

**CEEn-2018CPST-009**

# Sewer System Consolidation

## Team Invictus



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# Introduction

- **Project Tasks and Deliverables**
- **Design and Analysis**
- **Discussion of Results**
- **Conclusions**
- **Recommendations**

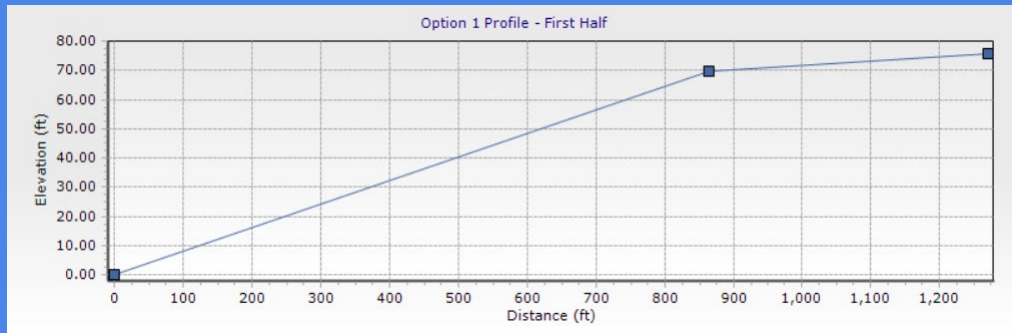
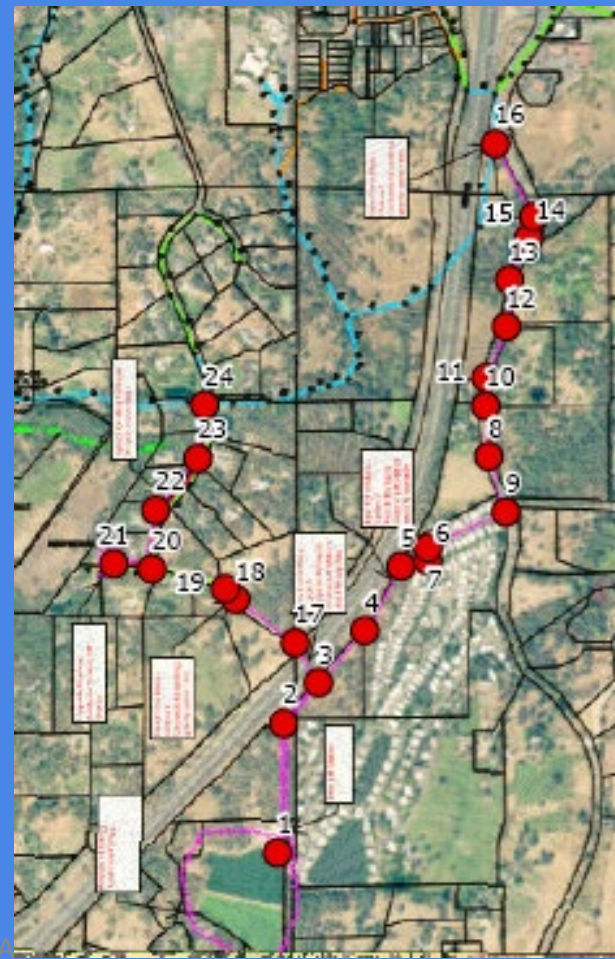


## Project Tasks and Deliverables

- **Evaluate the following through calculations and WaterCAD analysis:**
  - Multiple sewer force main pipe alignments
  - Multiple existing sewer lift station upgrades
  - Multiple new sewer lift station options
- **Determine the most economical project through performing a cost analysis**

