Appendix C.5

Sanitary Sewer System Engineering Report

Sanitary Sewer System Engineering Report

Hilltop Village at Wappinger
Town of Wappinger, New York

September 30, 2011
Revised January 2, 2012

POVALL
ENGINEERING, PLLC
25 Corporate Park Drive, Suite C
Hopewell Junction, New York 12533

Project No. 0552

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1 Introduction

The Applicant, Toll Brothers, Inc., is proposing to develop 145.30 acres of a 149.35 acre parcel located at All Angels Hill Road (CR 94) in the Town of Wappinger, New York. "The "Hilltop Village at Wappinger" is a 225 unit age restricted residential development located in the Town of Wappinger. The residential development consists of 132 single family homes, 93 townhomes, and a club house with recreational facilities (e.g., swimming pool and tennis court). The site is identified on the Town of Wappinger Tax Map as Tax Number 6257-02-630770.

The property is located within the United Wappinger Sewer District. The Dutchess County Department of Health (DCDOH) in conjunction with the Town Engineer (Morris Associates) and CAMO Pollution Control, Inc. (sewer operator) will be responsible for the review and approval of the sanitary sewer system, since the project is located Dutchess County and will connect to the Town of Wappinger sanitary sewer collection system.

The proposed sanitary sewer system will conform to the requirements defined in 10 NYCRR Subpart 5-1 of the New York State Sanitary Code, which references the design standards in the *Great Lakes - Upper Mississippi River Board of State Public Health and Environmental Managers Recommended Standards for Wastewater Treatment Works*, 2004 (also known as the *Ten States Standards for Wastewater*). The proposed wastewater collection system will also conform to the requirements of the New York State Department of Environmental Conservation (NYSDEC) *Design Standards for Wastewater Treatment Works*, 1988 and the *DCDOH Water and Wastewater Systems Design and Construction Standards*, effective version and the Town of Wappinger Sewer Department requirements.

2 Site Description

The parcel is located on All Angels Hill Road (CR 94) in the Town of Wappinger, Dutchess County, New York (see Figure 1). This parcel is bounded by All Angels Hill Road (CR 94) to the east, a commercial property to the north, and residential properties to the north, south, and west.

The site is currently undeveloped with the exception of a commercial paved driveway, which provides access to the adjacent Flavormatic business. The ground cover consists of a paved driveway, woods, and grass. The site varies in elevation from 256 feet, at the lowest elevation in the northwestern corner of the property, to 398 feet, at the highest elevation on a knoll in the middle of the site.

3 Projected Wastewater Generation

The proposed age restricted community will generate domestic type wastewater flows. The Town of Wappinger has specific average daily flow rates for the single family homes and the townhomes, which will be used in lieu of the NYSDEC unit flow rates. The anticipated wastewater generation rate for the club house will be determined by using the the unit flow rates in the New York State Department of Environmental Conservation (NYSDEC) *Design Standards for Wastewater Treatment Works*, 1988. The anticipated wastewater generation from each of the uses on the site is summarized in Table 1 below.

Table 1: Anticipated Wastewater Generation for the Site

Use Type	Size	Unit	Flow Rate per Unit (gpd)	Wastewater Generation (gpd)
Single Family Homes	132	homes	320(1)	42,240
Townhomes	93	homes	200(2)	18,600
Club House	3,762	Sq. ft.	0.08(3)	301
			Total	**61,141**

(1) The average daily use for a single family home with no more than four-bedrooms per residential unit in accordance with the Town of Wappinger's practices (Chapter 236-6 of the Town Code).
(2) The average daily use for a two-bedroom apartment/unit in accordance with the Town of Wappinger's practices (Chapter 236-6 of the Town Code).
(3) Water saving plumbing fixtures will be used and the NYSDEC *Design Standards for Wastewater Treatment Works* permits a 20 percent reduction in the hydraulic loading rate. The values shown have already been reduced by 20 percent.

According to the September 27, 2010 letter from Morris Associates to the Town of Wappinger Planning Board (see Appendix A), the "Hilltop Village at Wappinger" site straddles a drainage divide and the sewage flows in the 1994 Plan and Report for the Wappinger Sewers to be Upgraded and Connected to the Tri-Muni System, prepared by Paggi & Martin, were assigned accordingly with the eastern part of the site draining to the Rockingham pump station and the western part of the site draining to the Shamrock Hills pump station (discharging west to the Spook Hill trunk line). Morris Associates determined the maximum sewage flows to the Rockingham pump station and Spook Hill trunk line using the same factors and assumptions presented in the original report and a theoretical maximum build-out of the site. The maximum sewage flow allocations are as follows:

Discharging east to Rockingham pump station	25,092 gpd
Discharging west to Spook Hill trunk line	51,400 gpd

The wastewater generated from the club house, 19 single family homes, and 68 townhomes will be conveyed to the Rockingham pump station. Therefore, the wastewater design flow to the Rockingham pump station is **19,981 gpd**. The wastewater generated from the remaining 113 single family homes and 25 townhomes will be conveyed to the Shamrock Hills pump station. Therefore, the wastewater design flow to the Shamrock Hills pump station is **41,160 gpd**.

4 Sanitary Sewer Collection System Design and Layout

4.1 Collection and Conveyance System

The sanitary sewer collection and conveyance system will be designed to collect the wastewater generated from the site, which will be conveyed to either the Rockingham pump station or Shamrock Hills pump station (discharging west to the Spook Hill trunk line). The wastewater generated from the eastern part of the residential development will be conveyed via gravity to an existing manhole on Rich Drive (see Figure 2). The wastewater will then continue via gravity from the existing manhole to the Rockingham pump station.

The wastewater generated from the western part of the residential development will be conveyed via gravity flow to an existing manhole located on the emergency access road off of Shamrock Hills

Drive (see Figure 3). The wastewater will continue via gravity from the existing manhole to the existing pump station within the Shamrock Hills subdivision, which will pump the wastewater to an existing manhole in the Kendell Farms neighborhood. From there, the wastewater will flow via gravity to the Kendell Farms pump station, which will pump the wastewater to an existing manhole on Admore Drive and then flow via gravity to the Spook Hill trunk line.

The sanitary sewer collection system will consist of 8-inch SDR 35 PVC gravity main and precast concrete sanitary manholes. Each building will have a sanitary sewer lateral that will connect to the gravity main. Sanitary sewer manholes will generally be provided at all changes of direction, both vertical and horizontal, and spaced not more than 400 feet apart. The gravity main will be designed to provide the minimum self-cleansing velocity of at least 2.0 feet per second (fps).

4.2 Existing Pump Stations and Collection System Evaluations

The Rockingham pump station, Shamrock Hills pump station, Kendall Farms pump station, and the Orchard Drive/Ardmore Road collection system were analyzed to confirm the existing pump stations and collection system are able to handle the additional sewage flow from Hilltop Village at Wappinger. The results of the analysis are discussed below.

4.2.1 Rockingham Pump Station Evaluation

The wastewater to be conveyed from Hilltop Village at Wappinger to the Rockingham pump station is 19,981 gpd. This flow is less than the maximum allocated sewage flow of 25,092 gpd, as documented in Section 3.

4.2.2 Shamrock Hills Subdivision Pump Station Evaluation

The wastewater generated from the western part of the residential development will be conveyed to the Shamrock Hills subdivision pump station. As a result, the Shamrock Hills pump station was analyzed to determine the potential impacts as a result of the proposed Hilltop Village at Wappinger project.

As per the "Engineer's Report Sanitary Sewer System Shamrock Hills Subdivision" prepared by Povall Engineering, PLLC last revised May 17, 2006 and approved by the DCDOH on August 16, 2006, the total average daily flow for the 63 lot subdivision was 25,200 gpd. The pump station is equipped with two (2) Smith & Loveless 15 HP Model 4B2X pumps. Each pump can deliver approximately 100 gpm at 105 feet of head. The pump station was sized based upon the following design parameters:

Average Design Flow = 18 gpm.
Peak Flow = 108 gpm.
Total Dynamic Head = 105 feet.

The wastewater to be conveyed to the Shamrock Hills subdivision pump station is **42,160 gpd**.

The average design flow for a 24-hour day = 42,160 gpd/(24 hr x 60 min/hr) ≈ **29 gpm**. The peak flow is estimated to be four (4) times the average design flow = 29 gpm x 4 = **116 gpm**. Therefore, the total design flow to the Shamrock Hills pump station would be 116 gpm + 108 gpm = **224 gpm**.

