ADEQ Arizona Department of Environmental Quality

ENGINEERING REVIEW
ALTERNATIVE REQUEST (A312G) FOR TYPE 4 GENERAL PERMIT APPLICATIONS

GENERAL INFORMATION

1 Project Name

Project Name: Development Projects

2 Applicant (person responsible for overall compliance)

(Check One) ☒ Owner ☐ Operator

Name: Carol Johnson | Phone: 520 724-6334

Title: Sanitary Engineering Manager | Firm Name: Pima County Wastewater Reclamation

Mailing Address: 201 N. Stone Avenue | City: Tucson | State: AZ | Zip: 85701

Email: carol.johnson@pima.gov

3 Contact Person/Agent (if different from applicant)

Name: See Applicant. | Phone:

Title: | Firm Name:

Mailing Address: | City: | State: | Zip:

Email:

4 Rule Information ☐ On-site ($250 fee), or ☐ Sewage Collection System ($750 fee)

Rule Citation of Requirement for Which Alternative is Requested: R18-9-E301 4.01(D)(2)(f)

Description of Requested Alternative: PVC SDR35, PVC C900, and other classes of pipe as determined by design engineer as equivalent.

Continued on attachments ☐ No ☒ Yes

5 Alternative Justification

The applicant shall provide sufficient information for the Department to determine that the change achieves equal or better performance compared with the general permit requirement, or addresses site or system conditions more satisfactorily than the general permit requirements (Please attach any necessary calculations, drawings, or other supporting documentation). .

See attachments.

Continued on attachments ☐ No ☒ Yes

6 Applicant Certification

I, Carol Johnson, P.E., certify that this alternative request as described in this application and all attachments were prepared under my direction or authorization and all information is, to the best of my knowledge, true, accurate and complete. I also certify that this alternative request described in this form meets or exceeds the terms and conditions the General Aquifer Protection Permit(s) (A.A.C. R18-9-E301 through R18-9-E323) and applicable requirements of Arizona Revised Statutes Title 49, Chapter 2, and Arizona Administrative Code Title 18, Chapter 9 regarding aquifer protection permits.

Affix Seal (If appropriate)

Registered Professional Engineer (Sanitary) CERTIFICATE NO 34048 CAROL A. JOHNSON Date Signed 10-19-2018 ARIZONA U.S.A.

Carol A. Johnson

Signature

Carol A. Johnson
Expires: Sept. 30, 2020

Date

DEPARTMENT USE ONLY			
File Number	Approved E301 Velocity	R G J	11/6/18
Fee for each request submitted	Yes / No	Check Number	

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TECHNICAL MEMORANDUM

August 21, 2018

TO: Eric Wieduwilt, P.E.

THRU: Carol Johnson, P.E., Francisco Galindo, P.E.

FROM: Kevin Josker, P.E.

SUBJECT: Engineering Design Standards, Section 5.1.3(A) – Velocity and Slope

Pima County Engineering Design Standard (EDS) 5.1.3(A) requires placement of Ductile Iron Pipe (DIP) or "approved equal" sewer line when velocities of 10 fps or greater are predicted to occur. An approved equal is a pipe with equivalent or better erosion resistance and service life and performance better than DIP. The Arizona Administrative Code R18-9-E301(D)(2)(f) states that the sewer line be DIP or a pipe with equivalent erosion resistance, and structurally reinforce the receiving manhole or sewer main. High velocity and turbulence increase the generation of hydrogen sulfide gas.[1]

Pima County Regional Wastewater Reclamation Department (RWRD) intends to eliminate the use of DIP for new sewers to the maximum extent possible. Due to internal pipe corrosion associated with exposure to sewer gases and routine maintenance, RWRD has experienced lining failures on DIP for many years and has tried various pipe coatings with little or no success. Often the coatings appear promising based on lab tests or manufacturing data; however, in actual practice the interior coatings tend to quickly fail, or fail quality assurance tests, at the construction site.