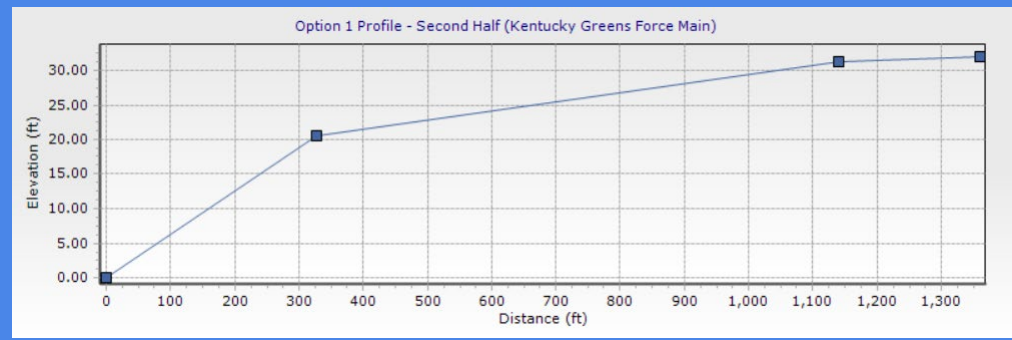
# Design and Analysis

## ELEVATION DATA



**Option 1 - Initial hill and under I-80**

**Option 1 - Kentucky Greens force main**



**Option 2 - Entire stretch**



# Design and Analysis Cont'd

## FLOW DATA

Kentucky Green Flow Data					
Pipe Size	6	Inches	-	0.5	ft
Area	0.196	ft <sup>2</sup>	Area	0.196	ft <sup>2</sup>
Minimum Velocity	2	ft/s	Minimum Velocity	6	ft/s
Q(flow)	0.393	ft <sup>3</sup> /s	Q(flow)	1.178	ft <sup>3</sup> /s
	176	gpm		529	gpm
	253808	gpd		761424	gpd

Pump Definitions		
-	Design Flow (gpm)	Design Head (ft)
Option 1A - crest	157	81.6
Option 1B - KG forcemain	167	81.7
Option 2	157	224.2

New Lift Stations			New Lift Stations		
Pipe Size	4	in	Pipe Size	4	in
	0.333	ft		0.333	ft
Area	0.087	ft <sup>2</sup>	Area	0.087	ft <sup>2</sup>
Minimum Velocity	2	ft/s	Minimum Velocity	6	ft/s
Q(flow)	0.175	ft <sup>3</sup> /s	Q(flow)	0.524	ft <sup>3</sup> /s
	78	gpm		235	gpm
	112804	gpd		338411	gpd

Kentucky Greens Assumptions for Flow		
Homes	14	-
People Per Home	4	-
Flow Per Person	200	gpd
Total Flow	11200	gpd
	7.78	gpm
* Rounded to 10 for low-ball error		