The pumps were evaluated to determine if they could handle the additional flow as a result of the Hilltop Village at Wappinger project. As shown in Table 2, the pump running time will be increased from 4 minutes to 10 minutes. As a result of the increased running time, the number of pump starts per hour for the duplex system as well as for each pump will be decreased.

Table 2: Shamrock Hills Pump Station Proposed Pump Running Time Modifications

Pump Station Pumps	Design	Proposed Modification
Running Time	4 minutes	10 minutes
Number of pump starts per hour (for duplex system)	4 to 5	3 to 4
Number of pump starts per hour (for each pump)	2 to 3	1 to 2

As shown in Table 3, the low level "on" will be raised approximately 7 inches, since the separation distance between the pump off and low level "on" has been increased from 6 inches to 13 inches as a result of the Hilltop Village at Wappinger project. The high level "on" and the high water alarm will also be raised approximately 7 inches.

Table 3: Shamrock Hills Pump Station Proposed Elevation Modifications

Component	Elevations	
	As-Built[1]	Proposed Modification
Top of Wet Well	**252.09**	--
Inv. In (SMH S-1)	**243.75**	--
Inv. In (SMH S-48)	**242.06**	--
Inv. Out (Force Main)	**246.09**	--
HW Alarm	243.59	244.15
High Level "On"	243.09	243.65
Low Level "On"	242.59	243.15
Pump Off	242.09	--
Bottom of Suction Pipe	241.59	--
Bottom of Tank	241.09	--

[1] As-Built information in **bold** was provided by Toll Brothers. All other information was determined based upon design separation distances

Based upon the analysis, the existing twin Smith & Loveless 15 HP Model 4B2X pumps can handle the additional flow with minor modifications to the pump station operation floats. Based upon the as-built elevation information provided, there is adequate space in the pump station to raise the floats. Design calculations are provided in Appendix B.

4.2.3 Kendell Farms Pump Station Evaluation

Based upon the above analysis, the existing pumps in the Shamrock Hills pump station will not have to be replaced as a result of the wastewater flow from the Hilltop Village at Wappinger project. The Shamrock Hills pump station flow rate/cycle will not impact the Kendell Farms pump station pumping flow, since the flow will remain unchanged. However, the increase of the Shamrock Hills pump station pumping cycles will cause the Kendell Farms pump station to cycle more often.

4.2.4 Orchard Drive/Ardmore Road Collection System

The Kendell Farms pump station discharges to the existing collection system within the Orchard Drive/Ardmore Road development. The collection system will also be unaffected, since the Kendell Farms pump station was unaffected by the Hilltop Village at Wappinger project.

5 Sanitary Sewer Collection System Testing

Prior to being placed in service, the required testing for each of the sanitary sewer system components is summarized in Table 4 below.

Table 4: Sanitary Sewer Collection System Testing

Component	Requirement	Testing Standard
Gravity Lines and Sewer Laterals	Deflection Test Low Pressure Test*	*Ten States Standards for Wastewater* ASTM F1417
Sanitary Manholes	Vacuum Test	ASTM C1244

* Alternatively, can test for leaks using infiltration test or exfiltration test. Refer to project plans for testing criteria

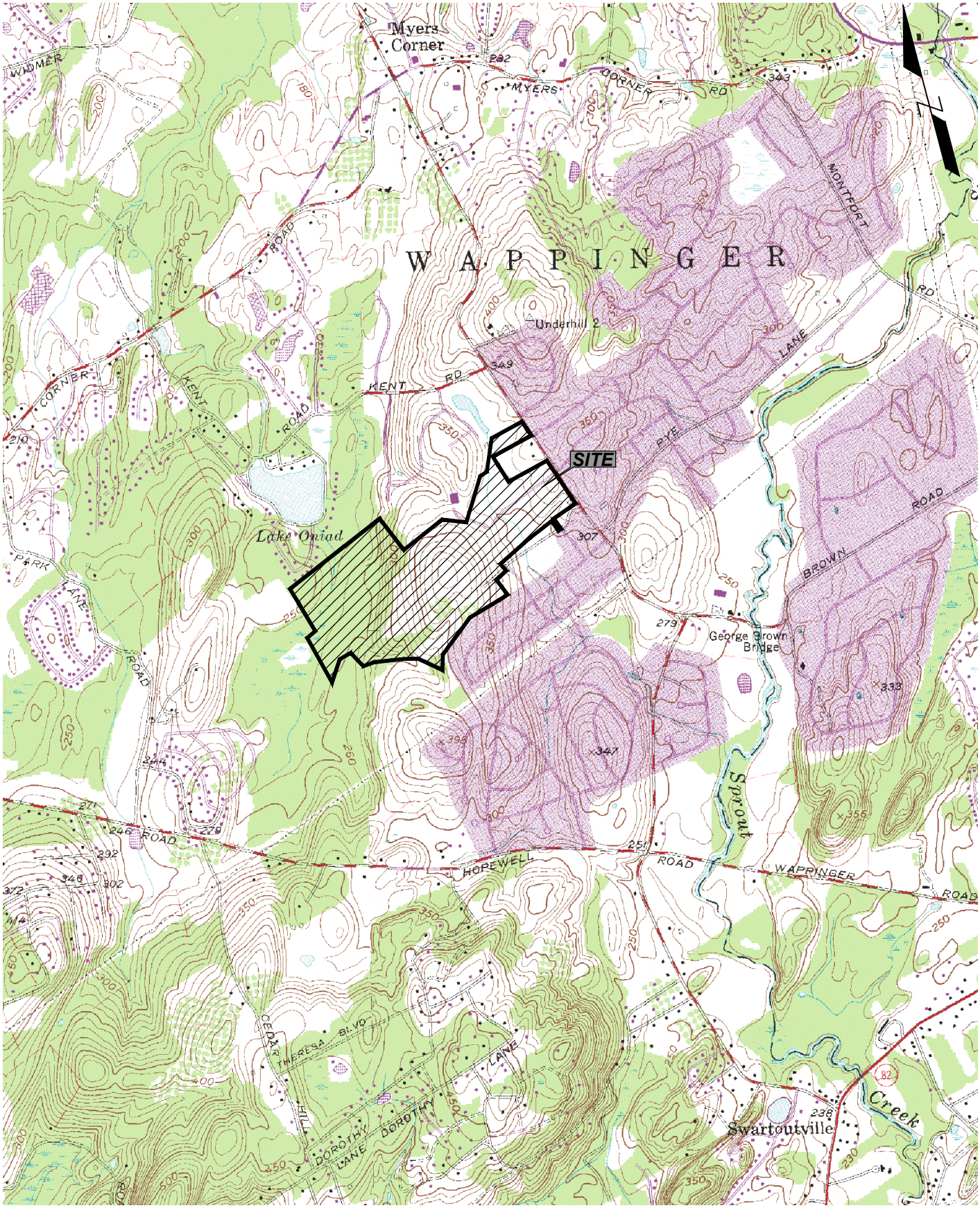
The Engineer will provide a certification letter to the DCDOH and Town once the testing has been completed. The testing standards have been provided in Appendix C for reference purposes.

6 Conclusions

The Shamrock Hills existing pump station, with minor float modifications, has sufficient capacity to service the proposed 225 unit age restricted residential development. The Kendell Farms pump station will cycle more often as a result of the increased cycling of the Shamrock Hills pump station. The Orchard Drive/Ardmore Road collection system will be unaffected by the proposed 225 unit age restricted residential development.

The proposed sanitary sewer collection system has been designed in accordance with *Ten States Standards for Wastewater*, 2004; the New York State Department of Environmental Conservation (NYSDEC) *Design Standards for Wastewater Treatment Works*, 1988; and the DCDOH *Water and Wastewater Systems Design and Construction Standards*, effective version, and meets all Town of Wappinger requirements.

