Table of Contents

Section 1 Existing Conditions **1-1**
1.1 Operations and Maintenance (O&M) 1-4
1.2 Variable Grade Sewers 1-5
1.2.1 Variable Grade Sewer Description 1-5
1.2.2 Variable Grade Performance 1-6
1.3 Pressure Sewers 1-7
1.3.1 Pump Station Description 1-7
1.3.2 Pump Station Performance 1-7

Section 2 Alternatives Analysis **2-1**
2.1 Enforce Current Sewer Regulations 2-1
2.2 Convert to Gravity Sewers 2-2
2.2.1 Henry-Playford Area Sewer Improvement 2-4
2.3 Convert to Vacuum Sewers 2-9
2.4 Upgrade and/or Replace Pumps 2-10
2.4.1 Convert to Septic Tank Effluent Pump (STEP) System 2-10
2.4.2 Replace Grinder Pumps with new Grinder Pumps 2-10
2.4.3 Replace Grinder Pumps with Progressing Cavity Pumps 2-11
2.5 Alternative Analysis 2-12

Section 3 Recommendations **3-1**
3.1 Replace Existing Grinder Pumps with New Grinder Pumps 3-1
3.2 Convert to Progressing Cavity Pumps 3-2
3.3 Lifecycle and O&M Costs 3-2
3.4 Recommendations 3-3
3.4.1 Pilot Test 3-3
3.4.2 Future Pump Replacement Plan 3-3

List of Tables

Table 1-1 Complaint Calls and O&M Cost Summary 1-4
Table 2-1 Conceptual Gravity Sewer Cost Estimate 2-4
Table 2-2 Alternative Benefit Summary 2-12

List of Figures

Figure 1-1 Location Map 1-2
Figure 1-2 Typical VGS Configuration 1-1
Figure 1-3 Typical Grinder Pump Configuration 1-1
Figure 1-4 Existing System 1-3
Figure 1-5 East End Overtime and Material Cost vs. Budgeted O&M Costs 1-4
Figure 1-6 General Profile of a VGS System 1-5
Figure 1-7 Cross Section of a VGS Septic Tank 1-6
Figure 1-8 Cross Section of a Grinder Pump Station 1-8
Figure 2-1 Topography Map 2-1
Figure 2-2 Gravity Sewer Alternative 2-5
Figure 2-3 Sanitary Sewer Computation Sheet 2-6
Figure 2-4 Sanitary Sewer Computation Sheet 2-7
Figure 2-5 Gravity Alternative Sewer Profile 2-8
Figure 2-6 Progressing Cavity Pump Vs Centrifugal Pump System Curves 2-11

Section 1
Existing Conditions

The East End of the City of Zanesville is a hilly area that consists of two main areas, one north of I-70 consisting of 190 developed acres and one south of I-70 consisting of 230 developed acres, as shown on **Figure 1-1**. As a result of the challenging terrain, many homes utilized septic tanks, privies, and even directed sewage into abandoned mine shafts to dispose of their wastewater. Over time, these existing systems began to fail, causing public health and safety issues. The public health and safety issues culminated in a collection system that was installed in the mid 1980's utilizing an EPA grant. By qualifying for the "Innovative and Alternative Technology Program," the City received a grant for 75 percent of the total design, engineering, and construction costs to install a new hybrid system, and a low interest loan for the remaining 25 percent[5].

The East End Sewers is comprised of three types of sewers:

- Variable Grade Sewers (VGS) consist of on-lot septic tanks connected to shallow, small diameter sewers that operate similar to a siphon as shown on **Figure 1-2**. There are 297 properties that utilize variable grade sewers.
- Pressure Sewers (PS) consist of single home grinder pump stations connected to shallow, small diameter sewers as shown on **Figure 1-3**. There are 382 properties that utilize pressure sewers.
- Gravity Sewers (GS). There are 32 properties that utilize conventional gravity sewers.

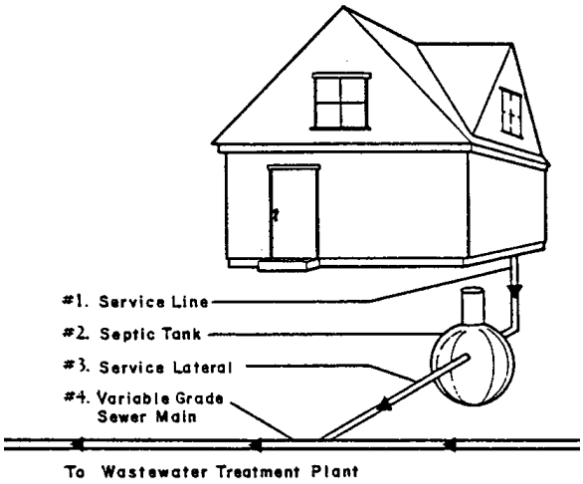


Figure 1-2 Typical VGS Configuration[6]

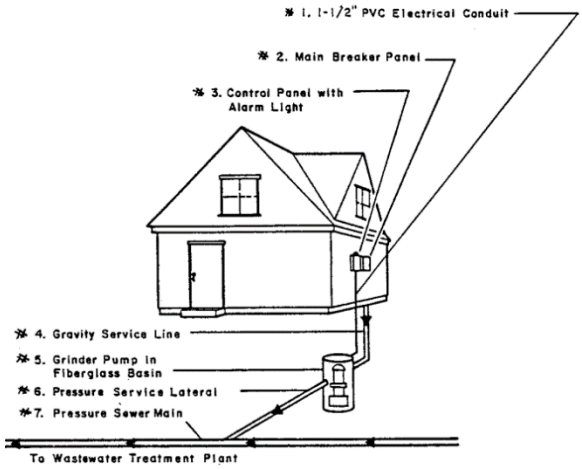
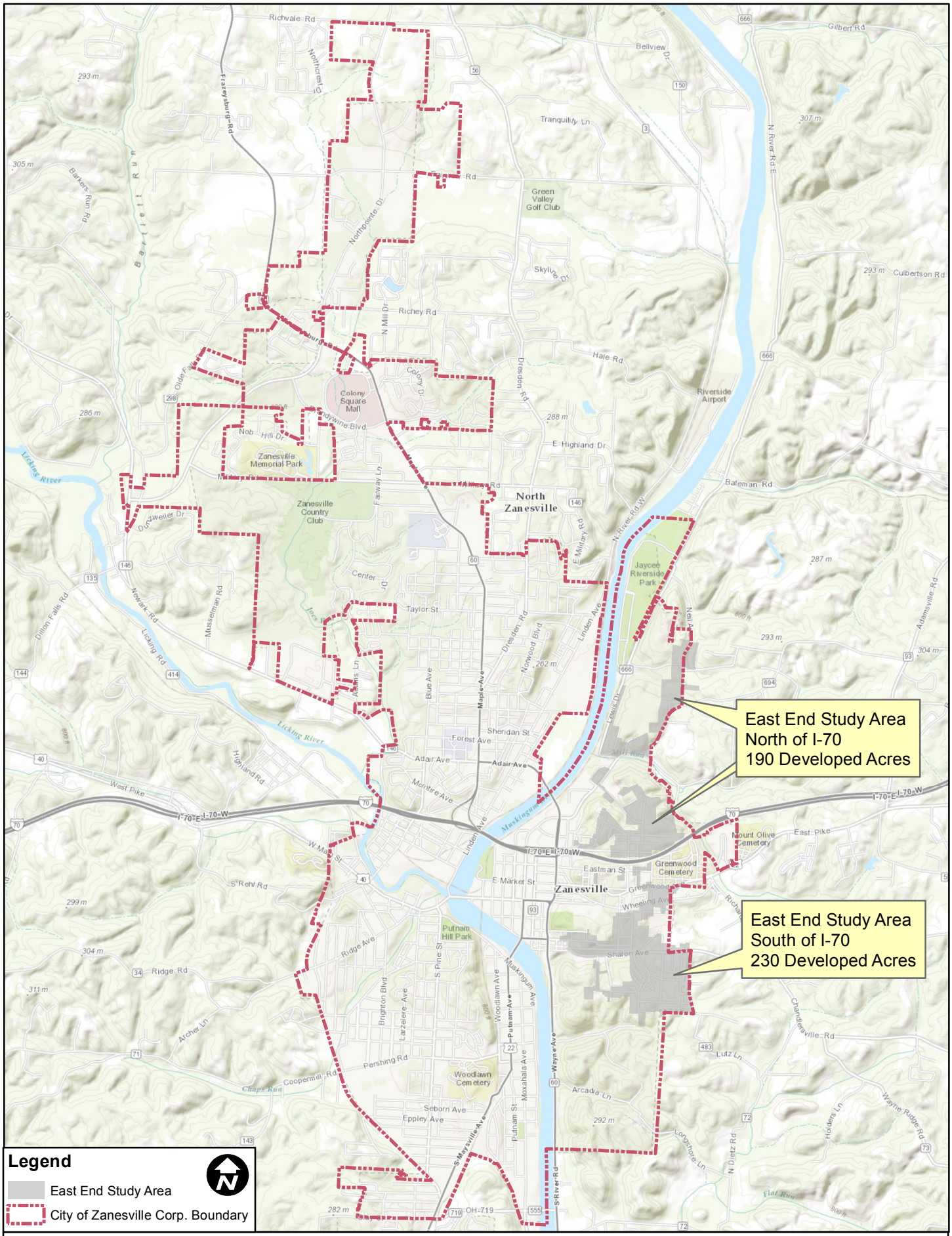


Figure 1-3 Typical Grinder Pump Configuration[6]

It is important to note that the East End Sanitary Sewer System is a hybrid system comprised of VGS, PS and GS, as shown on **Figure 1-4**. The vertical relief of some areas is as much as 100 feet and is one reason why the area developed without a public sanitary collection system. When the hybrid sanitary sewer system was designed and constructed, preference was given to VGS over GS. When the general topography allowed for a VGS system, it was supplied. However, if a property was located in a low spot and was below the VGS system, a grinder pump station was installed for the property and flow was pumped up into the VGS system main.

