

Technical Memorandum

Date: September 26, 2024
Prepared By: Taylor Braaten, PE
Project: Dickinson Project No. 202423
Dickinson 2024 Sanitary Sewer Manhole Repairs
Moore Project No. 24219
Owner: City of Dickinson, ND
Subject: Assessment of Sanitary Sewer Manholes



Purpose

Moore Engineering Inc. (Moore) was tasked with visually inspecting and documenting the conditions of 54 sanitary sewer manholes identified by the City of Dickinson (City). This memorandum presents findings, evaluations, and recommendations.

Background

Initial observations indicated that many of the sanitary sewer structures were significantly deteriorated. In subsequent conversations with the City, it was indicated that the sewage conveyed within the system has historically contained high concentrations of Hydrogen Sulfide gas (H_2S).

H_2S gas is produced in sewage systems primarily through the action of anaerobic bacteria that thrive in oxygen-depleted environments. In the absence of oxygen, anaerobic bacteria start to decompose organic matter within the system. These bacteria utilize the organic compounds as a food source, breaking down organics to gain energy. As part of this process, H_2S is produced as a byproduct.

H_2S gas significantly contributes to the degradation of cement within sanitary sewer structures through a sequence of chemical and biological processes. This gas volatilizes and accumulates in the air space above the sewage. In the presence of oxygen, H_2S undergoes oxidation, primarily facilitated by sulfur-oxidizing bacteria such as *Thiobacillus*, converting it into sulfuric acid (H_2SO_4). The sulfuric acid then reacts with the calcium compounds in the concrete, such as calcium hydroxide ($Ca(OH)_2$), forming calcium sulfate (gypsum), which is soluble and can be washed away. This reaction erodes the concrete, diminishing its structural integrity. Additionally, the activity of sulfur-oxidizing bacteria accelerates the formation of sulfuric acid, particularly in areas of the manhole where there is intermittent wetting and

drying. The resultant corrosion and surface erosion significantly reduces the lifespan of concrete structures in the system, necessitating frequent maintenance. Preventive measures, including applying protective coatings, improving ventilation, using chemical additives, and conducting regular maintenance, are essential to mitigate the corrosive effects of H₂S and prolong the durability of sanitary manholes.

H₂S gas tends to form more readily in certain parts of a sanitary sewer system, particularly where conditions are favorable for anaerobic activity and sulfate reduction. The areas where H₂S is most prevalent include:

1. **Low-flow or Stagnant Areas:** In sections of the sewer with slow-moving or stagnant wastewater, the oxygen levels are more likely to drop, creating anaerobic conditions. These areas are hotspots for H₂S production since sulfate-reducing bacteria thrive in such environments.
2. **Deep or Long Sewer Pipes:** Deeper or longer stretches of sewer pipes have lower oxygen availability, especially if the flow is slow. The lack of oxygen promotes anaerobic bacterial activity, increasing the chances of H₂S formation.
3. **Force Mains (Pressurized Pipes):** Sewage in force mains is often under pressure and may experience longer residence times, leading to anaerobic conditions. When the sewage is discharged into gravity-fed pipes, the H₂S can be released into the sewer atmosphere.
4. **Manholes and Junctions:** These areas are often points where gases can accumulate. When wastewater falls from one level to another (such as from a pipe into a manhole), turbulence can release H₂S from the water into the air.
5. **Pumping Stations:** Pumping stations that move sewage through the system can create conditions where H₂S gas is released. Turbulence from pumps can also exacerbate the release of H₂S gas from sewage.
6. **Sewer Systems with Long Retention Times:** If sewage remains in the system for an extended period, especially in warm climates, it increases the chances for organic matter to decompose anaerobically, resulting in more H₂S production.

These areas require careful monitoring and may need specific mitigation measures, such as ventilation, chemical dosing (e.g., iron salts or oxidizers), or the use of biofilters to control H₂S buildup and prevent corrosion or health hazards.

Inspection Data

The sanitary structures were inspected from July 17th to July 19th, 2024. Structure data, 360-degree videos, and rim elevations were collected for analysis.

Evaluation

Upon review of the data collected, the severe deterioration appears to be limited to the 10th Ave E corridor. Additionally, minor deterioration was present in sanitary structures in the 12th St W corridor. All other evaluated areas saw little to no signs of deterioration from H₂S.