Figures



WAPPINGERS FALLS AND HOPEWELL JUNCTION QUADRANGLES

POVALL ENGINEERING, PLLC

WILLIAM H. POVALL III, P.E.
N.Y.S.P.E. LICENSE #075020

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HILLTOP VILLAGE AT WAPPINGER

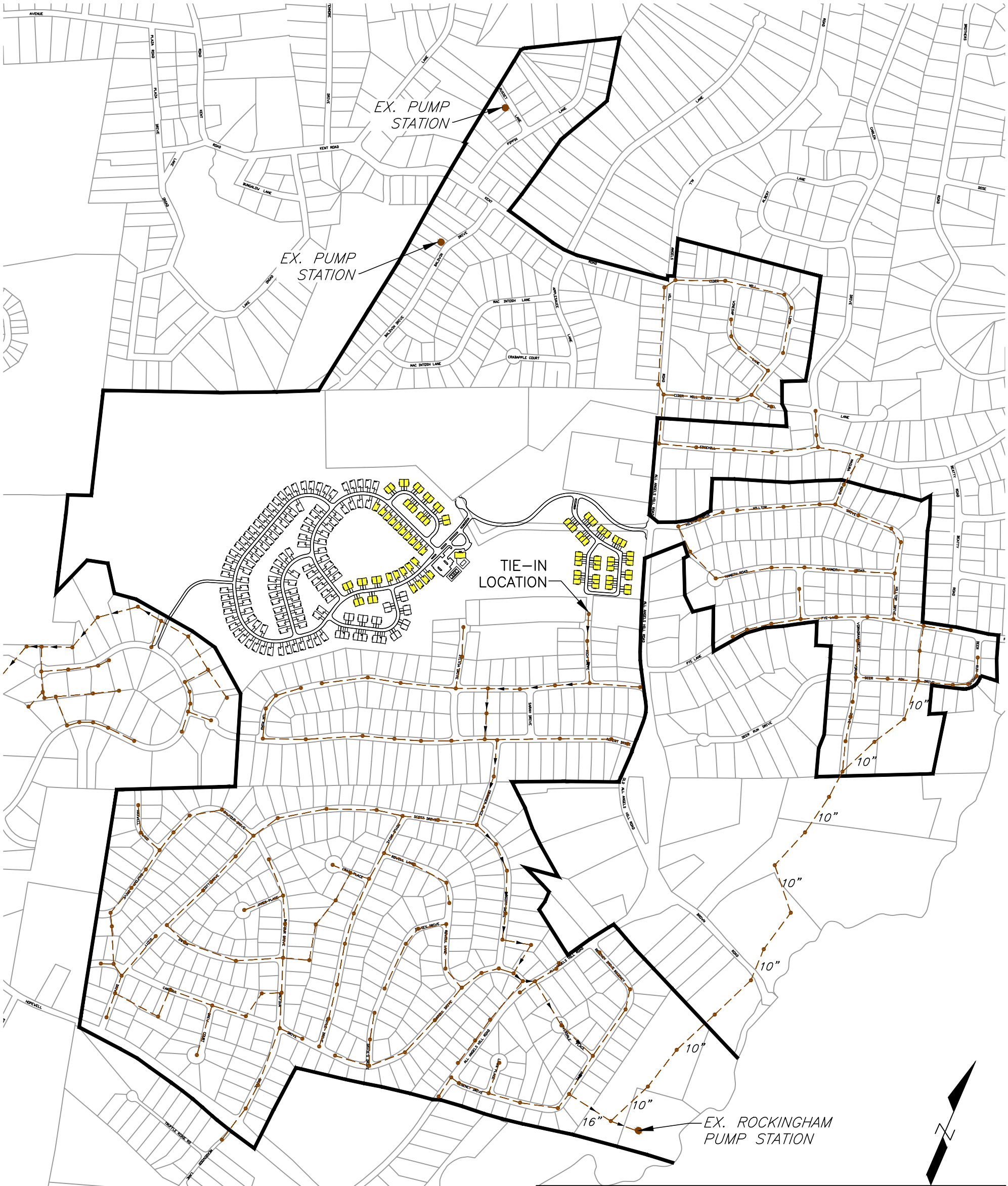
USGS SITE LOCATION MAP

TOWN OF WAPPINGER DUTCHESS COUNTY, NEW YORK

JOB #:	0552
DATE:	06/27/11
SCALE:	1"=2000'

FIGURE 1

File Path: R:\PE\DRAWINGS\0500\0552\dwg\0552_SWA 2011-09.dwg, Layout: FIG 1 USGS



LEGEND

▬▬▬	ROCKINGHAM FARMS SEWER DISTRICT LIMITS
— — —	EXISTING SANITARY SEWER LINE
Ⓢ	EXISTING SANITARY SEWER MANHOLES
◀	WASTEWATER FLOW PATH FROM SITE
▭	UNITS CONVEYED TO ROCKINGHAM PS

NOTES:

1. THE LOCATIONS OF THE EXISTING SANITARY SEWER LINES AND MANHOLES ARE APPROXIMATE AND BASED UPON THE FOLLOWING MAPS:
   A. "ROCKINGHAM FARMS SEWER DISTRICT" PREPARED BY PAGGI & MARTIN ENGINEERING LAST REVISED JULY 7, 1996.
   B. "ROCKINGHAM FARMS SECTION I" PREPARED BY HERBERT L. KARTIGNER, PE, LS LAST REVISED JUNE 22, 1966.
2. THE SEWER DISTRICT BOUNDARY WAS REVISED BASED UPON SEWER DISTRICT INFORMATION PROVIDED ON DUTCHESS COUNTY PARCEL ACCESS.
3. THE ROCKINGHAM PUMP STATION CONVEYS THE WASTEWATER TO THE SPOOK HILL TRUNK LINE.

REVISIONS	
DATE:	DESCRIPTION:
01/02/12	PER TOWN ENGINEER COMMENTS

POVALL ENGINEERING, PLLC

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HILLTOP VILLAGE AT WAPPINGER

UNITED WAPPINGER SEWER DISTRICT

TOWN OF WAPPINGER — DUTCHESS COUNTY, NEW YORK

JOB #: 0552
DATE: 08/03/11
SCALE: 1"=750'

FIGURE 2

NOTES:

1. THE LOCATION OF THE EXISTING SANITARY SEWER LINES, FORCE MAIN AND MANHOLES ARE APPROXIMATE.
2. THIS MAP WAS DEVELOPED BASED UPON A FIGURE ENTITLED "SHAMROCK HILLS SUBDIVISION OFFSITE SEWER SYSTEMS" PREPARED BY POVALL ENGINEERING, PLLC LAST REVISED MAY 17, 2006.

REVISIONS	
DATE:	DESCRIPTION:

LEGEND

- EXISTING FORCE MAIN
- EXISTING SANITARY SEWER LINE
- EXISTING SANITARY SEWER MANHOLES
- WASTEWATER FLOW PATH FROM SITE
- UNITS CONVEYED TO SHAMROCK HILLS PS

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HILLTOP VILLAGE AT WAPPINGER

SHAMROCK HILLS AND KENDELL FARMS PUMP STATIONS

TOWN OF WAPPINGER — DUTCHESS COUNTY, NEW YORK

JOB #: 0552
DATE: 08/03/11
SCALE: 1"=600'
FIGURE 3

Appendix A

Morris Associates Letter

MORRIS ASSOCIATES
ENGINEERING CONSULTANTS, PLLC
☒ 9 Elks Lane, Poughkeepsie, New York 12601 Tel: (845) 454-3411 Fax: (845) 473-1962
☐ 64 Green Street, Suite 1, Hudson, New York 12534 Tel: (518) 828-2300 Fax: (518) 828-3963

VIA E-MAIL TO Planning and Zoning office

September 27, 2010

Town of Wappinger
Planning Board
20 Middlebush Road
Wappingers Falls, NY 12590

Attn: Mr. Victor Fanuele, Chairman

Re: Hilltop Village
All Angels Hill Road
6257-02-630770
MA # W20963.0

Dear Chairman Fanuele and Planning Board Members:

This office reviewed the original Map, Plan and Report (MPR) for the Wappinger sewers to be upgraded and connected to the Tri-Muni system, prepared by Paggi & Martin in 1994. At the time the report was prepared, the Hilltop Village site was vacant land. The report assumed that part of the site would be developed per COP zoning, and part would be developed per R-40 zoning.

The Hilltop Village site straddles a drainage divide, and in the original MPR the sewage flow was assigned accordingly, with the eastern part of the site draining to the Rockingham pump station and the western part of the site draining to the Spook Hill trunk line.

Using the same factors and assumptions as in the original report, this office computed the sewage flows, based on a theoretical maximum buildout of the 145.3 acre site. The actual site plan may show different flows, but the flows should not exceed the amounts shown below.

Draining east to Rockingham pump station	25,092 gpd
Draining west to Spook Hill trunk line	51,440 gpd

This information is being provided to all other interested parties as cc's to this letter.

Re: Hilltop Village
All Angels Hill Road
6257-02-630770
MA # W20963.0

If you have any questions, please contact me at (845) 454-3411 extension 30.