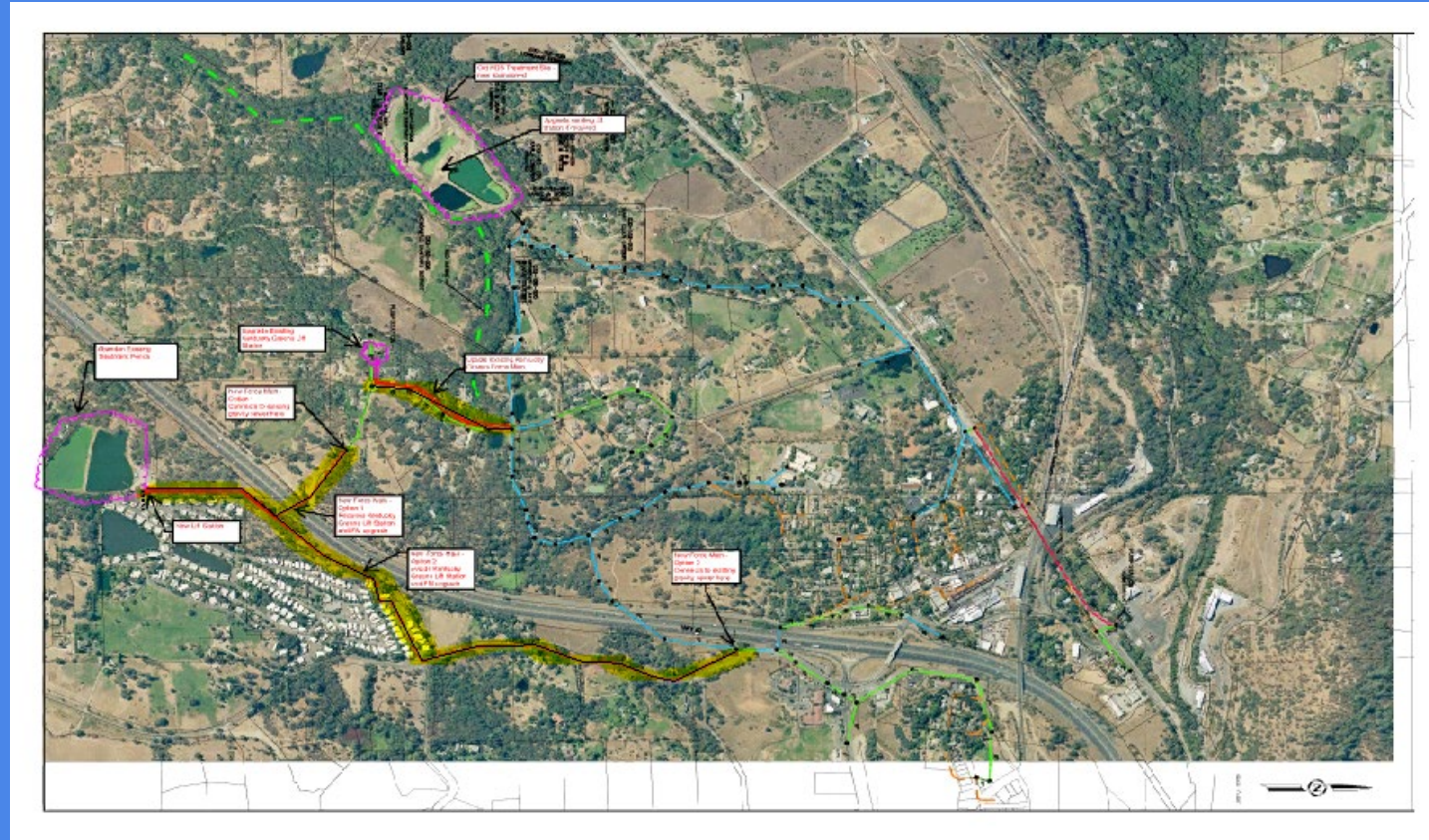
# Design and Analysis Cont'd

## MODELING

### Force main portions of Option 1

- Option 1A not feasible