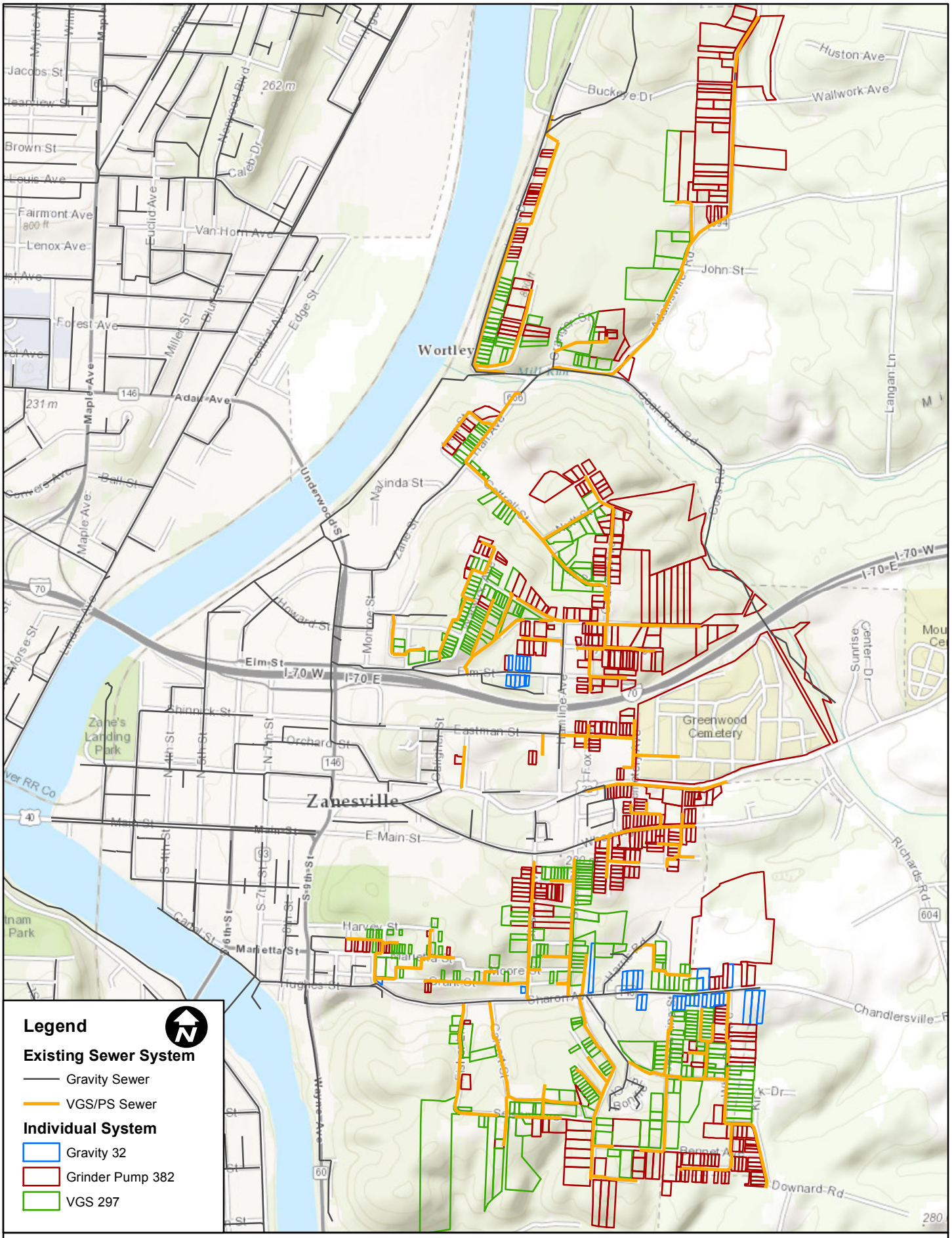
3/27/2015 8:38:17 AM
PW_XM1\Documents\20235\107614\07 Final Deliverables\01 Contractual Deliverables\Draft_Report\Section 1 Existing Conditions\Figure_1-1_Location_Map.mxd



CDM Smith

City of Zanesville
East End Sanitary Sewer Study
Location Map

Figure 1-1



City of Zanesville
East End Sanitary Sewer Study
Existing System

Figure 1-4

CDM Smith

3/27/2015 8:39:55 AM

PW_XM1\Documents\20235\107614\07 Final Deliverables\01 Contractual Deliverables\Draft_Report\Section 1 Existing Conditions\Figure_1-4_Existing_Conditions.mxd

1.1 Operations and Maintenance (O&M)

Based on conversations with the City of Zanesville, it appears that the gravity systems and the VGS systems are operating as expected with few maintenance requirements. However, within the last five years (beginning in 2010), the City of Zanesville has begun to see an increase in the maintenance costs of the East End system – specifically, issues with the single home grinder pump stations.

The number of complaint calls, as well as O&M cost information provided by the City of Zanesville, is summarized in **Table 1-1**.

Table 1-1: Complaint Calls and O&M Cost Summary[7]

Year	City-wide		East End Costs		
	Complaint Calls	O&M Budget	Materials	Overtime	Materials plus Overtime*
2014	140	$ 33,500	$ 29,825	N/A	N/A
2013	133	$ 20,000	$ 40,822	$ 22,756	$63,578
2012	127	$ 20,000	$ 25,926	$ 16,948	$42,874
2011	99	$ 20,000	$ 35,889	$ 6,701	$42,590
2010	88	$ 20,000	$ 22,833	N/A	N/A
2009	104	$ 25,000	N/A	N/A	N/A
2008	92	$ 25,000	N/A	N/A	N/A
2007	81	$ 25,000	N/A	N/A	N/A

When this information is graphed, as shown on **Figure 1-5,** the O&M cost of these stations is showing an increase over time.

There is an upward trend in both O&M dollars (overtime as well as material) that correlate with an increase in complaint calls from 2010 to 2014. Most calls were to service grinder pump stations that were clogged with disposable wipes and other items not intended for the sanitary sewer system. It can be seen that materials and overtime for the East End alone are consuming more than the sewer O&M budget for the entire City. The cost of materials and overtime for the East End system alone is almost $64,000 per year; almost double the O&M budget for the entire City.

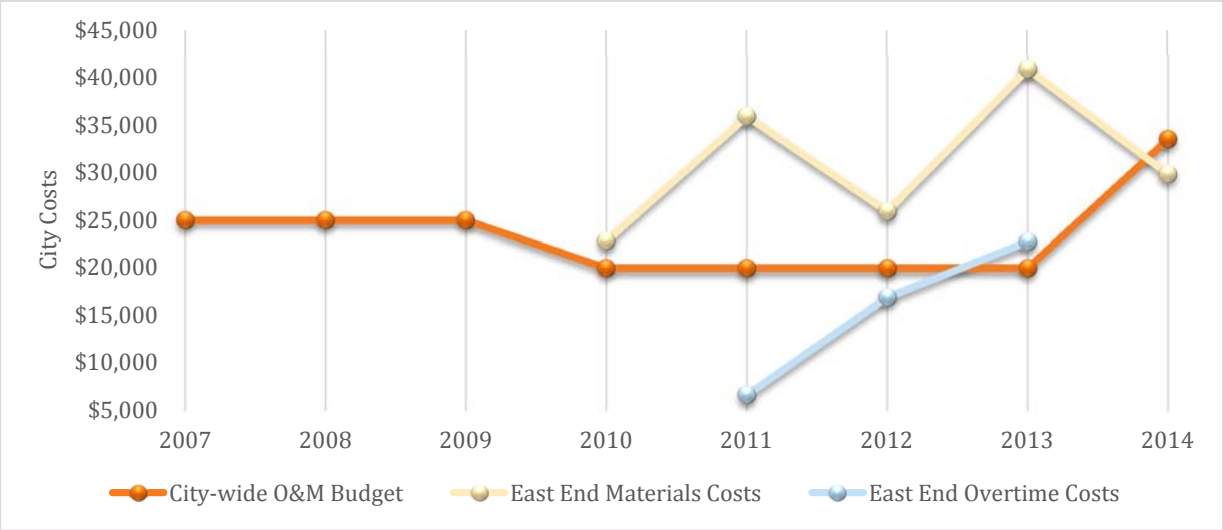


Figure 1-5 East End Overtime and Material Cost vs. Budgeted O&M Costs

Currently, the City has been replacing failing station equipment with similar equipment for almost $3,000 each. This includes a new pump and rail assembly for $2,300, which typically requires a new control panel for $500, and new wiring from the control box to the pump station for $122. These are material costs only and do not include the labor for City crews to perform the work. Changing the existing pump with a similar pump does not address the frequent ragging problem, and crews can get called back to one of these sites to perform maintenance, regardless of the age of the equipment.

1.2 Variable Grade Sewers

Variable Grade Sewers (VGS) consist of small sewer mains of 2- or 4-inch diameter that are laid at a constant depth (follow surface grade) and with a net decrease in elevation from the start at the highest point to the finish at the lowest point. This allows sewage to flow much like a siphon by gravity as shown in **Figure 1-6**. Here, the onsite septic tank is higher than the main. When topography does not allow for an onsite septic tank to be higher than the main, a grinder pump station was installed.