RWRD Conveyance Department has inspected thousands of miles of the sewer system with Closed Circuit Television (CCTV). Internal protective coatings have deteriorated within five years of installation and must be repaired. Several coating products have been used with no success (see pictures end of memo).

The State of Arizona has granted Pima County Department of Environmental Quality (PDEQ) authority to review, approve, and permit sewer construction plans in Pima County. Recently, PDEQ indicated they may provide a blanket waiver of the DIP requirement for installations, if the available alternatives meet good engineering practice. RWRD recommends the practices described on the following pages as meeting the required criteria.

DESIGN CONSIDERATIONS

When velocities of 10 fps or greater are encountered in the sewer line, dissolved hydrogen sulfide gas is released in the pipe and at the lower manhole.[2] The gas builds up, displacing air in the manhole and pipe, becoming more concentrated. Oxidizing bacteria in the pipe combines with the gas, producing sulfuric acid, attacking the surface of the pipe. The pipe is subject to erosive (abrasive) forces as well as corrosive forces. Coated DIP pipe eventually succumbs to these forces and must be monitored, maintained, and repaired. Polyvinyl Chloride (PVC) is inert to sulfuric acid and exhibits exceptional resistance to abrasion, decreasing maintenance and repair costs.[3]

System Design – PVC sewer pipe normally used in RWRD's collection system is Standard Dimension Ratio (SDR) 35. Design must provide a clear, unobstructed pipe bore, an exceptional seal in pipe and joints, limiting infiltration/exfiltration, and effective collection and transportation of wastewater.[4]

Installation – Failure criterion of PVC pipe is not fracture strength, instead, it is measured by pipe diametric deflection. Industry recommendations for maximum deflection when used for gravity sewers is 7.5%.[5] The pipe/soil interaction becomes the system. When pipe stiffness and soil stiffness are in equilibrium, deflection will not occur. Joint integrity is maintained, providing a tight seal, impregnable to tree roots, infiltration, and exfiltration that can crack pipes allowing debris to enter the system and create more abrasion.

Application – Installed in aggressive environments that include external and internal corrosion, chemical attack, biological attack, permeation, weathering, and abrasion.[6]

Resistance to Aggressive Environments

External corrosion – PVC is resistant to alkaline and acidic soils and does not require external coatings nor plastic wraps. PVC is a nonconductor and has no galvanic response, eliminating the need for cathodic protection.[7]

Internal corrosion – PVC walls are very smooth and are resistant to slime buildup[8] that can harbor bacteria. There may be some small deposition of grease but PVC is not conducive to precipitates. Tuberculation caused by corrosion by-products is nonexistent. Flow areas are not reduced over time, operation and maintenance costs remain steady.[9]

Chemical attack – PVC is resistant to chemicals normally found in domestic sewer systems (industrial uses need to be evaluated on a case-by-case basis). Tables exist[10] (not included here) that assess the suitability of using PVC for unusual or specific environments. Factors affecting chemical resistance include:

- Temperature (not a concern under normal operating circumstances – domestic).
- Chemical (or mixture of chemicals) present.
- Chemical concentration (usually diluted).
- Length of exposure (usually brief or periodic).
- Frequency of exposure.
- Geometry of piping system.
- Fittings, gaskets, and lubricants need to be evaluated independently of the PVC pipe. PVC pipe and fittings are resistant to chemical concentrations generally found in water and sewer systems.[11]

Biological attack – Includes micro- (bacteria, fungi) and macro-organisms (tree roots, insects, and rodents). PVC is not susceptible to normal processes of deterioration because it is not a source of nutrients for these organisms. Small amounts of slime may adhere to the walls providing an opportunity for hydrogen sulfide gas to react with the bacteria producing dilute sulfuric acid. PVC is inert to this acid. Fittings, gaskets, and lubricants need to be evaluated. Materials have been developed to be non-reactive under normal sewer operating conditions.

Permeation – PVC is impermeable, wall strength and elasticity are not affected. If the pipe were to become brittle it would be more susceptible to abrasion.[12]

Weathering – Once buried PVC pipe is unaffected.