- Option 1B a must

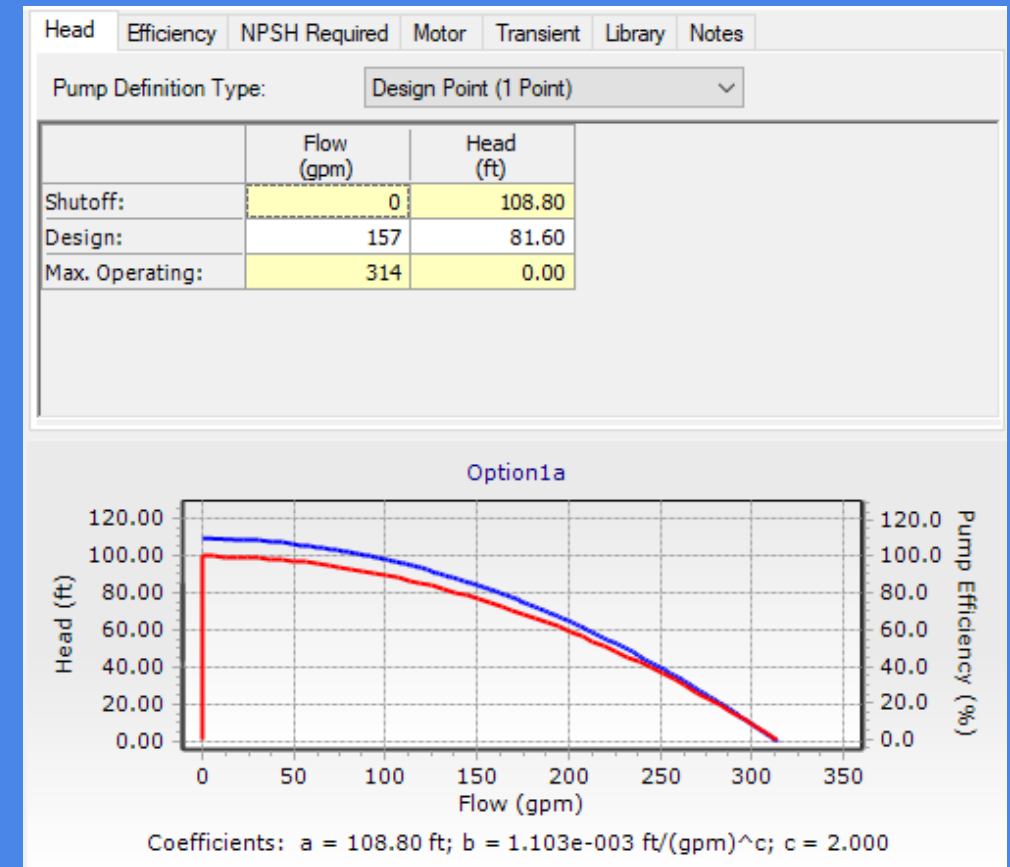
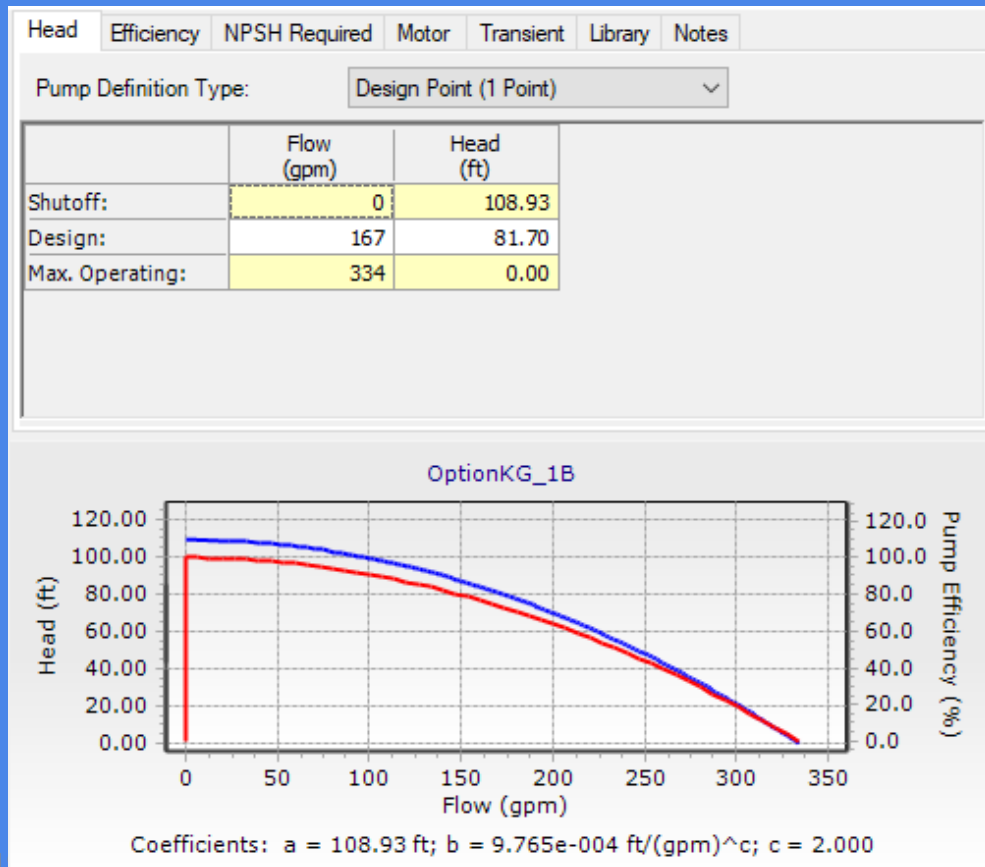
### All of Option 2