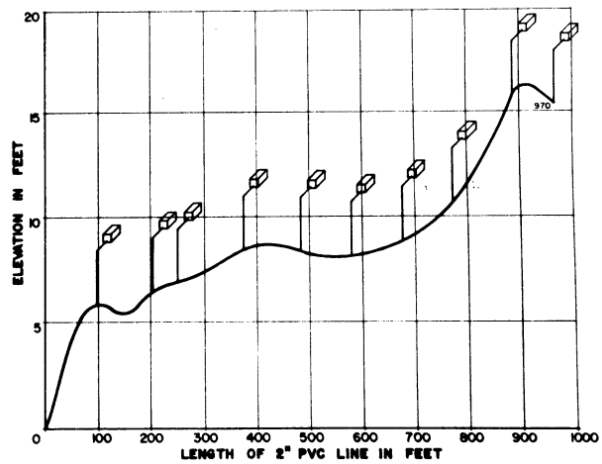


Figure 1-6 General Profile of a VGS system[3]

Minimum laying depth is 42 inches to top of sewer main pipe and maximum cover depth of pipe is 54 inches. This ensures the pipe lines are below frost depth but can still be installed using a trencher for excavation.

1.2.1 Variable Grade Sewer Description

All properties that use a VGS system have a septic tank as a pretreatment system prior to discharge of effluent to the sewer main. The septic tanks eliminate larger solids and grease that could cause a blockage in the small diameter transmission sewers. The City installed 1,000 gallon spherical high density polyethylene tanks, see **Figure 1-7,** which are no greater than five feet deep. The City very wisely paid for the installation of the septic tanks and the house connections to ensure the integrity of the system and to reduce water infiltration and inflow (I/I). Other similar systems installed in different municipalities during the same time period required homeowners to install the house connections. These systems have experienced high I/I during wet weather.

Installation of the VGS mainlines were kept as shallow as possible so that a trencher could be used for excavation in place of a backhoe. This was a cost savings of 7 percent to 35 percent compared to the same line sizes as other systems bid in Ohio at that time.[5]

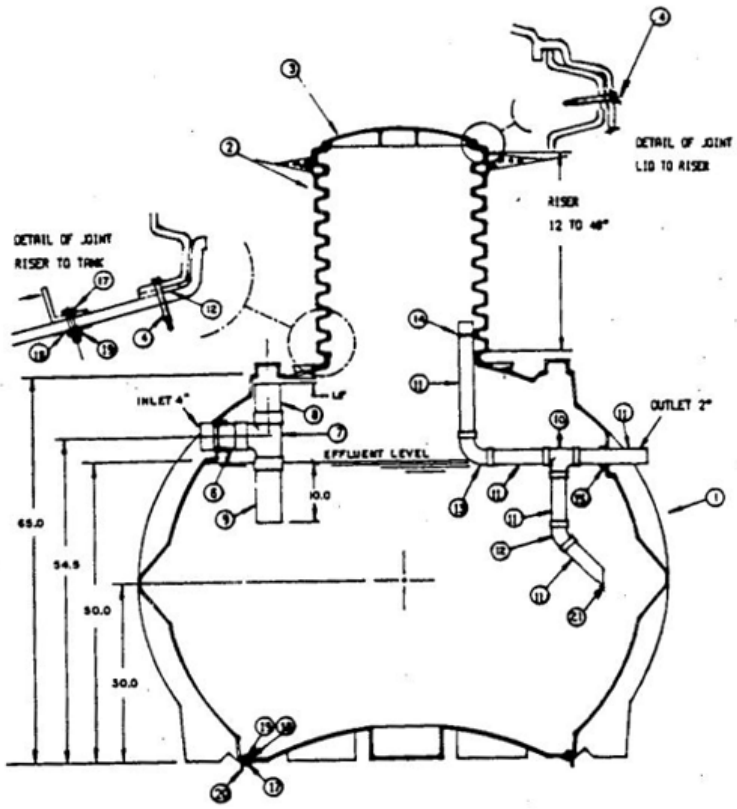
The advantage to the City of Zanesville in 1984 for installing the VGS system was that it was considered a new technology and was approved for the Innovative and Alternative Technology federal grant program. This meant that if the VGS alternative was found feasible for portions of the hilly East End sewer shed, the City of Zanesville would receive a grant for those areas and have 75 percent paid by the Federal Government. The grant was used to entice municipalities to risk installing the new technologies so historical data could be obtained regarding its reliability and effectiveness.

1.2.2 Variable Grade Performance

The VGS have functioned very well with minimal emergency maintenance calls. The maintenance requirements are typically for check valve or stab valve replacement, of which less than 10 of each have been replaced annually in the last several years.

The disadvantage of the VGS system is that the City owns the septic tanks and thus is responsible for pumping the tanks out when they are full of solids. Based on a cleaning cycle of every five years, the City pumps out approximately 60 tanks per year.

The City has a perpetual maintenance easement of 5 feet on either side of the service lateral. The easement is intended to help access the tank, however most of the tanks are located close to the home and in backyards. This means access for the pumper truck is difficult requiring many lengths of hose and it is common for the truck to drive over customer lawns to get close enough to pump out the tank[5]. This can result in private property damage.



NO.	DESCRIPTION
1	Tank, 1,000 Gallon
2	Riser, 48"
3	Lid, 24"
4	Self-Drilling Screws, #12 x 2"
5	Gasket Tape
6	Bell, 4" PVC
7	Sanitary Tee, 4" PVC
8	Pipe, 4" SCH 40 PVC
9	Pipe, 4" SCH 40 PVC
10	Tee, 2" PVC
11	Pipe 2" SCH 40 PVC
12	45 Degree Sweep Ell, 2" PVC
13	90 Degree Sweep Ell, 2" PVC
14	U-Bolt, 1/4-20 x 2" Pipe
15	"O" Ring, Neoprene
16	Top Ring, Stainless Steel
17	HHCS 1/4-20 x 1 1/4 SS
18	Fender Washer, 1/4" SS
19	Hex Nut 1/4-20 SS
20	Bottom Ring, Stainless Steel
21	Outlet Baffle

Figure 1-7 Cross Section of a VGS Septic Tank

1.3 Pressure Sewers

The East End Pressure Sewers (PS) consist of small sewer mains of 2- or 4-inch diameter that were generally installed lower than the VGS system and tie into the VGS system making the East End a hybrid between the two technologies. As described in the VGS system, the mains are laid at a constant depth (following surface grade) and with a net decrease in elevation from the start at the highest point to the finish at the lowest point. Minimum laying depth is 42 inches to top of sewer main pipe and maximum cover depth of pipe is 54 inches. This ensures the pipe lines are below frost depth but can still be installed using a trencher for excavation.

1.3.1 Pump Station Description

Where VGS was not able to be installed, PS system pump stations were installed. These stations consist of a two-foot diameter wet-well with a pump and a control box located on the house. The City of Zanesville is responsible for maintaining the pump station, shown on **Figure 1-8**, and the resident or property owner is responsible for the cost of electricity.

The advantage to the City of Zanesville in 1984 was that installing a PS pump station where a VGS system was not feasible was that it was considered a new technology. Therefore, it was approved for the Innovative and Alternative Technology federal grant program. This meant that if the VGS alternative was not feasible, PS systems were feasible for portions of the hilly East End sewer shed. The City of Zanesville would receive a grant for those areas and have 75 percent paid by the Federal Government. The grant was used to entice municipalities help to mitigate the risk of installing new technologies so historical data could be obtained regarding its reliability and effectiveness.

1.3.2 Pump Station Performance

The disadvantage of the PS pump stations is that the City owns and operates the grinder pump stations and thus is responsible for any malfunctioning pumps. The City has seen a noticeable increase in the use of disposable wipes for cleaning as well as for personal use that did not exist when the stations were designed. As a result, many of the stations experience ragging and clogging problems requiring increased maintenance costs - both material and overtime.

The City has a perpetual maintenance easement of 5 feet on either side of the service lateral. The easement is intended to help access the pump station, however most of the pump stations are located close to the home and in backyards. This means access for maintenance personnel can be difficult.

The pump stations are only two feet in diameter. When the mechanical connections of the station deteriorate, that is, pump to forcemain failures or pump to the lifting rails failures, repairs are often very difficult. Man-entry is nearly impossible. As these systems age, parts will become harder and harder to find. The wiring is starting to become brittle and connections in the junction box are made with wire nuts, which can become loose. The City has experienced that rebuilt pumps are not as efficient as original models. Rebuilding these motors, rewinding the stator, and replacing the bearings can cost nearly $5,000.

Issues with these pump stations include:

- The older model pumps were not designed to chop up disposable wipes into small solids that can be transported by the small diameter sewer lines.
- It now costs the City over $23,000 per year in overtime to respond to East End sewer back-up calls.