Abrasion – PVC pipe shows exceptional resistance to normal sewer flow, insignificant wear from mechanical cleaning, and minimal wear from sand and gravel at various velocities.[13]

DIP Disadvantages

The primary concern for specifying DIP for reaches where velocities exceeded 10 fps is corrosion and abrasion resistance. Hydrogen sulfide gas remains in solution but is released to the atmosphere under turbulent conditions, where it combines with moisture on the non-submerged surface of the pipe and is biologically oxidized to sulfuric acid.[14] Other pipes, such as concrete, VCP, and ACP with various coatings do not have the durability to withstand such an aggressive environment. Factory installed internal and external coatings prolonged the lifespan of DIP but still resulted in high maintenance and operation costs. Third party, specialty contractors were hired to install various coatings in the field at great expense. This met with limited success, or created additional problems with eventual failure.

Over the most recent three year period, 157 pipes were lined at the cost indicated:

Over 3 JOC Years*		
Assets	Feet	Actual Cost
157	28,200	$3.2 M
Open Work Orders		
Assets	Feet	Projected Cost
482	831,000	$96.0 M

*Conveyance Department Costs reported June 2018

DIP is not stocked locally and must be ordered. Lead time is 4 to 6 weeks. Internal coatings are installed at the manufacturer's yard, a Holiday test is performed, then retested at the construction site. If a failure occurs, repairs are made in the field and the material is retested. The material may be rejected. Recently, there have been many failures at the construction site.

Conclusion

PVC, compared to DIP, has the advantage of being lightweight and still exhibit the tensile strength, impact strength, and a high modulus of elasticity in a hostile environment for an extended period of time. Studies have shown expected lifespans of greater than 100 years[15], and can be buried to depths of 50 feet and greater.[16] It does not require special coatings, can be used in any soil type condition, or multiple conditions, without requiring any other type of internal or external protection.

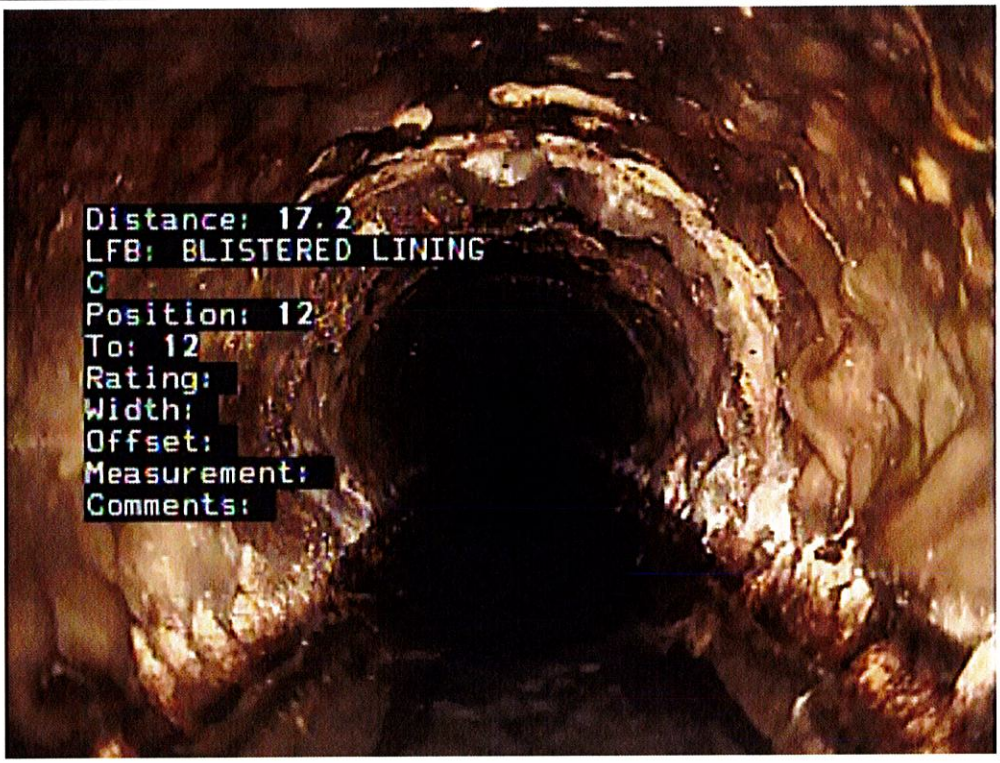
PVC is hydraulically smoother years after installation and inert to biological and chemical attack. Tuberculation is eliminated, keeping fluid friction and flow resistance stable, maintaining flow capacity, minimizing cleaning and maintenance costs.[17] With proper installation, infiltration/exfiltration concerns and destructive root intrusions are eliminated.[18]