# Design and Analysis Cont'd

## MODELING cont'd

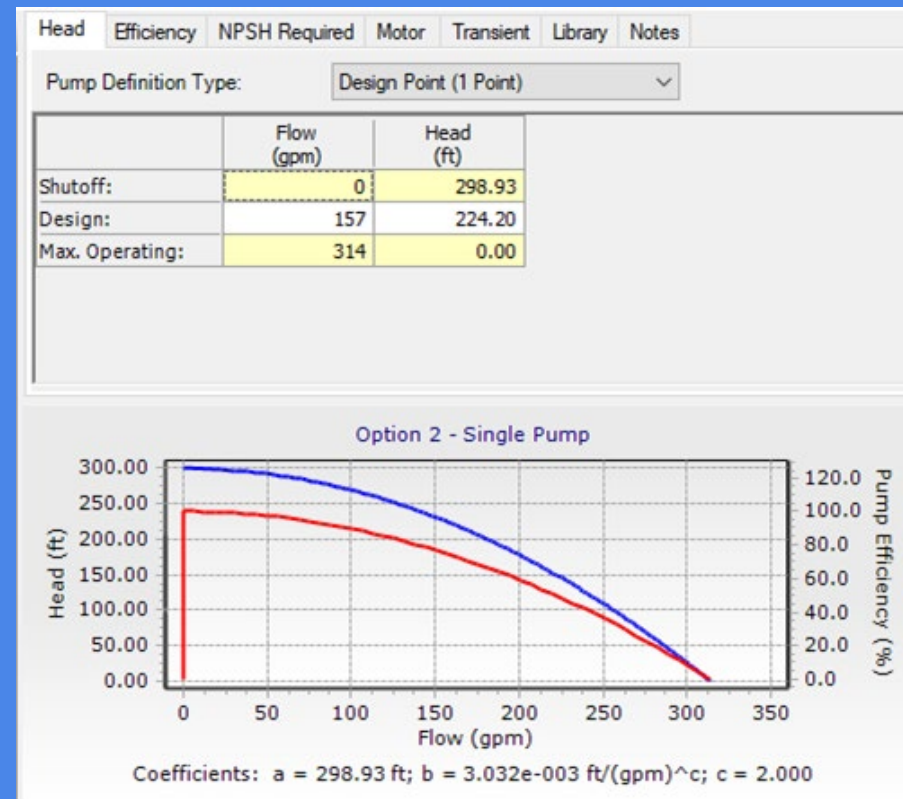
### Option 1



# Design and Analysis Cont'd

## MODELING cont'd

### Option 2





# Discussion of Results

## WaterCAD modeling of Option 1

- Velocities between 3 and 4 ft/s
- Pressures between 1 and 7 psi

Label ▲	Elevation (ft)	Pressure (psi)	Hydraulic Grade (ft)
J1.01	69.90	4	80.11
J1.02	20.60	7	37.25
J1.03	31.20	1	33.12

Label ▲	Velocity (ft/s)	Flow (gpm)	Length (Scaled) (ft)	Start Node	Stop Node	Diameter (in)	Material	Hazen-Williams C
P1.01	3.55	139	865	PMP1A	J1.01	4.0	PVC	150.0
P1.02	3.55	139	406	J1.01	T1A	4.0	PVC	150.0
P1.03	3.08	271	328	PMP1B	J1.02	6.0	PVC	150.0
P1.04	3.08	271	813	J1.02	J1.03	6.0	PVC	150.0
P1.05	3.08	271	220	J1.03	T1B	6.0	PVC	150.0