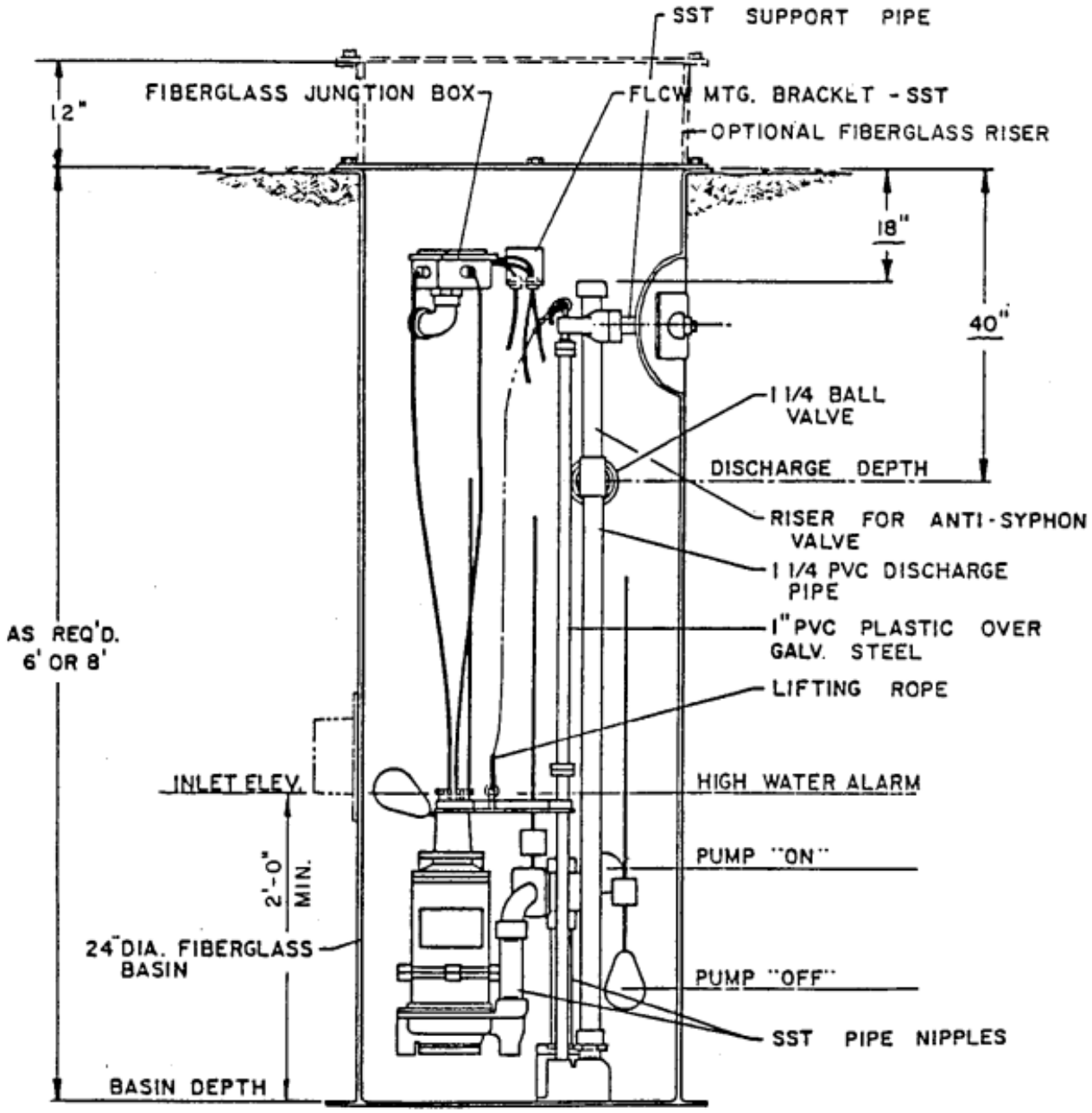


Figure 1-8 Cross Section of a Grinder Pump Station

Section 2

Alternatives Analysis

After discussions with the City of Zanesville, it became clear that the grinder pump stations are primarily responsible for the recent increase in O&M costs – both materials and overtime. Therefore, this report will focus on the grinder lift stations. Four main mitigation strategies are described in the following sections:

1. Enforce Current Sewer Regulations
2. Convert to Gravity Sewers
3. Upgrade/Replace Existing Equipment
4. Convert to Vacuum Sewers

2.1 Enforce Current Sewer Regulations

This alternative considers the option of strictly enforcing the sewer regulations, in addition to the City's existing public notification efforts, regarding the discharge of inappropriate materials into the sewer system. Enforcing the current sewer regulations could include fines for residents who repeatedly cause blockages by disposing of items that are not intended for the sanitary sewer.

This primarily is a development caused by the increasing consumer demand for pre-moistened wipes. These "flushable" wipes are advertised as thicker, stronger, medical grade cloth that is biodegradable and breaks apart after flushing. Despite what manufacturers claim, the wipes – even the ones that say flushable – do not dissolve fully in water. The wipes get tangled in pipes, especially in pumps completely clogging them.

The problem has worsened in recent years because more such products are available on the market and consumer demand for easily disposable antibacterial products is growing. The problem received world-wide attention in July 2013 when London England sewer officials reported removing a 15-ton "bus-sized lump" of wrongly flushed grease and wet wipes, dubbed the "fatberg".

Example Public Notification Flyer

These wipes are not flushable especially for low pressure sewer systems. The wipes can immediately get caught-up in the pumps and the smaller diameter sewer lines creating a blockage which requires a City sewer crew to respond to and clear. Worst case scenario is basement flooding and the associated health hazards of contact with raw sewage.

Each time a sewer crew has to respond to a sewer blockage or pump malfunction it costs the City approximately $156. Note that $156 represents the average labor cost incurred for East End sewers. Some calls are more expensive while others are less.

Issues with this alternative are:

- It may be seen as unfair for the City to fine East End residents for blockages to their "innovative" sewer system while all other customers that are on the conventional gravity system are not.
- Ideally, enforcement would be City-wide. However, the problem would only impact the East End due to the collection system that is in place. Wipes would be caught at the waste water treatment plant for the conventional gravity system and pinpointing specific locations that are flushing these materials would be a challenge.
- The East End sewers serve primarily lower income homes which would have a difficult time paying a fine of any amount.
- Many of the calls are repeat offenders that are renting and may just move and leave the fine to the owner.

2.2 Convert to Gravity Sewers

This alternative considers servicing the East End Area entirely or in part by conventional gravity sewers. There are four main challenges to converting the East End to gravity:

1. Topography
2. House Plumbing
3. Depth of Bedrock
4. Constructability

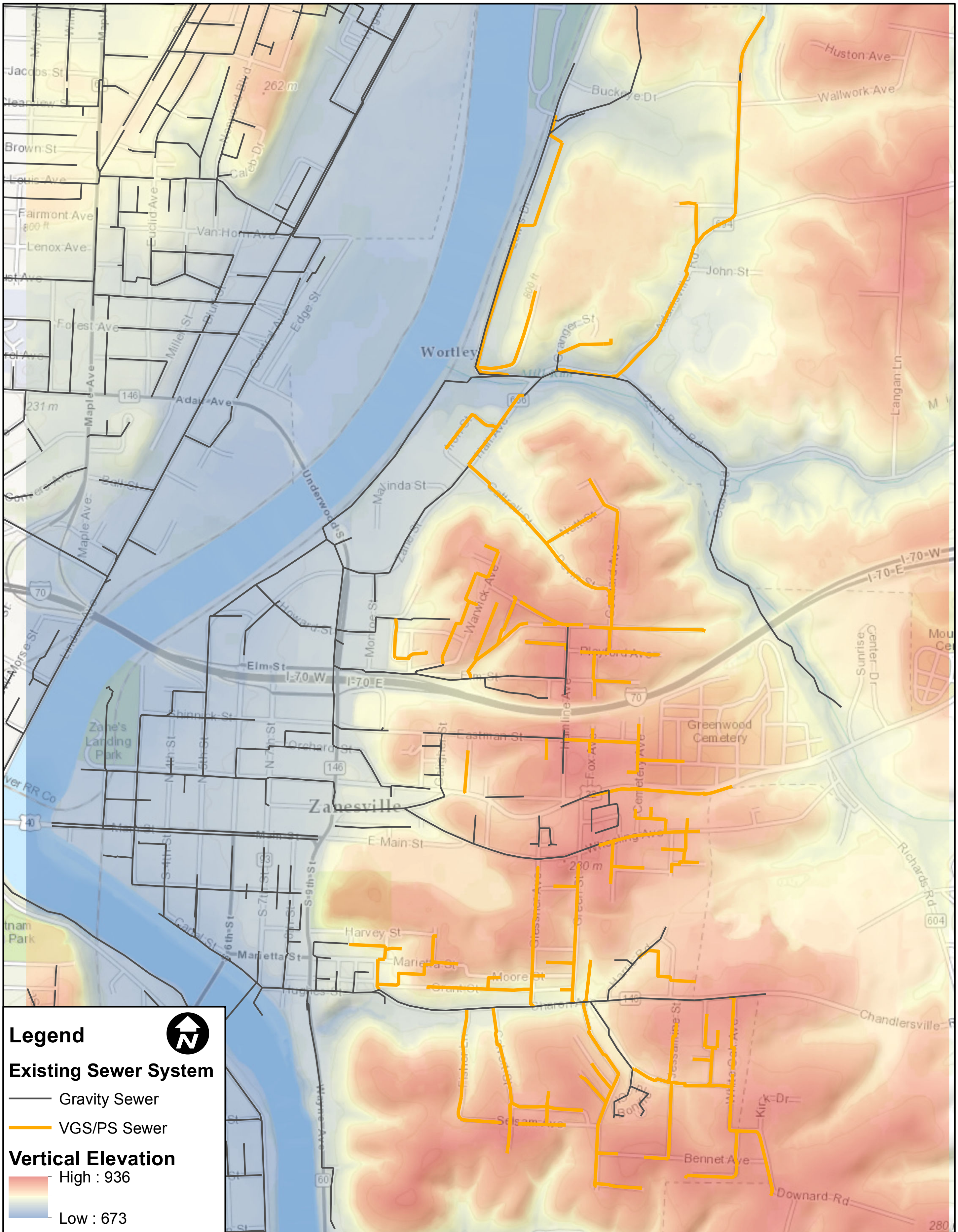
Topography: The East End has over 150 vertical feet of relief as shown on **Figure 2-1**. To further complicate matters, relief can change from one side of the street versus the other. It can also change dramatically from one house to another house on the same side of the street. This tends to lead to deeper sewers, so that all of the properties within a tributary area can be serviced.

House Plumbing: Generally, when the East End was developed, most of the plumbing of the structures was directed to the rear of the property. This is not an issue when areas are relatively flat with room for alleys to accommodate public utilities. However, this is generally not the case in the East End. Because the house plumbing discharges out the rear of properties the VGS septic tanks, as well as the grinder pump stations, are located in challenging locations to tie into a gravity sewer.