Very truly yours,

MORRIS ASSOCIATES
Engineering Consultants, PLLC

Robert J. Gray, P.E.
Engineer to the Town

RJG/peh/cb

cc Christopher Colsey, Town Supervisor (by e-mail copy)
Barbara Roberti, Zoning Administrator (by e-mail copy)
Graham Foster, Highway Superintendent (by e-mail copy)
Mark Liebermann, Fire Inspector (by e-mail copy)
George Kolb, Building Inspector (by e-mail copy)
Albert P. Roberts, Esq., Town Attorney (by e-mail copy)
David Stolman, AICP, Planning Board Planning Consultant (by e-mail copy)
Mike Tremper, CAMO (by e-mail copy)
William H. Povall III, P.E., applicant's engineer (by e-mail copy)

Appendix B

Design Calculations

POVALL ENGINEERING, PLLC
25 Corporate Park Drive, Suite C
Hopewell Junction, NY 12533
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F: (845) 897-0042

Job No.:	0552	**Prepared By:**	CMZ	**Date:**	8/5/11	**Reviewed By:**	WHP
Job Name:	Hilltop Village at Wappinger	**Revised By:**		**Rev. Date:**		**Reviewed By:**	
Location:	All Angels Hill Road	**Municipality:**	Town of Wappinger			**County:**	Dutchess

SHAMROCK HILLS SUBDIVISION SANITARY PUMP STATION

1) Design Flow

- Flow with water saving fixtures (20% reduction)

Q_{design} = 25,200 gpd = 18 gpm (based on a 24-hour day)

Q_{max} = 36 gpm (w/ a factor of 2.0)

Q_{peak} = 108 gpm (w/ a factor of 6.0)

2) Provide 10-30 minutes retention at max design flow

- Required Volume:

Q_{max} x 10 min. = 360 gal

Q_{design} x 20 min. = 360 gal

Q_{design} x 30 min. = 540 gal (max design dose vol. in wet well)

- Pump Station Internal Dimensions = 6 ft diameter

- Internal Area of Wet Well = $\frac{1}{4}\pi d^2$ = 28.3 sf
- Volume Per Foot of Wet Well = 28.3 cf or 211.5 gal

3) Dose Volume Change

- Draw Down = Vol. Req. / Vol. Per Ft. of Manhole = 1.70 ft. = 20.42 in

use 20.0 in = 1.67 ft.

- Check: draw down x internal area = 47.1 cf or **352.5 gal** ($\leq Q_{design}$ @ 30 min)

4) Pump Station Elevations

Volume between pump off and LL "On" = 14.44 cf

Height between pump off and LL "On" = 0.51 ft

Component	Design Elevation (ft)
Top of Wet Well =	250.0
Inv. In (SMH S-1) =	243.8
Inv. In (SMH S-48) =	242.0
Inv. Out (Force Main) =	248.6
HW Alarm =	242.0
High Level "On" =	241.5
Low Level "On" =	241.0
Pump Off =	240.5
Bottom of Suction Pipe =	239.5
Bottom of Tank =	239.0

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Job No.:	0552	**Prepared By:**	CMZ	**Date:**	8/5/11	**Reviewed By:**	WHP
Job Name:	Hilltop Village at Wappinger	**Revised By:**		**Rev. Date:**		**Reviewed By:**	
Location:	All Angels Hill Road	**Municipality:**	Town of Wappinger			**County:**	Dutchess

5) Determine Pump Running Time

- Pump Rate = 100 gpm (from operation curve)

- Dose Volume:
  Draw Down Height x Wet Well Area = 353 gal
  Wet Well Volume / ft.= 211.5 gal

  Running Time = 3.53 min, **use** **4 min**

- Pump Cycle for Peak Flow:
  Time for Q_{max} to fill Dose Volume = 9.79 min, **use** **10 min** (time between starts > 5 min)

- For Max Day Flow:
  Number of Pump Starts per hour = 4 TO 5 for duplex pump system
  Number of Pump Starts per hour = 2 TO 3 for each pump

Notes:
- Provide 10-30 minutes retention at max design flow
- No. Starts = 60 min / (Time for Qpeak to Fill Dose Vol.+ Pump Running Time to Pump Out Dose)
- No. Start/Stops per hour: Maximum of 10 to 12 starts per hour
- Maximum = 6 starts per hour for one pump
- Maximum = 12 starts per hour for duplex (2) pump system

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Hopewell Junction, NY 12533
P: (845) 897-8205
F: (845) 897-0042

Job No.:	0552	**Prepared By:**	CMZ	**Date:**	8/5/11	**Reviewed By:**	WHP
Job Name:	Hilltop Village at Wappinger	**Revised By:**		**Rev. Date:**		**Reviewed By:**	
Location:	All Angels Hill Road	**Municipality:**	Town of Wappinger			**County:**	Dutchess

SHAMROCK HILLS SUBDIVISION SANITARY PUMP STATION EVALUATION

1) Design Flow

- Flow with water saving fixtures (20% reduction)

$Q_{design\ Shamrock}$ = 25,200 gpd = 18 gpm (based on a 24-hour day)

$Q_{design\ Hilltop}$ = 41,160 gpd = 29 gpm (based on a 24-hour day)

Q_{max} = 94 gpm (w/ a factor of 2.0)

Q_{peak} = 224 gpm *

Notes:

* factor 6.0 for Shamrock Hills PS & 4.0 for Hilltop Village

2) Provide 10-30 minutes retention at max design flow

- Required Volume:

Q_{max} x 10 min. = 940 gal

Q_{design} x 20 min. = 940 gal

Q_{design} x 30 min. = 870 gal (max design dose vol. in wet well)

- Pump Station Internal Dimensions = 6 ft diameter

- Internal Area of Wet Well = $\frac{1}{4}\pi d^2$ = 28.3 sf
- Volume Per Foot of Wet Well = 28.3 cf or 211.5 gal

3) Dose Volume Change

- Draw Down = Vol. Req. / Vol. Per Ft. of Manhole = 4.44 ft. = 53.33 in

use 54.0 in = 4.50 ft.

- Check: draw down x internal area = 127.2 cf or **951.8 gal** ($\leq Q_{design}$ @ 30 min)

4) Pump Station Elevations

Volume between pump off and LL "On" = 29.94 cf

Height between pump off and LL "On" = 1.06 ft

Component	Elevation (ft) As-built[a,b]	Revised
Top of Wet Well =	**252.09**	--
Inv. In (SMH S-1) =	**243.75**	--
Inv. In (SMH S-48) =	**242.06**	--
Inv. Out (Force Main) =	**246.09**	--
HW Alarm =	~~243.59~~	244.15
High Level "On" =	~~243.09~~	243.65
Low Level "On" =	~~242.59~~	243.15
Pump Off =	242.09	--
Bottom of Suction Pipe =	241.59	--
Bottom of Tank =	241.09	--

Notes

[a] Bold information from as-built information provided by Toll Brothers.

[b] Remaining information determined based upon design separation distances.

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Hopewell Junction, NY 12533
P: (845) 897-8205
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Job No.:	0552	**Prepared By:**	CMZ	**Date:**	8/5/11	**Reviewed By:**	WHP
Job Name:	Hilltop Village at Wappinger	**Revised By:**		**Rev. Date:**		**Reviewed By:**	
Location:	All Angels Hill Road	**Municipality:**	Town of Wappinger			**County:**	Dutchess

5) Determine Pump Running Time

- Pump Rate = 100 gpm (from operation curve)

- Dose Volume:
  Draw Down Height x Wet Well Area = 952 gal
  Wet Well Volume / ft.= 211.5 gal

  Running Time = 9.52 min, **use** **10 min**

- Pump Cycle for Peak Flow:
  Time for Q_{max} to fill Dose Volume = 10.13 min, **use** **10 min** (time between starts > 5 min)

- For Max Day Flow:
  Number of Pump Starts per hour = 3 TO 4 for duplex pump system
  Number of Pump Starts per hour = 1 TO 2 for each pump

Notes:

- Provide 10-30 minutes retention at max design flow
- No. Starts = 60 min / (Time for Qpeak to Fill Dose Vol.+ Pump Running Time to Pump Out Dose)
- No. Start/Stops per hour: Maximum of 10 to 12 starts per hour
- Maximum = 6 starts per hour for one pump
- Maximum = 12 starts per hour for duplex (2) pump system

Appendix C

Testing Standards

RECOMMENDED STANDARDS
for
WASTEWATER FACILITIES

POLICIES FOR THE DESIGN, REVIEW, AND APPROVAL OF PLANS AND SPECIFICATIONS

FOR WASTEWATER COLLECTION AND TREATMENT FACILITIES

2004 EDITION

A REPORT OF THE WASTEWATER COMMITTEE

OF THE

GREAT LAKES -- UPPER MISSISSIPPI RIVER

BOARD OF STATE AND PROVINCIAL PUBLIC HEALTH AND ENVIRONMENTAL MANAGERS

MEMBER STATES AND PROVINCE

ILLINOIS
INDIANA
IOWA
MICHIGAN
MINNESOTA
MISSOURI
NEW YORK
OHIO
ONTARIO
PENNSYLVANIA
WISCONSIN

of cover shall be considered in determining the minimum trench width necessary to adequately support the pipe.

b. Ledge rock, boulders, and large stones shall be removed to provide a minimum clearance of 4 inches (100 mm) below and on each side of all pipe(s).