# Discussion of Results Cont'd

## WaterCAD modeling of Option 2

- Velocities at 4.15 ft/s
- Pressures between 15 and 60 psi

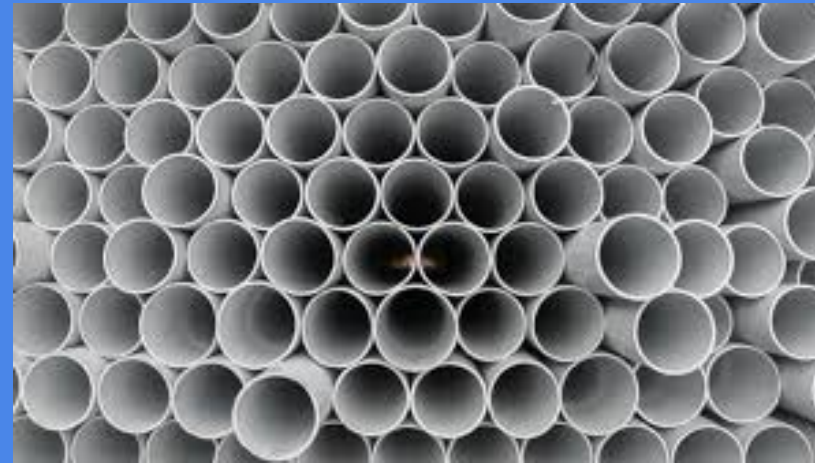
Label ▲	Elevation (ft)	Pressure (psi)	Hydraulic Grade (ft)
J2.01	70.00	60	208.62
J2.02	75.00	52	194.71
J2.03	73.00	50	187.65
J2.04	51.40	58	184.69
J2.05	51.10	57	183.26
J2.06	49.70	54	174.61
J2.07	57.50	48	167.33
J2.08	72.20	38	159.61
J2.09	94.90	25	153.11
J2.10	107.00	18	148.47
J2.11	107.50	16	143.65
J2.12	106.00	15	140.88

Label ▲	Velocity (ft/s)	Flow (gpm)	Length (Scaled) (ft)	Start Node	Stop Node	Diameter (in)	Material	Hazen-Williams C
P2.01	4.15	162	865	PMP2	J2.01	4.0	PVC	150.0
P2.02	4.15	162	983	J2.01	J2.02	4.0	PVC	150.0
P2.03	4.15	162	500	J2.02	J2.03	4.0	PVC	150.0
P2.04	4.15	162	209	J2.03	J2.04	4.0	PVC	150.0
P2.05	4.15	162	101	J2.04	J2.05	4.0	PVC	150.0
P2.06	4.15	162	612	J2.05	J2.06	4.0	PVC	150.0
P2.07	4.15	162	514	J2.06	J2.07	4.0	PVC	150.0
P2.08	4.15	162	546	J2.07	J2.08	4.0	PVC	150.0
P2.09	4.15	162	460	J2.08	J2.09	4.0	PVC	150.0
P2.10	4.15	162	327	J2.09	J2.10	4.0	PVC	150.0
P2.11	4.15	162	341	J2.10	J2.11	4.0	PVC	150.0
P2.12	4.15	162	196	J2.11	J2.12	4.0	PVC	150.0
P2.13	4.15	162	628	J2.12	T2	4.0	PVC	150.0

## Design and Analysis Cont'd

### COST ANALYSIS

- Preliminary report
- Estimates are conservative
- Based on provided examples
- Rates from recent cost trends



# Design and Analysis Cont'd

## OPTION 1 - Opinion of Probable Cost

No.	Item	Quantity	Unit	Unit Cost	Cost
1	Mobilization / Demobilization	10%	LS	\$ -	\$ 108,000.00
2	Sheeting, Shoring, and Bracing	5%	LS	\$ -	\$ 52,000.00
3	SWPPP and Erosion Control	1	LS	\$ 5,000.00	\$ 5,000.00
4	Excavation	1	LS	\$ 5,000.00	\$ 5,000.00
5	Dewatering	1	LS	\$ 5,000.00	\$ 5,000.00
6	Pre-Cast Concrete Wet Well (6-ft dia x 8-ft depth)	1	LS	\$ 15,000.00	\$ 15,000.00
7	Wet Well Lid and Access Hatch with Safety Grate	3	EA	\$ 8,000.00	\$ 24,000.00
8	Lift Station Valve Vault (6-ft L, 4-ft W, 6-ft D)	1	LS	\$ 15,000.00	\$ 15,000.00
9	Reinforced Concrete Footings / Equipment Slabs	10	CY	\$ 1,000.00	\$ 10,000.00
10	Yard Piping	1	LS	\$ 10,000.00	\$ 10,000.00
11	Sewer Pumps, Motors, and Accessories	4	EA	\$ 30,000.00	\$ 120,000.00
12	Pump Station Valves	20	EA	\$ 2,000.00	\$ 40,000.00
13	Inlet and Outlet Manholes	23	EA	\$ 2,400.00	\$ 55,000.00
14	PVC SDR Pipe 4-in dia (includes installation and backfill)	2200	LF	\$ 40.00	\$ 88,000.00
15	PVC SDR Pipe 6-in dia (includes installation and backfill)	2000	LF	\$ 50.00	\$ 100,000.00
16	Bore and Jack under I-80	200	LF	\$ 1,500.00	\$ 300,000.00
17	Site Improvements (fencing/wall, gate, pavement pad, shade cover, etc.)	1	LS	\$ 60,000.00	\$ 60,000.00
18	Generator and Automatic Transfer Switch	1	LS	\$ 50,000.00	\$ 50,000.00
19	Site Electrical, Controls, Instrumentation, and SCADA	1	LS	\$ 120,000.00	\$ 120,000.00
				SUB-TOTAL ESTIMATED COST =	\$ 1,182,000.00
				15% FINAL CONTINGENCY =	\$ 177,000.00
					<u>\$ 1,400,000.00</u>