10th Ave E Corridor:

Most manholes in this area had been rehabilitated with cementitious repair mortar and an epoxy top-coat between 2012 and 2014. However, the inspection revealed complete coating failure. Although epoxy products are corrosion-resistant, some perform poorly in H₂S-rich environments.

A manhole is considered structurally compromised after losing approximately two inches of concrete. In many instances, visible reinforcing steel indicates that the structures have reached this point, making further rehabilitation (e.g., coating) unviable.

12th St W Corridor:

The manholes in this area lack any protective coating and show early signs of deterioration, such as the loss of the original "cream" finish on the concrete surface. Once the aggregate is exposed, intervention is needed to prevent further degradation.

Recommendations

1. H₂S Gas Mitigation:

The City should explore methods to reduce H₂S production, such as chemical injection or oxygenation, to prevent further corrosion of the sewer system.

2. Protective Coating for 12th St W:

Apply a coating system to the manholes in this area to prevent future corrosion and extend their lifespan. Ensure the coating has passed Severe Wastewater Analysis Testing (SWAT).

3. Replacement of 10th Ave E Structures:

Due to the extreme deterioration of these manholes, replacement is recommended. Three options are proposed:

- Option 1: Replace with traditional concrete structures coated with a SWAT-approved product. Expect regular inspections and re-coating every 10-15 years. This option would require bypass pumping and large-scale excavation, leading to prolonged public disruption.
- Option 2: Replace with polymer manholes resistant to H₂S corrosion. While more expensive than concrete, these structures are maintenance-free and provide a long-term solution. However, installation would involve significant disruption due to excavation and bypass pumping.
- Option 3: Install polymer liners into existing manholes. These liners, made from polymer resin, offer a structural fix and a long-term maintenance-free solution. Installation would involve less disruption than complete replacement, but polymer inserts are more expensive than other liner systems.

4. Monitor High-Risk Areas:

Regular monitoring of manholes in high-risk areas, such as those at low points or near force main discharges, is essential.

Project Costs

Sanitary structure rehabilitation and replacement projects are challenging for engineers and contractors to estimate. This difficulty arises because key factors, such as the extent of damage, installation methods, and the chosen repair technique, often remain uncertain until construction begins. Additionally, expenses such as bypass pumping, traffic control, and mobilization must also be considered. The total project cost for the identified work is estimated to be \$2,100,000, which includes a higher contingency due to the specialized nature of the project.

Project Funding

Grant funding for sanitary sewer projects is limited due to the relatively low operating and maintenance costs of these systems. However, loan funds for such projects are available through the Clean Water State Revolving Fund (CWSRF). This low-interest loan, typically at 2%, is provided by the Environmental Protection Agency (EPA) and is locally managed by the North Dakota Department of Environmental Quality (NDDEQ) in partnership with the North Dakota Public Finance Authority (PFA).

Conclusion

In conclusion, the assessment of the sanitary sewer manholes in Dickinson reveals significant deterioration, particularly in the 10th Ave E corridor, where protective coatings have failed and the

structures have reached critical levels of corrosion. For these manholes, polymer inserts are recommended. Meanwhile, early-stage deterioration in the 12th St W corridor can be mitigated with preventive coatings. With an estimated total project cost of \$2,100,000, the City should prioritize both immediate and long-term solutions, including the application of advanced materials and proactive monitoring, to ensure the longevity and functionality of its sewer infrastructure.

Attachments

1. Sanitary Sewer Manhole Condition Evaluation
2. Example Manhole Condition Photos
3. Cost Estimate
4. Manhole Location Maps

2024 Sanitary Sewer Manhole Repairs

Sanitary Sewer Manhole Condition Evaluation

City of Dickinson, ND

Prepared By: Moore Engineering, Inc.