Over the past 15-years, installed PVC has not failed or needed any maintenance other than routine inspection, according to Conveyance Department records. PVC SDR 35 pipe meets the expectations of an "approved equal" to DIP for the applications and service life contained in the Pima County Engineering Design Guide for sanitary sewer.

It is recommended DIP be replaced with PVC in the mentioned conditions of Velocity and Slope.

SMH 3197-107 - 3197-104, 14-inch, laid 2009-2010, inspected 2011, coating failing

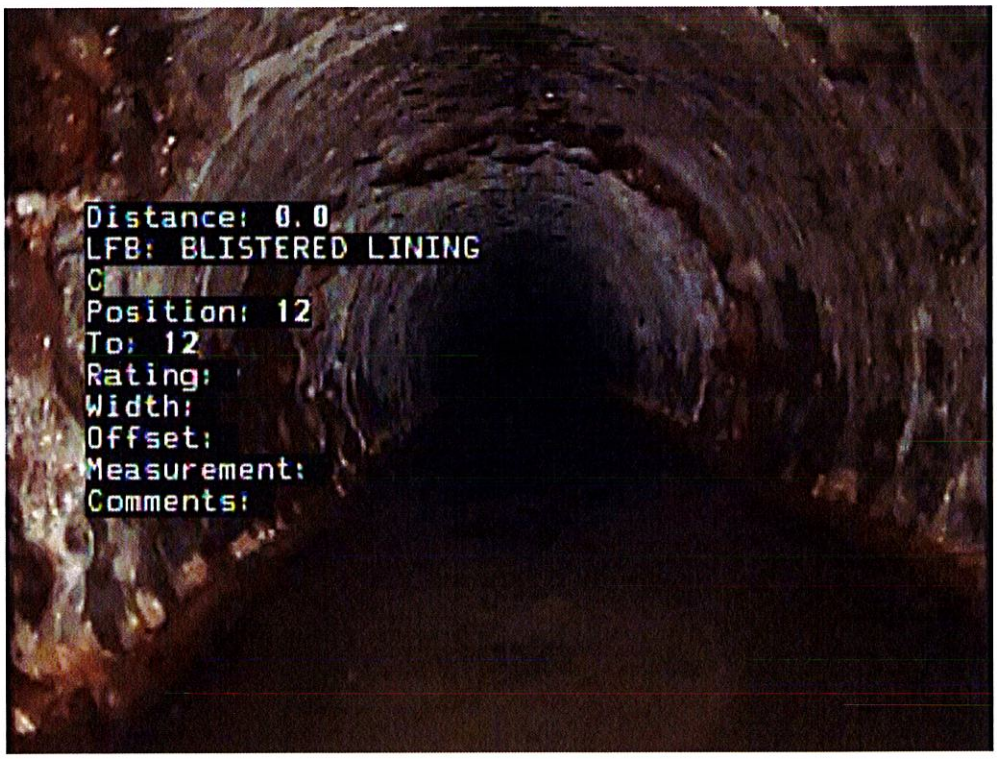
SMH 3250-01 - 3328-03, 12-inch, laid 2007, inspected 2015