# Design and Analysis Cont'd

## OPTION 2 - Opinion of Probable Cost

No.	Item	Quantity	Unit	Unit Cost	Cost
1	Mobilization / Demobilization	10%	LS	\$ -	\$ 79,000.00
2	Sheeting, Shoring, and Bracing	5%	LS	\$ -	\$ 38,000.00
3	SWPPP and Erosion Control	1	LS	\$ 5,000.00	\$ 5,000.00
4	Excavation	1	LS	\$ 5,000.00	\$ 5,000.00
5	Dewatering	1	LS	\$ 5,000.00	\$ 5,000.00
6	Pre-Cast Concrete Wet Well (6-ft dia x 8-ft depth)	1	LS	\$ 15,000.00	\$ 15,000.00
7	Wet Well Lid and Access Hatch with Safety Grate	3	EA	\$ 8,000.00	\$ 24,000.00
8	Lift Station Valve Vault (6-ft L, 4-ft W, 6-ft D)	1	LS	\$ 15,000.00	\$ 15,000.00
9	Reinforced Concrete Footings / Equipment Slabs	10	CY	\$ 1,000.00	\$ 10,000.00
10	Yard Piping	1	LS	\$ 10,000.00	\$ 10,000.00
11	Sewer Pumps, Motors, and Accessories	2	EA	\$ 30,000.00	\$ 60,000.00
12	Pump Station Valves	20	EA	\$ 2,000.00	\$ 40,000.00
13	Inlet and Outlet Manholes	32	EA	\$ 2,400.00	\$ 77,000.00
14	PVC SDR Pipe 4-in dia (includes installation and backfill)	6300	LF	\$ 40.00	\$ 252,000.00
15	Site Improvements (fencing/wall, gate, pavement pad, shade cover, etc.)	1	LS	\$ 60,000.00	\$ 60,000.00
16	Generator and Automatic Transfer Switch	1	LS	\$ 50,000.00	\$ 50,000.00
17	Site Electrical, Controls, Instrumentation, and SCADA	1	LS	\$ 120,000.00	\$ 120,000.00
				SUB-TOTAL ESTIMATED COST =	\$ 865,000.00
				15% FINAL CONTINGENCY =	\$ 130,000.00
					<u>\$ 1,000,000.00</u>

## Discussion of Results Cont'd

Option	Sub-total Estimated Cost	Contingency (15%)	Total Cost
1	\$ 1,182,000.00	\$ 177,000.00	\$ 1,359,000.00
2	\$ 865,000.00	\$ 130,000.00	\$ 995,000.00

- **Boring under I-80 is the single greatest cost at an estimated \$300,000**
- **The cost of extra pipe for Option 2 (\$64,000) is nearly offset by the cost of additional pumps from Option 1 (\$60,000)**

## Conclusions

- Both models would have velocities and pressures that are within SPMUD specifications
- The project would likely cost \$1.0 - 1.4 million
- Option 1 would require the pump servicing the Kentucky Greens Lift Station to be upgraded
- Option 2 would need 1.5 times more pipe than Option 1

## Recommendations

- **Implement Option 2**
- **Perform an inflow and infiltration (I&I) study**
- **Record and/or obtain updated flow data**
  - **From the mobile home park**
  - **For existing city lines**



**The End**

**Any Questions?**