Location	Pt #	Manhole No.	Existing Coating	Manhole Condition Comments	Recommendation	Estimated Cost
East of 6th Ave South of Broadway	85002	B10-110	N/A	Previously coated? Brick bottom	Polymer Insert	\$ 32,600.00
East of 6th Ave South of Broadway	85003	B10-111	Epoxy	Previously coated, structural cracks present, severe cone deterioration	Polymer Insert	\$ 24,600.00
6th Ave SE	85030	B10-131	Epoxy	Previously coated, multiple coating failure points, no flow	Monitor	\$ -
6th Ave SE	85032	B10-132	Epoxy	Previously coated, multiple coating failure points, no flow	Monitor	\$ -
6th Ave SE	85031	B10-140		Could Not Open Casting		\$ -
River Drive	85029	B10-49	Liner	Previously lined	Monitor	\$ -
River Drive	85028	B10-50	Liner	Previously lined	Monitor	\$ -
River Drive	85027	B10-51		Severe Deterioration	Polymer Insert	\$ 24,000.00
East of 6th Ave South of Broadway	85001	B10-6	N/A	Severe Deterioration	Polymer Insert	\$ 22,600.00
10th Ave E - Between Franklin St & 10th St	88738	B2-119	Epoxy	Coating bubbling and cracking, especially in bottom 4', portions of coating completely missing	Polymer Insert	\$ 32,000.00
10th Ave E & Franklin St	86793	B2-120	Epoxy	Coating bubbling and cracking.	Polymer Insert	\$ 34,000.00
10th Ave E & 9th St E	86800	B2-121	Epoxy	Coating completely missing from bottom 6', wire mesh from MH structure exposed.	Polymer Insert	\$ 36,000.00
10th Ave E & 8th St E	86833	B2-122	Epoxy	Coating bubbling and cracking, especially in bottom 4'.	Polymer Insert	\$ 26,000.00
10th Ave E & 7th St E	86863	B2-123	Epoxy	Coating bubbling and cracking.	Polymer Insert	\$ 33,000.00
10th Ave E & Buffalo Bend & - north	86871	B2-124	Epoxy	Coating bubbling and cracking especially in bottom 4'.	Polymer Insert	\$ 36,000.00
10th Ave E - Between 3rd St & Buffalo Bend	86884	B2-125	Epoxy	Coating bubbling and cracking especially in bottom 4', portions of coating completely missing.	Polymer Insert	\$ 42,000.00
10th Ave E & 3rd St E	86893	B2-126	Coal Tar	Walls severely deteriorated.	Polymer Insert	\$ 44,000.00
10th Ave E & 2nd St E	86923	B2-127	Epoxy	Coating bubbling.	Polymer Insert	\$ 36,000.00
10th Ave E & 1st St E	86940	B2-128	Mortar & Epoxy	Appears MH was previously coated with mortar & epoxy. Coating completely missing and mortar	Polymer Insert	\$ 32,000.00
10th Ave E	59810	B2-129	Mortar & Epoxy	Appears MH was previously coated with mortar & epoxy. Coating completely missing and mortar	Polymer Insert	\$ 32,000.00
Villard St E	85010	B2-142	N/A	Minor Corrosion on walls worsens on bottom section	Clean and Coat	\$ 4,600.00
Villard St E	85011	B2-143		Little to no corrosion.	Monitor	\$ -
Villard St E	85005	B2-144	N/A	Minor Corrosion on bottom section.	Monitor	\$ -
Villard St E	85012	B2-145	N/A	Minor Corrosion on the bottom section.	Monitor	\$ -
Villard St E	85009	B2-145A		Minor Corrosion on the bottom section.	Monitor	\$ -
Villard St E	85006	B2-145B	N/A	Minor Corrosion on the bottom section.	Clean and Coat	\$ 8,650.00
Villard St E	85007	B2-178	Epoxy	Manhole has been coated. Coating appears to have failed in bottom section	Clean and Coat	\$ 6,400.00
14th St E	85008	B2-179	Liner	Some sort of Liner installed, Severe Cone Deterioration	Replace Cone, Install interior Drop	\$ -
10th Ave SE	85004	B2-180		Could Not Open Casting		\$ -
10th Ave E & Buffalo Bend - south	86873	B2-222	Coal Tar	MH installed in ~2015. Coal tar beginning to bubble, portion of wall beginning to deteriorate.	Polymer Insert	\$ 36,000.00
10th Ave E - Between 7th St & 8th St	86869	B2-245	Epoxy	Coating bubbling and cracking, especially in bottom 8', portions of coating completely missing.	Polymer Insert	\$ 30,000.00
Franklin St	86788	B3-210	Coal Tar	Good condition. No deterioration. Sewage backup at time of photo.	Monitor	\$ -
10th Ave E & 9th St E	86795	B3-211	Coal Tar	Good condition. No deterioration.	Monitor	\$ -
10th Ave E & 8th St E	86832	B3-218	Coal Tar	Good condition. No deterioration.	Monitor	\$ -
7th St E	86862	B3-219	Coal Tar	Good condition. No deterioration.	Monitor	\$ -
Buffalo Bend	86870	B3-307	Coal Tar	MH walls in fair condition, beginning to bubble.	Monitor	\$ -
Villard St W	85037	B5-6	Epoxy	Previously coated, minor bubbling present in coating	Monitor	\$ -
Villard St W	85036	B5-7	Epoxy	Previously coated, minor bubbling present in coating	Monitor	\$ -
Villard St W	85034	B5-75	Epoxy	Previously coated, I&I present between casting and Manhole	Monitor	\$ -
Villard St W	85035	B5-8	Epoxy	Previously coated, minor bubbling present on bench in coating	Monitor	\$ -
1st St SW	85033	B9-11	Epoxy	Previously coated, signs of coating failuer	Clean and Coat	\$ 5,050.00
1st St SW		B9-145	N/A	I&I Present	Monitor/ coat for I&I, seal pipe penetrations	\$ -
12th St W	85015	E33-110	N/A	Minor corrosion	Clean and Coat	\$ 6,400.00
12th St W	85014	E33-112	N/A	Minor corrosion worsening as you go down	Clean and Coat	\$ 6,850.00
12th St W	85013	E33-113	N/A	Minor corrosion worsening as you go down	Clean and Coat	\$ 6,850.00