Depth to Bedrock: The depth of the bedrock in the East End is largely unknown. Since gravity sewers are generally installed at a depth of 8 feet or greater, this could be a major cost for the installation of a gravity sewer.

Constructability: Existing road right-of-ways are narrow, there is also not a lot of space between structures.

After considering these four main challenges, locations for a central main trunk sewer were evaluated. Due to the changing topography, the concept of one or two trunk sewers that would serve the East End was determined to not be feasible. Next, multiple regional trunk sewer extensions were considered. One location, found near Henry Street, appeared to convert the most grinder pump stations to gravity.



3/27/2015 9:05:34 AM

PW_XM1\Documents\20235\107614\07 Final Deliverables\01 Contractual Deliverables\Draft_Report\Section 2 Alternatives Analysis\Figure_2-1_Topography_Map.mxd

CDM Smith

City of Zanesville
East End Sanitary Sewer Study
Topography Map

Figure 2-1

2.2.1 Henry-Playford Area Sewer Improvement

This improvement would consist of 2,272 linear feet of 8-inch and 1,075 linear feet of 10-inch sanitary sewer. It would convert 34 homes from grinder pump stations and convey flows east to the existing 21-inch sanitary sewer, as shown in plan-view on **Figure 2-2**. **Figure 2-3** and **Figure 2-4** present conceptual sewer design calculations. These calculations utilize the 10-State Standards peaking factor, 3.5 people per dwelling unit, and assumes an eight foot depth at the tie-in manhole. **Figure 2-5** presents the profile of the sewer improvement. This conceptual alignment would require construction easements as well as a permanent easement to serve the homes west of Goddard Avenue, while east of Goddard Avenue the alignment utilizes the existing right-of-way from the intersection of Goddard Avenue and Henry Street to the outlet on the existing 21-inch trunk sewer.

The unit costs were developed from several sources, including local bid tabs, and national cost information. The unit costs shown are conceptual installed costs, which include ancillary costs such as excavation and backfill, surface restoration, and bypass pumping and reconnection of service connections. Rock excavation is NOT included. Land acquisition, temporary easements, engineering and construction management and contingency markup elements are also NOT included. New sewers are located in the City right-of-way where possible and will require significant pavement and other restoration.

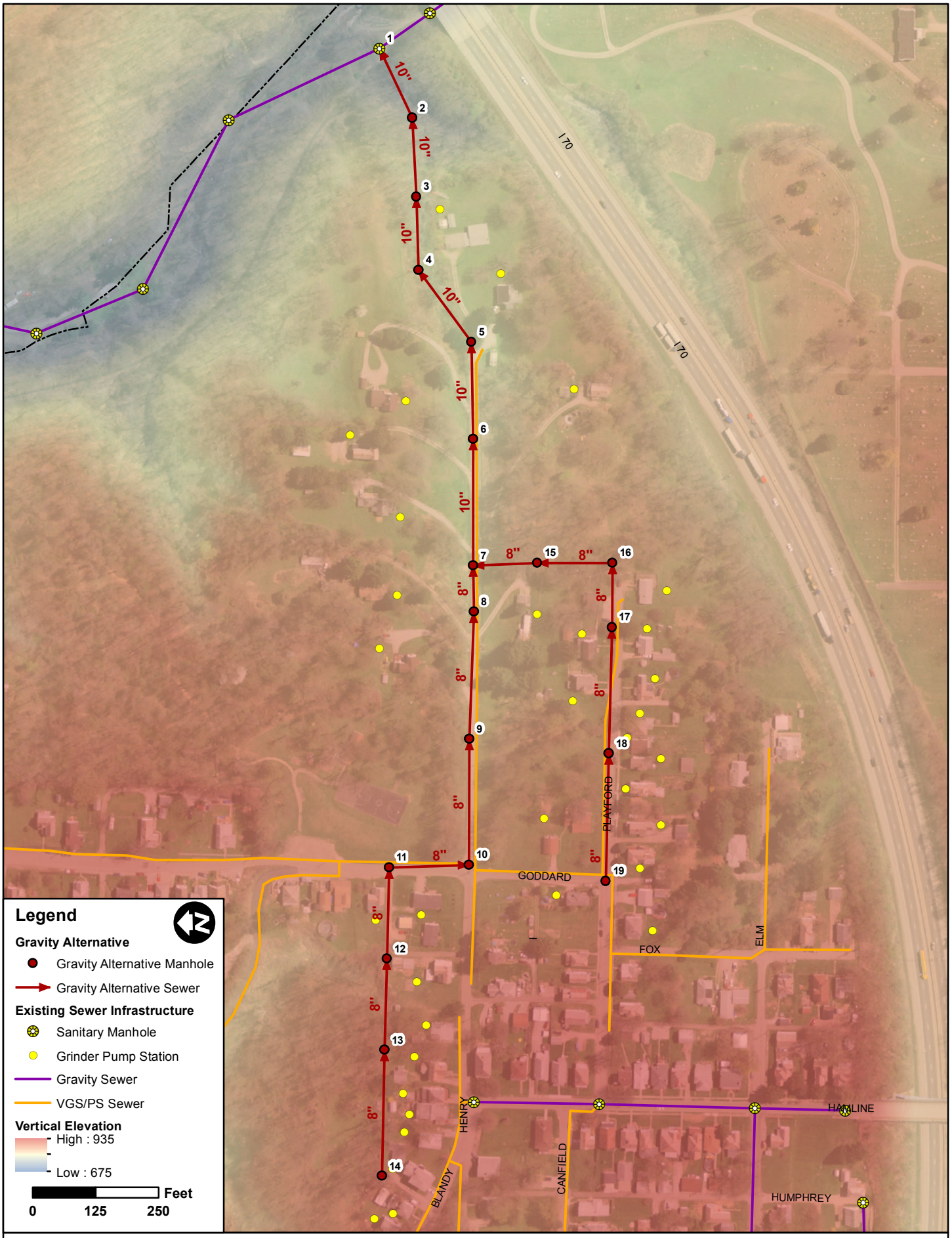
Table 2-1 Conceptual Gravity Sewer Cost Estimate

Item	Length (ft)	Unit Cost Per LF	Total
8” Sewer in Easement	889	$350	$311,150
8” Sewer in Pavement	1,383	$400	$553,200
10” Sewer in Easement	632	$400	$252,800
10” Sewer in Pavement	443	$450	$199,350
Total	**3,347**	**-**	**$1,316,500**

While this improvement would eliminate 34 grinder pump stations it has the following negative aspects:

- Depth of bedrock is unknown. Bedrock is very likely to be encountered and will increase the cost of this improvement dramatically.
- The construction duration for this alternative would be lengthy and would inconvenience local residents.
- This improvement impacts only 9 percent, or 34 out of 382 existing grinder pump stations. Since the grinder pump stations that have clogging problems are not specific to the Henry-Playford area this gravity sewer would impact a relatively small percentage of the problem.

For these reasons, converting the East End Sewers or sections of the system to gravity is not recommended.



CDM Smith

City of Zanesville
East End Sanitary Sewer Study
Gravity Sewer Alternative

Figure 2-2

PW_XM1\Documents\20235\107614\07 Final Deliverables\01 Contractual Deliverables\Draft_Report\Section 2 Alternatives Analysis\Figure_2-2_Gravity_Sewer.mxd

3/27/2015 9:39:16 AM

FIGURE 2-3 SANITARY SEWER COMPUTATION SHEET

10-States Peaking Facor — 100 gal/cap/day — 3.5 people per DU — n= 0.013

Project: **Henry Gravity Sewer**
Job No.:
Design Reference: 10-State Standards

Date: 3/27/15
By: DDR
Checked: MAL

Struc.	Struc. Index	Sta.	Population Dwelling Unit	Population Pop	Population Cumul Pop	ADF Gal/Day	Peaking Factor	Peak Flow CFS	Length ft.	Dia. In	Slope%	Vel	Cap. Flowing Full	Status	In	Out	TC	Remarks
14		25+37.40	6	21.00		2,100	2.63	0.478							892.30		900.30	
			0		21.00				248.40	8	3.00%	6.0	2.1	OK				7.19 ft. cover
																		8.00 ft. depth
13		22+89.00	3	10.50		3,150	2.46	0.670							884.75	884.85	895.20	0.10 DROP
			0		31.50				250.90	8	3.00%	6.0	2.1	OK				9.54 ft. cover
																		10.45 ft. depth
12		20+38.10	3	10.50		4,200	2.34	0.849							877.12	877.22	881.10	0.10 DROP
			0		42.00				191.50	8	3.00%	6.0	2.1	OK				3.07 ft. cover
																		3.98 ft. depth
11		18+46.60	0	0.00		4,200	2.34	0.849							871.28	871.38	879.80	0.10 DROP
			0		42.00				177.50	8	9.00%	10.4	3.6	OK				7.61 ft. cover
																		8.52 ft. depth
10		16+69.10	0	0.00		4,200	2.34	0.849							853.31	855.31	873.20	2.00 DROP
			0		42.00				250.10	8	7.00%	9.2	3.2	OK				17.08 ft. cover
																		19.89 ft. depth
9		14+19.00	2	7.00		4,900	2.27	0.964							835.70	835.80	848.00	0.10 DROP
			0		49.00				252.90	8	7.00%	9.2	3.2	OK				11.39 ft. cover
																		12.30 ft. depth
8		11+66.10	4	14.00		6,300	2.17	1.185							817.90	818.00	825.00	0.10 DROP
			0		63.00				91.10	8	7.00%	9.2	3.2	OK				6.19 ft. cover
																		7.10 ft. depth
7		10+75.00	0	77.00		14,000	1.88	2.284							811.35	811.52	818.70	0.17 DROP
			22		140.00				250.80	10	5.00%	9.0	4.9	OK				6.36 ft. cover
																		7.35 ft. depth
6		8+24.20	2	7.00		14,700	1.87	2.378							798.71	798.81	808.40	0.10 DROP
			0		147.00				192.60	10	2.00%	5.7	3.1	OK				8.60 ft. cover
																		9.69 ft. depth
5		6+31.60	2	7.00		15,400	1.85	2.471							794.76	794.86	803.40	0.10 DROP
			0		154.00				177.50	10	5.00%	9.0	4.9	OK				7.55 ft. cover
																		8.64 ft. depth
4		4+54.10	2	7.00		16,100	1.84	2.563							783.89	785.89	804.20	2.00 DROP
			0		161.00				145.80	10	10.00%	12.7	6.9	OK				17.32 ft. cover
																		20.31 ft. depth
3		3+08.30	0	0.00		16,100	1.84	2.563							761.31	769.31	793.40	8.00 DROP
			0		161.00				156.30	10	4.00%	8.1	4.4	OK				23.10 ft. cover
																		32.09 ft. depth
2		1+52.00	0	0.00		16,100	1.84	2.563							747.06	755.06	764.10	8.00 DROP
			0		161.00				152.00	10	4.00%	8.1	4.4	OK				8.05 ft. cover
																		17.04 ft. depth
1		0+00.00	0	0.00		16,100	1.84	2.563							740.88	740.98	749.40	0.10 DROP
			0		161.00				0.01	10	5.00%	9.0	4.9	OK				7.43 ft. cover
																		8.52 ft. depth