33.83 Bedding, Haunching, and Initial Backfill

a. Bedding Classes A, B, C, or crushed stone as described in ASTM C 12 shall be used and carefully compacted for all rigid pipe provided the proper strength pipe is used with the specified bedding to support the anticipated load, based on the type soil encountered and potential ground water conditions.

b. Embedment materials for bedding, haunching and initial backfill, Classes I, II, or III, as described in ASTM D 2321, shall be used and carefully compacted for all flexible pipe provided the proper strength pipe is used with the specified bedding to support the anticipated load, based on the type soil encountered and potential groundwater conditions.

c. All water entering the excavations or other parts of the work shall be removed until all the work has been completed. No sanitary sewer shall be used for the disposal of trench water, unless specifically approved by the engineer, and then only if the trench water does not ultimately arrive at existing pumping or wastewater treatment facilities.

33.84 Final Backfill

a. Final backfill shall be of a suitable material removed from excavation except where other material is specified. Debris, frozen material, large clods or stones, organic matter, or other unstable materials shall not be used for final backfill within 2 feet (0.6 m) of the top of the pipe.

b. Final backfill shall be placed in such a manner as not to disturb the alignment of the pipe.

33.85 Deflection Test

a. Deflection tests shall be performed on all flexible pipe. The test shall be conducted after the final backfill has been in place at least 30 days to permit stabilization of the soil-pipe system.

b. No pipe shall exceed a deflection of 5 percent. If deflection exceeds 5 percent, the pipe shall be excavated. Replacement or correction shall be accomplished in

accordance with requirements in the approved specifications.

c. The rigid ball or mandrel used for the deflection test shall have a diameter not less than 95 percent of the base inside diameter or average inside diameter of the pipe depending on which is specified in the ASTM Specification, including the appendix, to which the pipe is manufactured. The test shall be performed without mechanical pulling devices.

33.9 Joints and Infiltration

33.91 Joints

The installation of joints and the materials used shall be included in the specifications. Sewer joints shall be designed to minimize infiltration and to prevent the entrance of roots throughout the life of the system.

33.92 Service Connections

Service connections to the sewer main shall be water tight and not protrude into the sewer. If a saddle type connection is used, it shall be a device designed to join with the types of pipe which are to be connected. All materials used to make service connections shall be compatible with each other and with the pipe materials to be joined and shall be corrosion proof.

33.93 Leakage Tests

Leakage tests shall be specified. This may include appropriate water or low pressure air testing. The testing methods selected should take into consideration the range in groundwater elevations during the test and anticipated during the design life of the sewer.

33.94 Water (Hydrostatic) Test

The leakage exfiltration or infiltration shall not exceed 100 gallons per inch of pipe diameter per mile per day [9 L/(mm of pipe diameter·km·d)] for any section of the system. An exfiltration or infiltration test shall be performed with a minimum positive head of 2 feet (0.6 m).

33.95 Air test

The air test shall, as a minimum, conform to the test procedure described in ASTM C 828 for clay pipe, ASTM C 924 for concrete pipe, ASTM F 1417 for plastic pipe, and for other materials test procedures approved by the regulatory agency.

sewer, service connection, or drop manhole pipe shall discharge onto the surface of the bench.

34.6 Watertightness

Manholes shall be of the pre-cast concrete or poured-in-place concrete type. Manhole lift holes and grade adjustment rings shall be sealed with non-shrinking mortar or other material approved by the regulatory agency.

Inlet and outlet pipes shall be joined to the manhole with a gasketed flexible watertight connection or any watertight connection arrangement that allows differential settlement of the pipe and manhole wall to take place.

Watertight manhole covers are to be used wherever the manhole tops may be flooded by street runoff or high water. Locked manhole covers may be desirable in isolated easement locations or where vandalism may be a problem.

34.7 Inspection and Testing

The specifications shall include a requirement for inspection and testing for watertightness or damage prior to placing into service. Air testing, if specified for concrete sewer manholes, shall conform to the test procedures described in ASTM C 1244.

34.8 Corrosion Protection For Manholes

Where corrosive conditions due to septicity or other causes are anticipated, corrosion protection on the interior of the manholes shall be provided.

34.9 Electrical

Electrical equipment installed or used in manholes shall conform to Paragraph 42.35.

35. INVERTED SIPHONS

Inverted siphons shall have not less than two barrels, with a minimum pipe size of 6 inches (150 mm). They shall be provided with necessary appurtenances for maintenance, convenient flushing, and cleaning equipment. The inlet and discharge structures shall have adequate clearances for cleaning equipment, inspection, and flushing. Design shall provide sufficient head and appropriate pipe sizes to secure velocities of at least 3.0 feet per second (0.9 m/s) for design average flows. The inlet and outlet details shall be so arranged that the design average flow is diverted to one barrel, and so that either barrel may be cut out of service for cleaning. The vertical alignment should permit cleaning and maintenance.

Designation: F 1417 – 92 (Reapproved 2005)

An American National Standard

Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air[1]

This standard is issued under the fixed designation F 1417; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method provides procedures for testing plastic pipe sewer lines, using low-pressure air to prove the integrity of the installed material and the construction procedures. Two procedures are included to find the rate of air leakage—the constant-pressure method and the time-pressure drop method.

1.2 This test method shall be performed on lines after all connections and service laterals have been plugged and braced adequately to withstand the test pressure. The time between completion of the backfill operation and low-pressure air testing may be specified by the approving authority.

1.3 This test method also may be used as a preliminary test, which enables the installer to show the condition of a buried line prior to final backfill, paving, and other construction activities.

1.4 This test method is applicable to all gravity sewer lines made of thermoplastic pipe, reinforced thermosetting resin (RTRP) pipe, and reinforced plastic mortar (RPM) pipe, defined in Terminology D 883, D 1600, and F 412.

1.5 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific precautionary statements, see Section 5.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

C 828 Practice for Low-Pressure Air Test of Vitrified Clay Pipe Lines (4 to 12-in.)

C 924 Practice for Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method

D 883 Terminology Relating to Plastics

D 1600 Terminology for Abbreviated Terms Relating to Plastics

D 2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings

D 3567 Practice for Determining Dimensions of Fiberglass (Glass-Fiber-Reinforced Thermosetting Resin) Pipe and Fittings

F 412 Terminology Relating to Plastic Piping Systems

2.2 *Uni-Bell PVC Pipe Association Standard:*

UNI-B-6-90 Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe[3]

3. Summary of Test Method

3.1 The section of the line to be tested is plugged. Air, at low pressure, is introduced into the plugged line. The line passes the test if the rate of air loss, as measured by pressure drop, does not exceed a specified amount in a specified time. Pressure drop may be determined by using Table 1 or Table 2, or calculated by use of the formulas in 9.1.

4. Significance and Use

4.1 This low-pressure air test detects damaged piping or improper jointing by measuring the rate at which air under pressure escapes from an isolated section of sewer.

4.2 The rate of air loss will indicate the presence or absence of damaged piping or leaking joints. This test method is not intended to show total system water leakage limits and cannot be used as a quantitative measure of leakage under service conditions for infiltration or exfiltration.

NOTE 1—A finding of acceptable air loss specified in this test method can be interpreted as an installation acceptance test in lieu of infiltration or exfiltration test.

4.3 This test method will ensure the best possible initial condition and quality workmanship of all property-installed sewer pipe.

5. Apparatus

5.1 *Plugs*—Mechanical or pneumatic type.

5.2 *Air Compressor*—A properly calibrated portable, oil-free air source with a singular control panel containing a main shut-off valve, pressure-regulating valve, 9 psig pressure-relief

[1] This test method is under the jurisdiction of ASTM Committee F-17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.62 on Sewer.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from Uni-Bell PVC Pipe Association, Suite 155, 2655 Villa Creek Drive, Dallas, TX 75234.

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TABLE 1 Minimum Specified Time Required for a 1.0 psig Pressure Drop for Size and Length of Pipe Indicated for *Q* = 0.0015

NOTE 1—See Practice UNI-B-6-90.
NOTE 2—Consult with pipe and appurtenance manufacturer for maximum test pressure for pipe size greater than 30 in. in diameter.

