1.00		Water load factor (see table 3.4.1-1 LRFD)
YLL =	1.75		Live load factor (see table 3.4.1-1 LRFD)
KYE=	1.50		Installation factor for earth load, LRFD Section 12-75. Installation Factor typically taken as 1.5 to provide traditional safety. For installations where detailed construction controls are implemented, designers may reduce the installation factor to values as low as 1.0. This will allow increases in depths of fill. Construction controls include monitoring of backfill materials, compaction levels during construction, and of deflection during sidefilling, backfiling, and after construction.The reviwer shall notify IPS if assumed value of installtion factor is appropriate for particular project.
ηEV =	1.05		Earth load modifier as specified in Article 1.3.2. AASHTO LRFD
ηLL =	1.00		Live load modifier as specified in Article 1.3.2. AASHTO LRFD
Φs =	0.90		Resistance factor for soil stiffness AASHTO LRFD T.12.5.5-1
ΦT =	1.00		Resistance factor for thrust effects AASHTO LRFD T.12.5.5-1
Φbck =	0.70		Resistance factor for buckling capacity AASHTO LRFD T.12.5.5-1
Φf=	1.00		Resistance factor for flexure AASHTO LRFD T.12.5.5-1
Kwa=	1.30		Factor for uncertainty in level of ground water table (AASHTO LRFD 12.12.3.8) . The designer may use the factor Kwa with values up to 1.3 to account for this uncertainty or may select conservative values of Hw with a lower value of Kwa but not less than 1.0.
K2top=	0.6		Coefficient to account for variation of thrust around circumference. AASHTO LRFD , 12-75
K2spr=	1		
k =	4		Plate buckling coefficient k=4 for for supported elements
Kb=	0.1		Bedding coefficient , a value of 0.10 is typical. AASHTO LRFD , 12-72
Dl=	1.5		Deflection lag factor, a value of 1.5 is typical. AASHTO LRFD, 12-79
Cn=	0.55		Calibration factor for non-linear effects in the global bucklin equation = 0.55 (dimensionless)

INFRAPIPE

AASHTO LRFD CALCULATOR FOR THERMOPLASTIC CULVERTS / WEHOLITE PROFILE-WALL HDPE PIPE

	Design Truck		
WL =	16,000	lbs.	The vehicular live load consists of a combination of the design truck or design tandem, and the design lane load. A design lane load is ignored in the calculation.
WL =	Design Tandem		
	12,500	lbs.	
	1		Number of loaded lanes
	1.20		Multiple presence factor.
Lt=	0.833	ft	Length of wheel contact area.
Wt =	1.667	ft	Width of wheel contact area .
LLDF=	1.15		Live load distribution factor.
Sw =	6	ft	Design Truck — Center to center spacing of wheels on one axle
Sa =	14	ft	Center to center spacing of wheels on adjacent axles
Sw =	6	ft	Design Tandem — Center to center spacing of wheels on one axle
Sa=	4	ft	Center to center spacing of wheels on adjacent axles

OUTPUTS

Live load pressure applied to the pipe crown (psi)	Pl=	61.397
Hydro static pressure (psi)	Pw=	2.16
Vertical soil pressure (psi)	Psp=	1.85

Flexibility factor, shall not exceed 95 (in/kip)	FF=	24.16	PASS

Factored compressive strain due to thrust	εuc=	2.03%	Thrust Strain
Resistance factor for thrust effects	ΦT=	1.00	
Factored compression strain limit of the pipe wall material	εyc=	4.10%	
Factored compressive strain due to thrust shall satisfay		εuc ≤ Φt *εyc	PASS

Factored compressive strain due to thrust	εuc=	2.03%	Global Buckling
Resistance factor for global buckling	Φbck=	0.70	
Nominal strain capacity for global buckling	εbck=	12.16%	
Factored compressive strain due to thrust shall satisfay		εuc ≤ Φbck *εbck	PASS

Factored compressive strain due to thrust	εuc=	2.03%	Combined Strain
Flexural strain due to flexure	εf=	1.06%	
Service limiting tensile strain of the pipe wall material	εyt=	5.00%	
Service compression strain limit of pipe wall material	εyc=	4.10%	
Resistance factor for flexure	Φf=	1.00	
Combined strain-tension		εf- εuc< Φf *εyt	PASS
Combine strain - compression		εf+εuc< Φf *1.5*εyc	PASS

Total deflection (in)	Δt=	2.87	Deflection (service limit state)
Deflection as a percentage of diameter	Δt/D=	3.12%	
Deflection requirement. Typicaly taken as 5% .		Δt ≤ Δa (5%)	PASS

The calculator is based on the AASHTO LRFD Bridge Design Specification.

Weholite is profile wall pipe manufactured in accordnace to ASTM F894 - Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe. Weholite is certified by 3rd party auditors (NSF, BNQ) to confirm that the requirements of ASTM F894 are met.

Infra Pipe Solutions makes no warranty or representations as to the accuracy of the information contained herein. By using any of the information contained herein, the user agrees said information is being provided for convenience only, without any warranty or guarantee of any kind whatsoever, and the information is being accepted and used at the user's sole risk. Use of this pipe burial report is not intended to replace the evaluation and judgement of a professional engineer in determining the suitability of a pipe for a given project as the methodology herein may not accurately represent the site conditions or be inclusive of all parameters that must be considered.

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Summarizing

- How far is the loopfield from the Mechanical?
- Are there any outside features obstructing access to the Mechanical?
  - Parking lot, Water Feature, Existing building Utilities
- How much space is available for manifolding inside the Mechanical?
- What is the volume of fluid needed using a vault vs interior manifold?
- What do the economics look like?
- Where is the water table?
- Is H20 load rating required?

QUESTIONS AND DISCUSSION

- I feel like each project is unique and there are many determining factors to whether or not a Geothermal vault is the correct answer for a specific project.
- Questions?

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