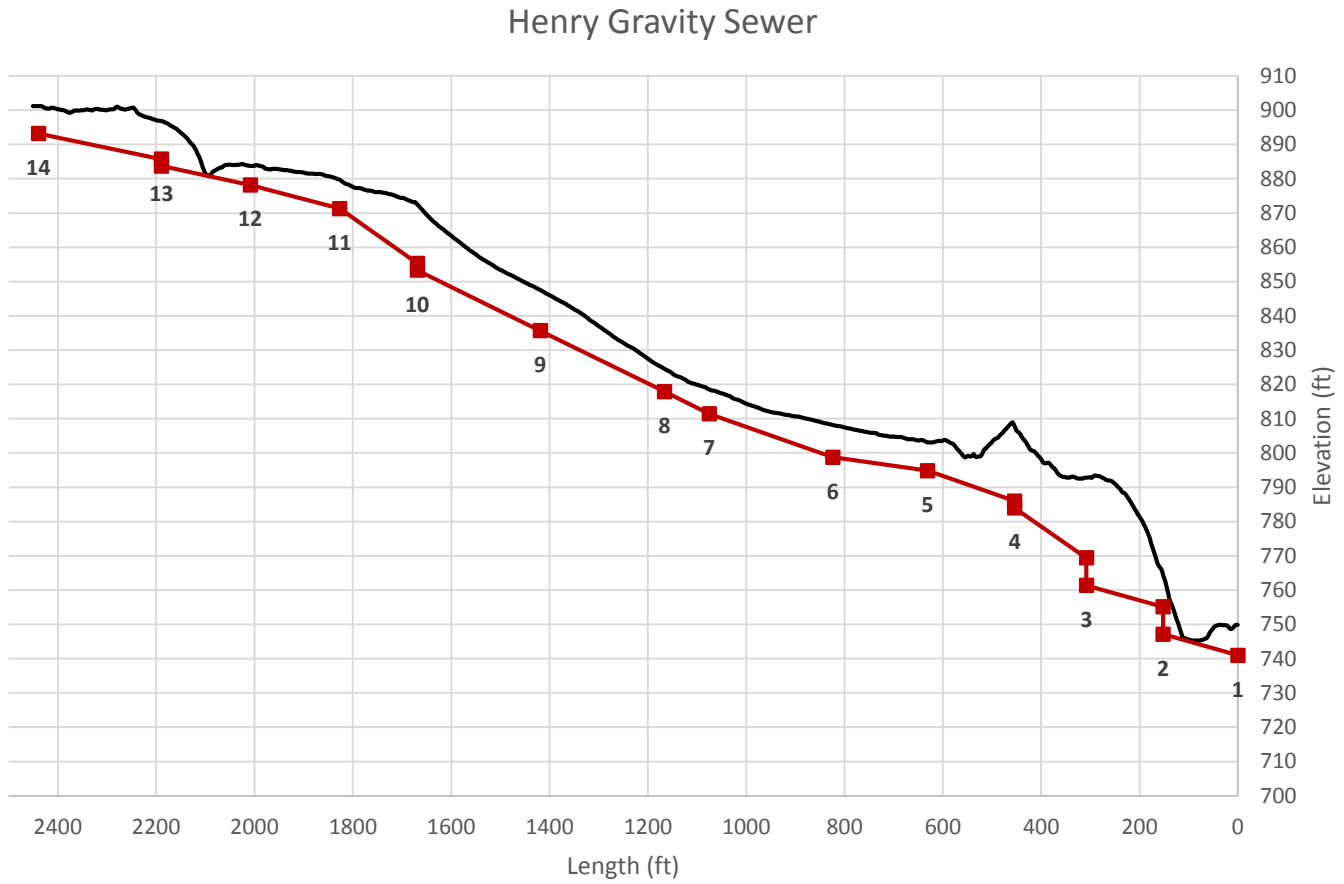
FIGURE 2-4 SANITARY SEWER COMPUTATION SHEET

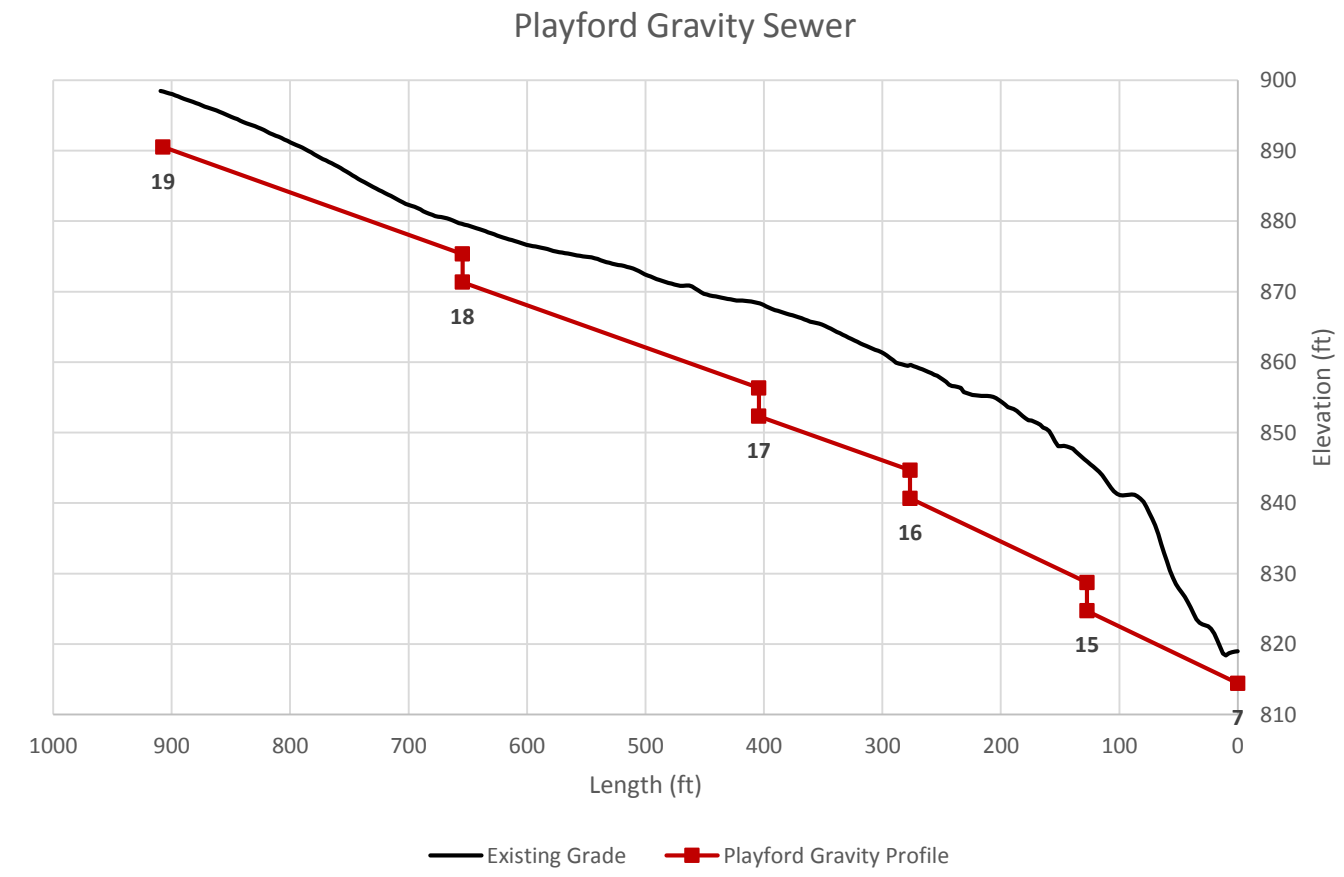
10-States Peaking Facor — 100 gal/cap/day — 3.5 people per DU — n= 0.013

Project: **Playford Gravity Sewer**
Job No.:
Design Reference: 10-State Standards