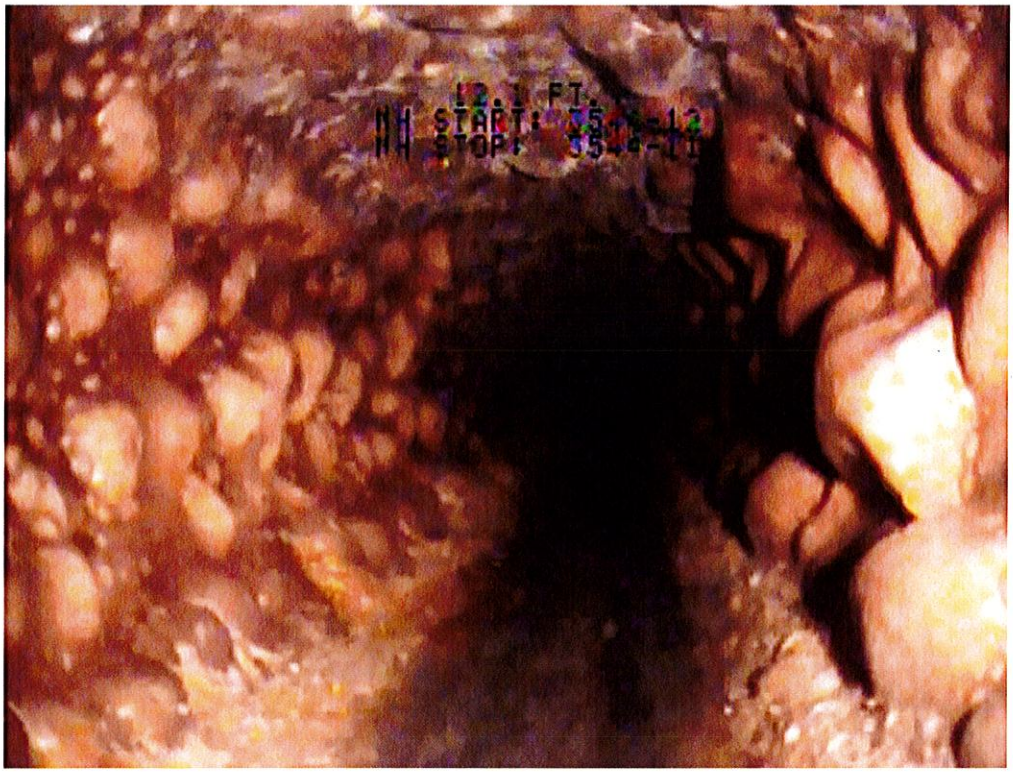
SMH 3250-01 - 3328-03, 12-inch, laid 2007, inspected 2015