Pipe Diameter, in.	Minimum Time, min:s	Length for Minimum Time, ft	Time for Longer Length, s	Specification Time for Length (L) Shown, min:s							
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft
4	3:46	597	0.380 L	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46
6	5:40	398	0.854 L	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:24
8	7:34	298	1.520 L	7:34	7:34	7:34	7:34	7:36	8:52	10:08	11:24
10	9:26	239	2.374 L	9:26	9:26	9:26	9:53	11:52	13:51	15:49	17:48
12	11:20	199	3.418 L	11:20	11:20	11:24	14:15	17:05	19:56	22:47	25:38
15	14:10	159	5.342 L	14:10	14:10	17:48	22:15	26:42	31:09	35:36	40:04
18	17:00	133	7.692 L	17:00	19:13	25:38	32:03	38:27	44:52	51:16	57:41
21	19:50	114	10.470 L	19:50	26:10	34:54	43:37	52:21	61:00	69:48	78:31
24	22:40	99	13.674 L	22:47	34:11	45:34	56:58	68:22	79:46	91:10	102:33
27	25:30	88	17.306 L	28:51	43:16	57:41	72:07	86:32	100:57	115:22	129:48
30	28:20	80	21.366 L	35:37	53:25	71:13	89:02	106:50	124:38	142:26	160:15
33	31:10	72	25.852 L	43:05	64:38	86:10	107:43	129:16	150:43	172:21	193:53
36	34:00	66	30.768 L	51:17	76:55	102:34	128:12	153:50	179:29	205:07	230:46

TABLE 2 Minimum Specified Time Required for a 0.5 psig Pressure Drop for Size and Length of Pipe Indicated for *Q* = 0.0015

NOTE 1—Consult with pipe and appurtenance manufacturer for maximum test pressure for pipe size greater than 30 in. in diameter.

Pipe Diameter, in.	Minimum Time, min:s	Length for Minimum Time, ft	Time for Longer Length, s	Specification Time for Length (L) Shown, min:s							
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft
4	1:53	597	0.190 L	1:53	1:53	1:53	1:53	1:53	1:53	1:53	1:53
6	2:50	398	0.427 L	2:50	2:50	2:50	2:50	2:50	2:50	2:51	3:12
8	3:47	298	0.760 L	3:47	3:47	3:47	3:47	3:48	4:26	5:04	5:42
10	4:43	239	1.187 L	4:43	4:43	4:43	4:57	5:56	6:55	7:54	8:54
12	5:40	199	1.709 L	5:40	5:40	5:42	7:08	8:33	9:58	11:24	12:50
15	7:05	159	2.671 L	7:05	7:05	8:54	11:08	13:21	15:35	17:48	20:02
18	8:30	133	3.846 L	8:30	9:37	12:49	16:01	19:14	22:26	25:38	28:51
21	9:55	114	5.235 L	9:55	13:05	17:27	21:49	26:11	30:32	34:54	39:16
24	11:20	99	6.837 L	11:24	17:57	22:48	28:30	34:11	39:53	45:35	51:17
27	12:45	88	8.653 L	14:25	21:38	28:51	36:04	43:16	50:30	57:42	64:54
30	14:10	80	10.683 L	17:48	26:43	35:37	44:31	53:25	62:19	71:13	80:07
33	15:35	72	12.926 L	21:33	32:19	43:56	53:52	64:38	75:24	86:10	96:57
36	17:00	66	15.384 L	25:39	38:28	51:17	64:06	76:55	89:44	102:34	115:23

valve, input pressure gage, and a continuous monitoring pressure gage having a pressure range from 0 psi to at least 10 psi with minimum divisions of 0.10 psi and an accuracy of ± 0.04 psi.

5.3 *Rotameter*, standard CFM reading with an accuracy of ± 2 %.

6. Safety Precautions

6.1 This low-pressure air test may be dangerous to personnel if, through lack of understanding or carelessness, a line is overpressurized or plugs/caps are installed or restrained improperly. It is extremely important that the various plugs be properly installed to prevent the sudden expulsion of a poorly installed or partially inflated plug. Observe the following minimum safety precautions:

6.1.1 No one shall be allowed in the manholes during testing.

6.1.2 Install and restrain all caps and plugs securely.

6.1.3 When lines are tested, it is mandatory that all the caps and plugs be braced as an added safety factor.

6.1.4 Do not overpressurize the lines. Do not exceed 9.0 psig.

NOTE 2—The axial force on a plug at 4 psig internal pressure is $F = P \pi D^2/4$ lb, where D is the inside diameter in inches. Thus, the axial force on an 8-in. plug at the start of a properly-conducted test is over 200 lb. Restraint systems must be designed to handle these forces with adequate safety factors. Every effort should be made to maintain backfill over the pipe during air testing.

6.1.5 A regulator or relief valve set no higher than 9 psi shall be included on all pressurizing equipment.

7. Preparation of the Line

7.1 Clean the section of sewer line to be tested by flushing or other means prior to conducting the low-pressure air test. This cleaning serves to eliminate debris and produce the most consistent results.

8. Procedures

8.1 Isolate the section of sewer line to be tested by inflatable stoppers or other suitable test plugs.

8.1.1 Plug or cap the ends of all branches, laterals, tees, wyes, and stubs to be included in the test to prevent air leakage. All plugs and caps shall be securely braced to prevent

blow-out. One of the plugs or caps should have an inlet tap, or other provision for connecting a hose to a portable air control source.

8.1.2 Connect the air hose to the inlet tap and portable air control source. The air equipment shall consist of necessary valves and pressure gages to control an oil-free air source and the rate at which air flows into the test section to enable monitoring of the air pressure within the test section.

8.1.3 Add air slowly to the test section until the pressure inside the pipe reaches 4.0 psig.

8.1.4 After the pressure of 4.0 psig is obtained, regulate the air supply so that the pressure is maintained between 3.5 to 4.0 psig for at least 2 min depending on air/ground temperature conditions. The air temperature should stabilize in equilibrium with the temperature of the pipe walls. The pressure will normally drop slightly until equilibrium is obtained; however, a minimum of 3.5 psig is required.

8.2 Determine the rate of air loss by either the constant pressure method or the time-pressure drop method.

NOTE 3—All test pressures are measured as gage pressure, which is any pressure greater than atmospheric pressure. Since water produces a pressure of 0.43 psi for every foot of depth, air test pressures must be increased to offset the depth of ground water over the sewer line. If the ground water level is 2 ft or more above the top of the pipe at the upstream end, or if the air pressure required for the test is greater than 9-psi gage, the air test method should not be used. Before the air test method is used, the ground water level should be lowered by pumping or dewatering.

8.2.1 *Constant Pressure Method*—Add air until the internal air pressure of the sewer line is raised to 4.0 psig and the test pipe section is stabilized as in 8.1. Release the pressure to 3.5 psig to run the constant pressure test. The air-flow rate in standard cubic feet per minute is read directly by a rotameter. Convert this air-flow rate to actual cubic feet per minute of air leaking from the test section by using the absolute pressure and temperature in the test section. The requirements for air loss under the constant pressure method shall be considered satisfied if the air loss does not exceed the specified leakage rate in cubic feet per minute per square foot of internal pipe surface area.

8.2.2 *Time-Pressure Drop Method*—Air is slowly introduced into the section of pipe to be tested, until the air pressure is raised to approximately 4.0 psi and the test pipe section is stabilized as in 8.1. Disconnect the air supply and decrease the pressure to 3.5 psi before starting the test. Determine the time required for the pressure to drop from 3.5 psi to 2.5 psi, and compare this interval to the required time to decide if the rate of air loss is within the allowable. Minimum holding times required by pipe diameter are shown in Table 1 and Table 2.

NOTE 4—The time-pressure drop method assumes an atmospheric pressure of 14.7 psia. Locations of high altitude need compensation for variation in atmospheric pressure to maintain the same air leakage test criteria.

8.3 Upon completion of the test, open the bleeder valve and allow all air to escape. Plugs should not be removed until all air pressure in the test section has been reduced to atmospheric pressure.

9. Test Time Calculations

9.1 *Test Time Criteria*—No test section shall be accepted if air loss is more than a specified leakage rate (in cubic feet per minute per square foot) determined by the approving authority.

9.2 Calculate all test times by the following formula:

$$T = 0.085\ DK/Q$$

where:

T = shortest time allowed for the air pressure to drop 1.0 psig, s,
K = 0.000419 DL but not less than 1.0,
Q = leak rate in cubic feet/minute/square feet of internal surface = 0.0015 CFM/SF,
D = measured average inside diameter of sewer pipe (see Test Method D 2122 and Practice D 3567), in., and
L = length of test section, ft.