Date: 3/27/15
By: DDR
Checked: MAL

Struc.	Struc. Index	Sta.	Population: Dwelling Unit	Population: Pop	Population: Cumul Pop	Design Average Flow	Peaking Factor	Peak Flow CFS	Length ft.	Dia. In	Slope%	Vel	Cap. Flowing Full	Status	In	Out	TC	Remarks
19		9+07.30	10	35.00		3,500	2.41	0.731							890.50		898.50	
			0		35.00				252.80	8	6.00%	8.5	3.0	OK				7.19 ft. cover
																		8.00 ft. depth
18		6+54.50	7	24.50		5,950	2.20	1.131							871.33	875.33	879.70	4.00 DROP
			0		59.50				250.20	8	6.00%	8.5	3.0	OK				3.56 ft. cover
																		8.37 ft. depth
17		4+04.30	0	0.00		5,950	2.20	1.131							852.32	856.32	868.40	4.00 DROP
			0		59.50				127.70	8	6.00%	8.5	3.0	OK				11.27 ft. cover
																		16.08 ft. depth
16		2+76.60	3	10.50		7,000	2.13	1.292							840.66	844.66	859.50	4.00 DROP
			0		70.00				149.30	8	8.00%	9.8	3.4	OK				14.03 ft. cover
																		18.84 ft. depth
15		1+27.30	2	7.00		7,700	2.10	1.397							824.72	828.72	846.20	4.00 DROP
			0		77.00				127.30	8	8.00%	9.8	3.4	OK				16.67 ft. cover
																		21.48 ft. depth
7		0+00.00	0					0.000							814.44	814.54	819.00	0.10 DROP
			0									0.0	0.0	OK				3.65 ft. cover
																		4.56 ft. depth
			0															
			0															
			0															
			0															
			0															
			0															
			0															
			0															
			0															
			0															
			0															
			0															
			0															
			0															
			0															





CDM Smith

City of Zanesville
East End Sanitary Sewer Study
Gravity Alternative Sewer Profile

Figure 2-5

2.3 Convert to Vacuum Sewers

Vacuum sewers have some of the same characteristics as low pressure sewers. They are suited for areas that cannot be cost effectively served by conventional gravity sewers. These areas, such as the East End sewer area, have topographic, hydrologic and geologic conditions that would dictate multiple pump stations in a conventional sewer system design. The East End area has very hilly terrain with several drainage areas and rock conditions that would make conventional deep, large diameter sewers very expensive to construct. Vacuum and pressure sewers use small diameter sewer mains that follow the contours of the ground which allows contractors to use the less expensive trenchers instead of backhoes for installation of the sewer lines in the hilly terrain.

This alternative would be to use the small diameter sewers that are in place and convert the collection system into a vacuum sewer. While vacuum sewers should be considered for their advantages of using the existing collection lines, there are many disadvantages to these systems:

- One disadvantage of vacuum sewers is that they are suited for dense developments with "moderate" terrain changes. The vacuum produced by the vacuum station is generally capable of lifting sewage 15-20 feet with a sealed system.
- The terrain in the East End is much hillier and many areas would require lifts much higher than 20 feet.
- The biggest disadvantage of vacuum sewers is that historically the systems that have been installed and operated have had many operational problems. The most common problem is debris such as wipes, toilet paper and other material flushed down the toilet getting hung-up on the vacuum valves.
- When the valves don't close fully the vacuum seal is broken and the corresponding compressor in the vacuum station runs continuously until it is identified. Then a maintenance person can locate the valve and remove the debris. This happens often and compressors can run continuously for whole weekends before a blockage is cleared.
- These problems result in high O&M costs for energy and labor.

For these reasons consideration of vacuum sewers for upgrade of the East End Sewers would not be recommended.

2.4 Upgrade and/or Replace Pumps

Another option is to embrace the system that is in place and continue to build on the City's active preventative maintenance program and plan to upgrade or replace grinder pumps and/or entire stations as they become a repetitive problem. To this end, there are generally two options, replace the pump alone keeping the existing control box, or replace the entire pump station.

The City could replace the old pumping units with new Myer V2 grinder systems that are designed to chop up the rags but it would cost approximately $4,000 each, and with 382 units that would be $1,528,000 for materials only.

2.4.1 Convert to Septic Tank Effluent Pump (STEP) System

The City could change the system to a Septic Tank Effluent Pump (STEP) System by installing a 1,000 gallon Romar septic tank between the pump and the house connection. This would settle all the solids and trap all the floatables such as wipes to protect the pumps. The tanks would cost approximately $800 and may be difficult for equipment access to install in backyards.

While this is a viable alternative, each property would need to be evaluated to site the 1,000 gallon tank. Most properties are hilly and/or small in size, making siting the tank ahead of the grinder pump station a challenge. Adding a tank ahead of the grinder pump station does not address the fact that these stations are over 30 years old.

For these reasons, converting grinder pump stations to STEP systems will not be considered further.

2.4.2 Replace Grinder Pumps with new Grinder Pumps

There are a few options available to the City if they choose to replace the grinder pumps. For a station that has a frequent ragging problem, replacing the failing pump with a new pump that does not specifically address the ragging problem is not a long term solution. Currently, the cost to replace existing equipment with equivalent new equipment is nearly $3,000. The pump and rail assembly cost $2,300, a new control box is $500 and new wiring is about $122.

Myer, the original manufacturer of the stations, has developed a pump that does address ragging. The V2 grinder pump is new to the market. The main advantage is that little to no retrofitting would be required, and it would be able to be installed into the existing pump station. This alternative would cost from $1,200 to $2,300 per pump station (depending on vendor). Most stations would likely require upgrades to the control box and wiring, which would cost about $300 per location. Retrofitting could be completed by city personnel and the prices are for material only.

The major downfall to the V2 pump is that they are largely unproven. The local pump supplier indicated that there have not been any installations within the region. The redesigned impeller does not have a proven track record.

Other manufactures produce a pump that alternates the direction of spin each time the pump cycles. This feature is not offered through Myer and would require retrofitting a new control box wiring and guide rail assembly to accommodate the pump. This would leave the existing fiberglass basins intact.

2.4.3 Replace Grinder Pumps with Progressing Cavity Pumps

Another option is to replace the pump and control box, leaving the fiberglass barrel of the existing station. This conversion replaces the existing centrifugal equipment with a progressing cavity pump setup provided by E/One. Progressing cavity pumps have the benefit of a nearly constant flow over a wide range of conditions. That is, the blue line for progressing cavity pumps in **Figure 2-6** is linear for a tight band of flows, while the red line which represents centrifugal pumps tends to limit out over a wider range of flows.

This has the following benefits:

- The wiring and controller from the house to the station is replaced.
- Brittle wiring is replaced with a quick connect setup.
- The existing pump well can be re-used.
- Lifting rails are eliminated, leaving a cleaner installation.

The cost associated with adopting this technology is about $2,500 per installation. With an economy of scale, this could be reduced to around $2,000 per installation for materials only. The modifications could be completed with City personnel after they are trained by E/One staff.

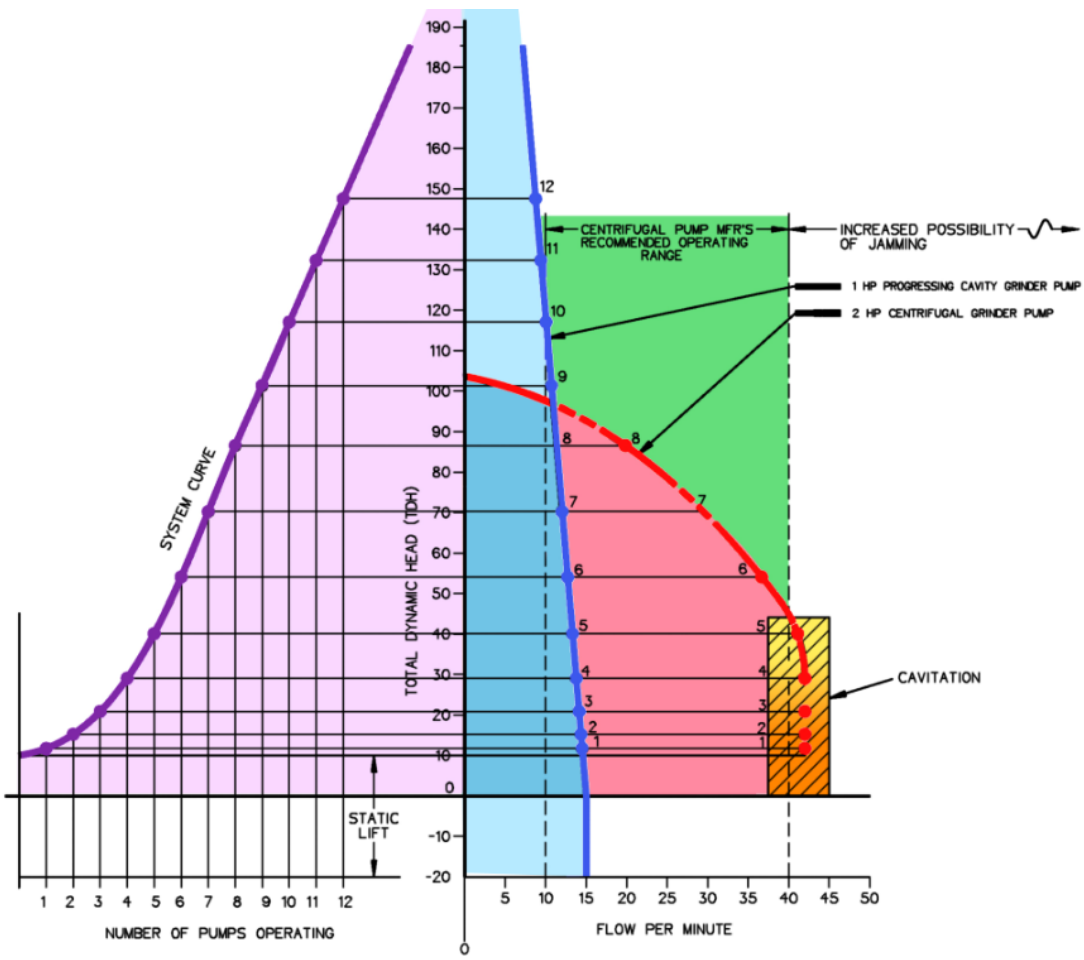


Figure 2-6 Progressing Cavity Pump Vs Centrifugal Pump System Curves

2.5 Alternative Analysis

Each mitigation strategy has several positive aspects and negative aspects. To allow for a basis of comparison the following performance metrics have been considered:

- Reduce O&M Costs – The main goal of the recommended action would be to reduce O&M costs associated with maintaining the grinder pump stations.
- Address all grinder stations – It is important that the recommended action address all grinder pump stations to reduce the frequency of service calls.
- Cost Effective – With the ever growing demand on the City's limited resources, the recommended action should not only reduce service calls, but do it cost-effectively.
- Ease of Implementation – The recommended action should be something that does not add burden to the City nor be overly complicated to implement.
- Public Acceptance – The recommended action should be an acceptable one to those living in the City of Zanesville.