SMH 3262-07 - 3262-08A, 24-inch, laid 2007, inspected 2015

SMH 3326-06 - 3326-07, 20-inch, laid 2008, inspected 2015



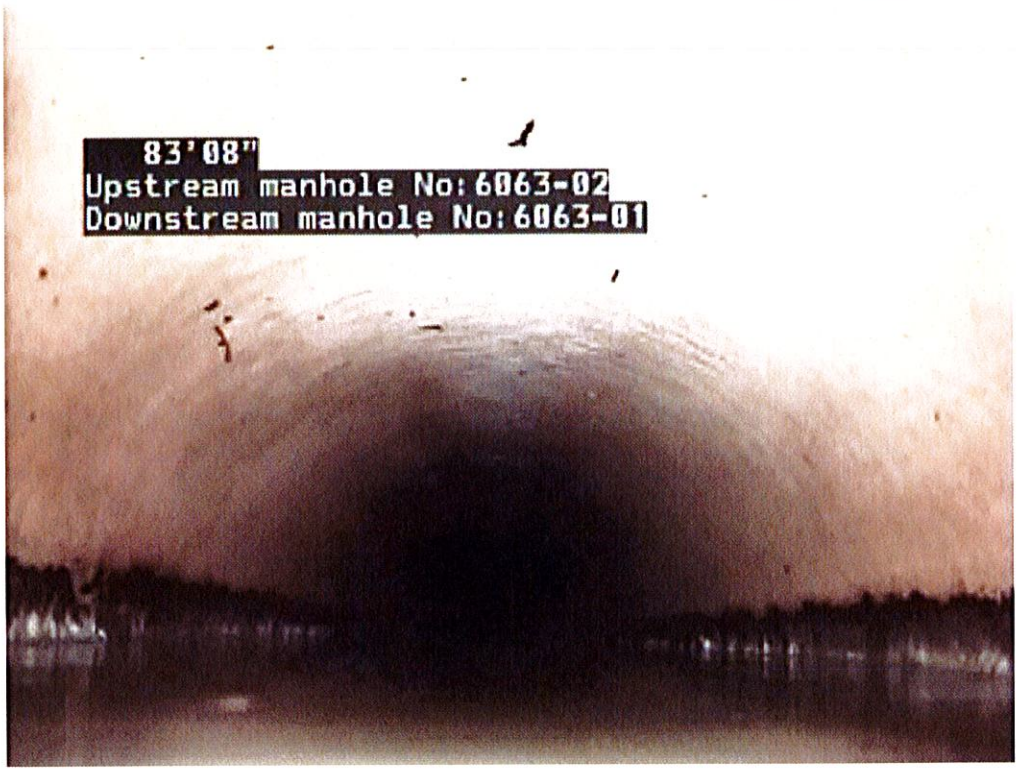
SMH 3326-07 - 3326-08, 20-inch, laid 2008, inspected 2015



SMH 3544-11 - 3544-12, 8-inch, laid 2006, inspected 2016

SMH 3713-10 - 3713-09, 12-inch, laid 2005, inspected 2015

SMH 2744-02 – 2744-03, 15-inch, laid in 1989, inspected 2015, Gravity Sewer



SMH 6063-02 – 6063-01, 15-inch, laid in 1993, inspected 2016, Gravity Sewer

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4. "Maintenance of PVC Sewer Pipe." *Uni-Bell PVC Pipe Association.* 2018. UNI-TR-3-03: p.4.

5. "Depth of Burial for PVC Pipe". *JM Eagle.* 2009. Technical Bulletin: p.1.

6. "Handbook of PVC Pipe: Design & Construction". *Uni-Bell PVC Pipe Association.* 2001. p.24.

7. "Gravity Sewer." *JM Eagle.* 2012. Technical Bulletin: p.1.

8. "Maintenance of PVC Sewer Pipe." *Uni-Bell PVC Pipe Association.* 2018. UNI-TR-3-03: p.8.

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10. "Handbook of PVC Pipe: Design & Construction". *Uni-Bell PVC Pipe Association.* 2001. pgs.28-55.

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12. A.J. Whittle & J. Tennakoon. "Predicting the Residual Life of PVC Sewer Pipes." *Iplex Pipelines & Ipswich Water.* Queensland, Australia: pgs. 4-9.

13. "Handbook of PVC Pipe: Design & Construction". *Uni-Bell PVC Pipe Association.* 2001. pgs.62-66.

14. Robert P.G. Bowker & Gerald A. Audibert & Hemang J. Shah & Neil A. Webster. "Detection, Control, And Correction Of Hydrogen Sulfide Corrosion In Existing Wastewater Systems." *Environmental Protection Agency*, September 1992, Document 832R92001, p.2-1.

15. A.J. Whittle & J. Tennakoon. "Predicting the Residual Life of PVC Sewer Pipes." *Iplex Pipelines & Ipswich Water.* Queensland, Australia: p. 9

16. Mike Glasgow, P.E., Southeastern Regional Engineer. "Urban Myths Die Hard." *PVC Pipe News,* Winter 2006: p.7.

17. "Gravity Sewer." *JM Eagle.* 2012. Technical Bulletin: p.1.

18. "Deflection: The Pipe/Soil Mechanism." *Uni-Bell Technical Report.* p. 32.

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