Table 1 contains the specified minimum times required for a 1.00 psig pressure drop from a starting pressure of 3.5 psig to a final pressure of 2.5 psig using a leakage rate of 0.0015 $ft^3/min/ft^2$ of internal surface.

9.3 The total leakage from any test section shall not exceed 625Q.

9.4 If the pressure drops 1.0 psig before the appropriate time shown in Table 1 has elapsed, the air loss rate shall be considered excessive and the section of pipe has failed the test. If the line fails the test, segmented testing may be utilized solely to find the location of leaks. Once leaks are located and repaired, retest the completed pipe installation to requirements of this test method.

9.5 For testing of long sections or sections of larger diameter pipes, or both, a timed-pressure drop of 0.5 psig shall be used in lieu of a 1.0 psig timed-pressure drop. If a 0.5 psig pressure drop is used, the appropriate required test time shall be exactly one-half the values shown in Table 1. (See Table 2.)

NOTE 5—It is not necessary to hold the test for the entire period of time in Table 1 or Table 2 when it is evident that the rate of air loss is zero or less than the allowable, and is authorized by the approving authority.

9.6 If lateral or service lines are included in the test, their length may be ignored for computing required test time if the test time requirements are met. The maximum permissible air loss should not exceed 625Q. If the test section fails, time shall be recomputed to include all the lateral lengths using the following formula:

$$T = 0.085 \left[\frac{D_1{}^2 L_1 + D_2{}^2 L_2 + \ldots + D_n{}^2 L_n}{D_1 L_1 + D_2 L_2 + \ldots + D_n L_n} \right] \frac{K}{Q}$$

where:

T = shortest time allowed for the air pressure to drop 1.0 psig, s,
K = 0.000419 ($D_1L_1 + D_2L_2 + \ldots + D_nL_n$), but not less than 1.0,
Q = 0.0015 CFM/SF,
D_1, D_2, *etc.* = nominal diameter of different size of pipe being tested, and
L_1, L_2, *etc.* = respective lengths of the different size pipes being tested.

If the recomputed test time is short enough to allow the section tested to pass, then the test section meets the requirements of this test method.

10. Precision and Bias

10.1 This test method provides qualitative data only; therefore, a precision and bias statement is nonapplicable.

11. Keywords

11.1 air test; plastic; sewer

APPENDIXES

(Nonmandatory Information)

X1. EXAMPLES

X1.1 In order to show the technique of applying this test method, the following examples have been prepared. The examples have been designed to illustrate the use of Table 1 and Table 2 and the formula in 9.1 that uses a leakage rate of 0.0015 CFM/ft^2.

X1.2 A manhole-to-manhole reach of nominal 12 in. pipe is 350 ft long. No lateral connections exist in the reach. What is the required test time for a 1.0 psig pressure drop?

X1.2.1 *Solution*—The required test time can be read directly from Table 1. For 350 ft of 12 in. pipe, the required test time is 19:56 (19 min and 56 s).

X1.3 A 350 ft section of nominal 12 in. pipe is ready for testing. A total of 128 ft of 4 in. lateral sewer pipe is connected to the 350 ft section and will be included in the test. What will be the required test time for a 0.5 psig pressure drop?

X1.3.1 *Solution*—Lateral sewers may be disregarded when selecting test times (see 9.1). Therefore, the required test time will be 9 min and 58 s as shown in Table 2.

NOTE X1.1—If the lateral sewers had not been disregarded, the required test time would be 10 min and 22 s, that is, only 24 s longer.

X1.4 What should the required test time be for a 1.0 psig pressure drop in 327 ft of nominal 8 in. diameter pipe between two manholes?

X1.4.1 *Solution*—The exact test time is easily calculated by using Table 1. Table 1 is used because a 1.0 psig pressure drop is specified. Since 327 ft exceed the 298 ft length associated with the minimum test time for an 8 in. pipeline, the fourth column in Table 1 is used to calculate the required test time as follows:

$$T = 1.520 \times L = 1.52 \times 327 = 497 \text{ s}$$

Therefore, the required test time for a 1.0 psig pressure drop is 497 s or 8 min and 17 s.

X1.5 A manhole-to-manhole reach of nominal 24 in. pipe is 82 ft long. What is the required test time for a 0.5 psig pressure drop?

X1.5.1 *Solution*—Table 2 is used because a 0.5 psig pressure drop is specified. Since 82 ft is less than the 99 ft length associated with the minimum test time for a 24 in. pipeline, the minimum test time shall apply. Thus, the required test time for a 0.5 psig pressure drop is 11:24 (11 min and 24 s).

X1.6 A 412 ft section of nominal 15 in. sewer pipe has been readied for air testing. A total of 374 ft of nominal 6 in. lateral piping and 148 ft of nominal 4 in. lateral piping branch off the 15 in.-sewer line. All laterals have been capped or plugged, or both, and will be tested together with the 15 in. main line. The specified pressure drop, which will be timed, is 0.5 psig. What is the appropriate test time for this pipe network?

X1.6.1 *Solution*—All lateral sewer sizes and lengths may be disregarded since their influence is generally not significant enough to warrant computation. Table 2 is used for a 0.5 psig pressure drop. The fourth column in the table gives the appropriate formula for calculating the required test time because 412 ft is longer than the third column value of 159 ft.

$$T = 2.671L = 2.671 \times 412 = 1100 \text{ s}$$

The required test time is 1100 s or 18 min and 20 s.

X1.7 A manhole-to-manhole reach of nominal 8 in. pipe is only 100 ft long. A total of 300 ft of nominal 4 in. lateral piping is connected to the 100 ft section and will be included in air testing the section. What will be the required test time for a 1.0 psig pressure drop?

X1.7.1 *Solution*—The required test time can be read directly from Table 1. Thus, for 100 ft of 8 in. pipe, the required holding time is 7:34 (7 min and 34 s). However, should the section fail to meet this test, recalculate the required holding time, taking into account the connected laterals. This recalculation is required because the total internal pipe surface area is less than 625 ft^2.

$$\text{Total area} = \pi \left[\frac{D\,L_1 + D\,L_2 + \ldots + D_n L_n}{12} \right]$$

$$= \pi \left[\frac{(8 \times 100) + (4 \times 300)}{12} \right] = 524 \text{ ft}^2$$

Using the equation provided in 9.1, the required test time should be recomputed as follows:

$$K = 0.000419\,[(8 \times 100) + (4 \times 300)]$$
$$= 0.838$$
$$0.838 = 1.0 \longrightarrow K = 1.0$$

NOTE X1.2—K will always be 1.0 when the total area is less than 625 ft^2.

$$T = = 0.085\left[\frac{(8^2 \times 100) + (4^2 \times 300)}{(8 \times 100) + (4 \times 300)}\right]\frac{1.0}{0.0015}$$

$$T = 317$$

The required test time is actually only 317 s or 5 min and 17 s for a 1.0 psig pressure drop. Therefore, if the section can meet this test time, it shall be accepted.

NOTE X1.3—For a specified 0.5 psig pressure drop, the test holding time would be only half as long, that is 2 min and 38 s.

X2. RATIONALE

X2.1 Low-pressure air testing is a fully accepted means of testing sewer lines. (Refs 1, 2, and 3)[4]

X2.2 It is true that due to the differing physical properties of water and air, no direct numerical correlation exists between air loss and water leakage. This does not mean that the two are unrelated. It has been established that lower air loss rates are associated with lower leakage rates.

X2.3 The data in these studies are based on installed sewer of concrete, clay, and asbestos cement sanitary sewers and were useful in deriving Practices C 828 and C 924.

[4] The boldface numbers in parentheses refer to the references listed at the end of this test method.

REFERENCES

(**1**) Hobbs, S. H., and Cherne, L. G., "Air Testing Sanitary Sewers," *WPCF Journal*, April 1968.

(**2**) Ramseier, R. E., "Low Pressure Air Test for Sanitary Sewers," *Journal of the Sanitary Engineering Division*, ASCE, April 1964.

(**3**) Ramseier, R. E., "Testing New Sewer Pipe Installation," *Water Pollution Central Federation Journal*, April 1972.

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Designation: C 1244 – 05a$^{\epsilon 1}$

Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill[1]

This standard is issued under the fixed designation C 1244; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

ϵ[1] NOTE—Table 1 was reformatted editorially in February 2006.

1. Scope

1.1 This test method covers procedures for testing precast concrete manhole sections when using the vacuum test method to demonstrate the integrity of the installed materials and the construction procedures. This test method is used for testing concrete manhole sections utilizing mortar, mastic, or gasketed joints.