These performance metrics are considered in **Table 2-2** using a scale of 0 through 5 with 5 being the most favorable and 0 being not favorable at all. The two mitigation techniques that scored the highest are to replace the grinder pumps only and to convert the grinder pumps to progressing cavity pumps.

Table 2-2 Alternative Benefit Summary

Alternative	Reduces O&M Costs	Address All Grinder Stations	Cost Effectiveness	Ease of Implementation	Public Acceptance	Total Score
Enforce Current Regulations	0	1	2	4	1	8
Convert to Gravity	3	3	1	1	3	11
Convert to STEP System	4	2	2	2	4	14
Replace existing Grinder Pumps with new Grinder Pumps	4	3	3	4	3	17
Convert to Progressing Cavity	5	4	4	3	5	21
Convert to Vacuum Sewers	Not viable					

An example using these performance metrics to evaluate the available alternatives:

- Enforcing Current Regulations was given a Reduces O&M Costs benefit score of zero because the existing enforcement is not producing a significant reduction in the amount of grinder pump station failures – nor is it anticipated that stronger enforcement would make a larger impact.
- Converting to Gravity was given a Reduces O&M Costs benefit score of three because the technology will reduce O&M costs where it could be implemented – gravity sewers just can't be feasibly implemented for the entire East End.
- Converting to STEP System was given a Reduces O&M Costs benefit score of four because if it would fit on each property, historically they operate with reduced maintenance costs as compared to other technologies.

- Replacing Grinder Pumps with new grinder pumps was given a Reduces O&M Costs benefit score of four because Myer's V2 pump was designed to handle similar flows that Zanesville is experiencing, however, the pump is largely unproven.
- Converting to Progressing Cavity Pumps was given the highest Reduces O&M Costs benefit score of five because this is a tried and true technology that does not appear to have significant issues with the flows that Zanesville has been experiencing.

After applying these performance metrics, all of the available mitigation strategies, replacing the existing grinder pumps with upgraded equipment and converting to progressing cavity pumps emerged as the best alternatives. These alternatives will be the focus of the Recommendations section of this report.

Section 3
Recommendations

The City of Zanesville, like many municipalities, is facing increasing operation and maintenance costs associated with disposable wipes. The recommended action should also extend the life of the system, that is, the system should be improved in meaningful ways for years to come. To meet this challenge the following mitigation methodologies were evaluated:

- Enforce current regulations / Public Education
- Convert to a gravity system
- Convert to a STEP system
- Replace grinder pumps
- Convert grinder pump stations
- Convert to vacuum sewers

Each mitigation strategy has several positive aspects and negative aspects. To allow for a basis of comparison, the following performance metrics should be considered:

- Reduce O&M Costs – The main goal of the recommended action would be to reduce O&M costs associated with maintaining the grinder pump stations.
- Address all grinder stations – It is important that the recommended action address all grinder pump stations to reduce the frequency of service calls.
- Cost Effective – With the ever growing demand on the City's limited resources, the recommended action should not only reduce service calls, but do it cost effectively.
- Ease of Implementation – The recommended action should be something that does not add burden to the City nor be overly complicated to implement.
- Public Acceptance – The recommended action should be an acceptable one to those living in the City of Zanesville.

After applying these performance metrics all of the available mitigation strategies, replacing the existing grinder pumps with upgraded equipment and converting to progressing cavity pumps, emerged as the best alternatives.

3.1 Replace Existing Grinder Pumps with New Grinder Pumps

Replacing the existing grinder pumps with new grinder pumps is a viable solution. It can be done with existing City personnel without any new training. Replacement of the existing grinder pumps with Myers new V2 grinder pump would likely require the control box to be upgraded along with the existing wiring. These existing components should be checked to ensure that they are in good working order.

It is anticipated that each new V2 pump and rail assembly will cost approximately between $1,400 and $2,300 each (depending on the supplier), along with $300 to $500 to upgrade the control box and $122 to $150 for wiring, making the total cost to replace all 382 grinder pumps to approximately $696,000 to $1,130,000 depending on supplier. This is the cost for materials only, and the labor to do the work would be completed with city personnel.

Because this pump is relatively unproven, a pilot of a few of these pumps should be considered. The locations to try these pumps should be chosen based on ragging and the head that the pump would pump against.

3.2 Convert to Progressing Cavity Pumps

Converting the system to progressing cavity pumps appears to be the best alternative. These pumps have the distinct advantage of operating over a large range of conditions without cavitation which leads to excessive wear on the pump. Converting to the E/One system would reuse the fiberglass barrel of the existing grinder station. Each conversion would come with a new control box and cabling for approximately $2,500 per installation. It has been assumed that a simple control box similar to what is existing would be installed. If each of the 382 grinder pump stations are converted, the cost for materials would be approximately $955,000.

While converting these single home grinder stations to progressing cavity pumps would be new to the City of Zanesville, this technology has been around since the 1970's and was developed specifically for pressure sewer applications, and was not a retro-fit of existing technology like many of the centrifugal pumps. It is therefore, recommended that a pilot be performed. This would involve converting one or two of the City's most problematic grinder pump stations to an E/One system. If the station or stations meet the City's needs, E/One would train City personnel on how to convert stations over, and a program could be developed that would convert a number of stations per year until either O&M costs decrease or all 382 stations are converted.

For a typical pump station, there is not a need for maintaining a progressive cavity pump station. The conversion to a progressing cavity pump eliminates the existing rail system. This type of pump uses a pressure transducer for level control eliminating the need for maintenance calls due to a faulty float. The main wearing part is the rubber stator/liner. The average wear time for this part is 7 to 10 years and it can be changed in the field by City personnel and does not require special tools. Typical motor life is twenty or more years.

3.3 Lifecycle and O&M Costs

As discussed in Section 1, the City spent $64,000 in 2013 on materials and overtime for maintaining these grinder pump stations. If the City assumes that a similar level of spending would be directed to the East End, it would spend approximately $48,000 per year on proactive replacements and $16,000 on future reactive materials and overtime for emergency calls (total of $64,000). The City could proactively begin replacing some of the oldest or most historically problematic pumping systems with more modernized equipment. Thus, two options for replacing the mechanical systems of each grinder pump station are shown below:

- Replace existing grinder pump station equipment with a new V2 pump, new rails, new cabling and a new control box for $3,000 per station, or $48,000 per year. Using this option, the City would be able to address 16 pump stations per year. At that rate, it would take about 24 years to replace the entire system.

- Replace existing grinder pump station equipment with a new progressing cavity pump, new cabling and a new control box for $2,500 per station. Using this option, the City would be able to be able to address 19 pump stations per year. At that rate, it would take just over 20 years to replace the entire system.

If the City starts with the stations that have the most problems, the payoff, while not immediate, will be substantial as more and more grinder pump stations are upgraded to new equipment that is designed to address the addition of disposable wipes to their normal sanitary flows.

3.4 Recommendations

In addition to the City's existing proactive maintenance program and public notification program, CDM Smith recommends the following implementation plan for the Zanesville East End sewer systems.

3.4.1 Pilot Test

Upfront costs alone may not be the best differentiator for distinguishing between the E/One pump and Myers V2 pump. There could be hidden costs per installation that are specific to the East End System. For that reason, it is recommended that the top four problematic grinder stations be identified and have two E/One pumps installed and the other two receive V2 pumps. This will clarify the actual installed cost per system and give the City an idea on performance without committing to a single system from the start. It is estimated that the material for the pilot would cost about $5,000 for two E/one Systems and $3,000 to $6,000 (depending on vender) for two V2 pumps, rails, controller retrofits, and wiring.

3.4.2 Future Pump Replacement Plan

After the pilot, the City would have the option of changing all stations over at once, or phase in the technology that economically performs the best. Therefore, out of the 382 grinder pump stations in the East End, approximately 378 stations would still have 30 year old equipment that is at the end of its useful life and will be in need of upgrades.

If the City would upgrade all pump stations that were not included in the pilot test, approximately 378 would need to be upgraded. To upgrade to the Myers V2 system, the City should be prepared to spend approximately $1.1 Million or $113,400 a year for the next 10 years. To convert to the E/One progressing cavity pump system, the City should be prepared to spend $0.9 Million or $94,500 a year for the next 10 years. This scenario ignores any of the reactive maintenance that the City has done over the years.

The actual amount of grinder pump stations that have been upgraded with new pumps was not available at the time of this report. If it is assumed that approximately 30 percent of the existing grinder pumps have been upgraded in some way, these pump stations would not need to be included in a 10 year upgrade program. The City would need to address approximately 265 grinder pump stations in a 10 year replacement program. Therefore, to upgrade to the Myers V2 system the City should be prepared to spend $0.8 Million or $79,500 annually for the next 10 years. To convert to the E/One system the City should be prepared to spend $0.6 Million or $66,250 a year for the next 10 years.