1.2 This test method is intended to be used as a preliminary test to enable the installer to demonstrate the condition of the concrete manholes prior to backfill.

1.3 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

1.4 This test method is the companion to metric Test Method C 1244M; therefore, no SI equivalents are shown in this test method.

NOTE 1—Vacuum test criteria presented in this test method are similar to those in general use. The test and criteria have been widely and successfully used in testing manholes.

NOTE 2—The user of this test method is advised that no correlation has been found between vacuum (air) and hydrostatic tests.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

C 822 Terminology Relating to Concrete Pipe and Related Products

C 924 Practice for Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method

C 969 Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines

C 1244M Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill

3. Terminology

3.1 For definitions of terms relating to manholes, see Terminology C 822.

4. Summary of Practice

4.1 All lift holes and any pipes entering the manhole are to be plugged. A vacuum will be drawn and the vacuum drop over a specified time period is used to determine the acceptability of the manhole.

5. Significance and Use

5.1 This is not a routine test. The values recorded are applicable only to the manhole being tested and at the time of testing.

6. Preparation of the Manhole

6.1 All lift holes shall be plugged.

6.2 All pipes entering the manhole shall be temporarily plugged, taking care to securely brace the pipes and plugs to prevent them from being drawn into the manhole.

7. Procedure

7.1 The test head shall be placed at the top of the manhole in accordance with the manufacturer's recommendations.

7.2 A vacuum of 10 in. Hg shall be drawn on the manhole, the valve on the vacuum line of the test head closed, and the vacuum pump shut off. The time shall be measured for the vacuum to drop to 9 in. Hg.

7.3 The manhole is acceptable if the time for the vacuum reading to drop from 10 in. Hg to 9 in. Hg meets or exceeds the values indicated in Table 1 or Table .

[1] This test method is under the jurisdiction of ASTM Committee C13 on Concrete Pipe and is the direct responsibility of Subcommittee C13.06 on Manholes and Specials.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

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TABLE 1 Minimum Test Times for Various Manhole Diameters (30 – 120 in.) in Seconds

Depth (ft)	Diameter, in.								
	30	33	36	42	48	54	60	66	72
	Time, in seconds								
<4	6	7	7	9	10	12	13	15	16
6	9	10	11	13	15	18	20	22	25
8	11	12	14	17	20	23	26	29	33
10	14	15	18	21	25	29	33	36	41
12	17	18	21	25	30	35	39	43	49
14	20	21	25	30	35	41	46	51	57
16	22	24	29	34	40	46	52	58	67
18	25	27	32	38	45	52	59	65	73
20	28	30	35	42	50	53	65	72	81
22	31	33	39	46	55	64	72	79	89
24	33	36	42	51	59	64	78	87	97
26	36	39	46	55	64	75	85	94	105
28	39	42	49	59	69	81	91	101	113
30	42	45	53	63	74	87	98	108	121

TABLE 1 Minimum Test Times for Various Manhole Diameters (30 – 120 in.) in Seconds *(continued)*

Depth (ft)	Diameter, in.							
	78	84	90	96	102	108	114	120
	Time, in seconds							
<4	18	19	21	23	24	25	27	29
6	26	29	31	34	36	38	41	43
8	35	38	41	45	48	51	54	57
10	44	48	52	56	60	63	67	71
12	53	57	62	67	71	76	81	85
14	62	67	72	78	83	89	94	100
16	70	76	83	89	95	101	108	114
18	79	86	93	100	107	114	121	128
20	88	95	103	111	119	126	135	142
22	97	105	114	122	131	139	148	156
24	106	114	124	133	143	152	161	170
26	114	124	134	144	155	164	175	185
28	123	133	145	155	167	177	188	199
30	132	143	155	166	178	189	202	213

7.4 If the manhole fails the initial test, the manhole shall be repaired by an approved method until a satisfactory test is obtained.

7.5 Use or failure of this vacuum test shall not preclude acceptance by appropriate water infiltration or exfiltration testing, (see Practice C 969), or other means.

8. Precision and Bias

8.1 No justifiable statement is presently capable of being made either on the precision or bias of this procedure, since the test result merely states whether there is conformance to the criteria for the success specified.

9. Keywords

9.1 acceptance criteria; concrete; manhole sections; test method; vacuum test

APPENDIX

(Nonmandatory Information)

X1. Air Testing for a Single Diameter Pipe

X1.1 The standard accepted method of air testing, for a single diameter pipe, Practice C 924, allows a drop of 1 psi pressure during the time calculated by the formula:

$$T_{Press.} = \frac{KD^2L}{Q} \quad \text{(X1.1)}$$

where:

T = time for 1 psi drop in pressure
K = 0.00037 for in./lb units
D = pipe diameter, in.
L = length of line, ft
Q = air loss, ft^3/min

X1.2 A pressure drop of 1 in. Hg for the vacuum test compares to a pressure drop of 0.490 psi for the air test.

$$1 \text{ in. Hg} \times \frac{14.696 \text{ lb/in.}^2}{29.02 \text{ 1 Hg}} = 0.490 \text{ psi} \quad \text{(X1.2)}$$

Therefore, the time relationship is:

$$T_{vac} = 0.490\, T_{press} \quad \text{(X1.3)}$$

or

$$T_{vac} = \frac{T_{press}}{2.04} \quad \text{(X1.4)}$$

X1.3 The allowable test times cited in Practice C 924, Table 2, for pipe sizes 4 in. to 24 in. diameter are provided in Table X1.1 and Table X1.2. The allowable test times for sizes above 24 in. were obtained by extrapolation. Therefore, using the appropriate Q. we find that:

for 30 in. (Q = 7 ft^3/min), $T_{vac} = 0.00018 \frac{D^2}{Q} L = 0.023\ L$

for 36 in. (Q = 8 ft^3/min), $T_{vac} = 0.00018 \frac{D^2}{Q} L = 0.029\ L$

for 42 in. (Q = 9 ft^3/min), $T_{vac} = 0.00018 \frac{D^2}{Q} L = 0.035\ L$

for 48 in. (Q = 10 ft^3/min), $T_{vac} = 0.00018 \frac{D^2}{Q} L = 0.041\ L$

for 54 in. (Q = 11 ft^3/min), $T_{vac} = 0.00018 \frac{D^2}{Q} L = 0.048\ L$

for 60 in. (Q = 12 ft^3/min), $T_{vac} = 0.00018 \frac{D^2}{Q} L = 0.054\ L$

for 66 in. (Q = 13 ft^3/min), $T_{vac} = 0.00018 \frac{D^2}{Q} L = 0.060\ L$

for 72 in. (Q = 14 ft^3/min), $T_{vac} = 0.00018 \frac{D^2}{Q} L = 0.067\ L$

for 78 in. (Q = 15 ft^3/min), $T_{vac} = 0.00018 \frac{D^2}{Q} L = 0.073\ L$

for 84 in. (Q = 16 ft^3/min), $T_{vac} = 0.00018 \frac{D^2}{Q} L = 0.079\ L$

for 90 in. (Q = 17 ft^3/min), $T_{vac} = 0.00018 \frac{D^2}{Q} L = 0.086\ L$

for 96 in. (Q = 18 ft^3/min), $T_{vac} = 0.00018 \frac{D^2}{Q} L = 0.092\ L$

for 102 in. (Q = 19 ft^3/min), $T_{vac} = 0.00018 \frac{D^2}{Q} L = 0.099\ L$

for 108 in. (Q = 20 ft^3/min), $T_{vac} = 0.00018 \frac{D^2}{Q} L = 0.105\ L$

for 114 in. (Q = 21 ft^3/min), $T_{vac} = 0.00018 \frac{D^2}{Q} L = 0.112\ L$

for 120 in. (Q = 22 ft^3/min), $T_{vac} = 0.00018 \frac{D^2}{Q} L = 0.118\ L$

TABLE X1.1 Minimum Test Times for Various Pipe Diameters (Practice C 924)

Nominal Pipe Size, in.	Time (*T*), min 100 ft.
4	0.3
6	0.7
8	1.2
10	1.5
12	1.8
15	2.1
18	2.4
21	3.0
24	3.6
27	4.2
30	4.8
33	5.4
36	6.0

TABLE X1.2 Allowable Air Loss for Various Pipe Diameters (Practice C 924)

Nominal Pipe Size, in.	Air Loss (*Q*), ft^3/min
4	2
6	2
8	2
10	2.5
12	3
15	4
18	5
21	5.5
24	6
30	7
36	8
42	9
48	10
54	11
60	12
66	13
72	14

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