2024 Sanitary Sewer Manhole Repairs

Sanitary Sewer Manhole Condition Evaluation

City of Dickinson, ND

Prepared By: Moore Engineering, Inc.



Location	Pt #	Manhole No.	Existing Coating	Manhole Condition Comments	Recommendation	Estimated Cost
	85025	E34-204	Epoxy	Previously coated, liner failing at seams	Monitor	\$ -
14th St E	85022	E34-21	Epoxy	Previously coated, coating failure at the bottom	Clean and Coat	\$ 7,750.00
14th St E	85024	E34-22	Epoxy	Previously coated, coating failure at the bottom and joints	Clean and Coat	\$ 8,650.00
	85026	E34-71	Epoxy	Coating/liner failure, significant deterioration	Polymer Insert	\$ 42,600.00
10th Ave E - North of Interstate	85021	E34-72	Epoxy	Complete coating failure, Top hat structure	Polymer Insert	\$ 14,600.00
10th Ave E - North of Interstate	85020	E34-73	Liner	Liner in the bottom section, liner is failing	Polymer Insert	\$ 24,600.00
10th Ave E	85019	E34-74	Liner	Manhole has liner, bench deterioration	Monitor	\$ -
10th Ave E	85018	E34-75	Liner	Manhole has liner, rings have severe deterioration	Replace top ring section/ Polymer Insert	\$ -
10th Ave E	85017	E34-76	No Coating	Severe Deterioration	Polymer Insert	\$ 38,600.00
10th Ave E & 10th St E	86781	E35-19	Epoxy	Coating bubbling and cracking.	Polymer Insert	\$ 30,000.00
10th Ave E - Between 10th St & Museum Dr	86785	E35-20	Epoxy	Coating bubbling and cracking especially in bottom 4', portions of coating completely missing.	Polymer Insert	\$ 30,000.00
10th Ave E & Museum Dr	86775	E35-21	Liner	Liner functioning well except for at pipe penetrations where structure severely deteriorating	Polymer Insert	\$ 36,000.00
NE Corner of Dickinson Inn - On Street (12th W)	85016		N/A	Minor Corrosion on walls worsens on bottom section	Clean and Coat	\$ 8,650.00
10th Ave E - Between Villard St & 1st St	58910		Mortar & Epoxy	severely deteriorated.	Polymer Insert	\$ 6,000.00

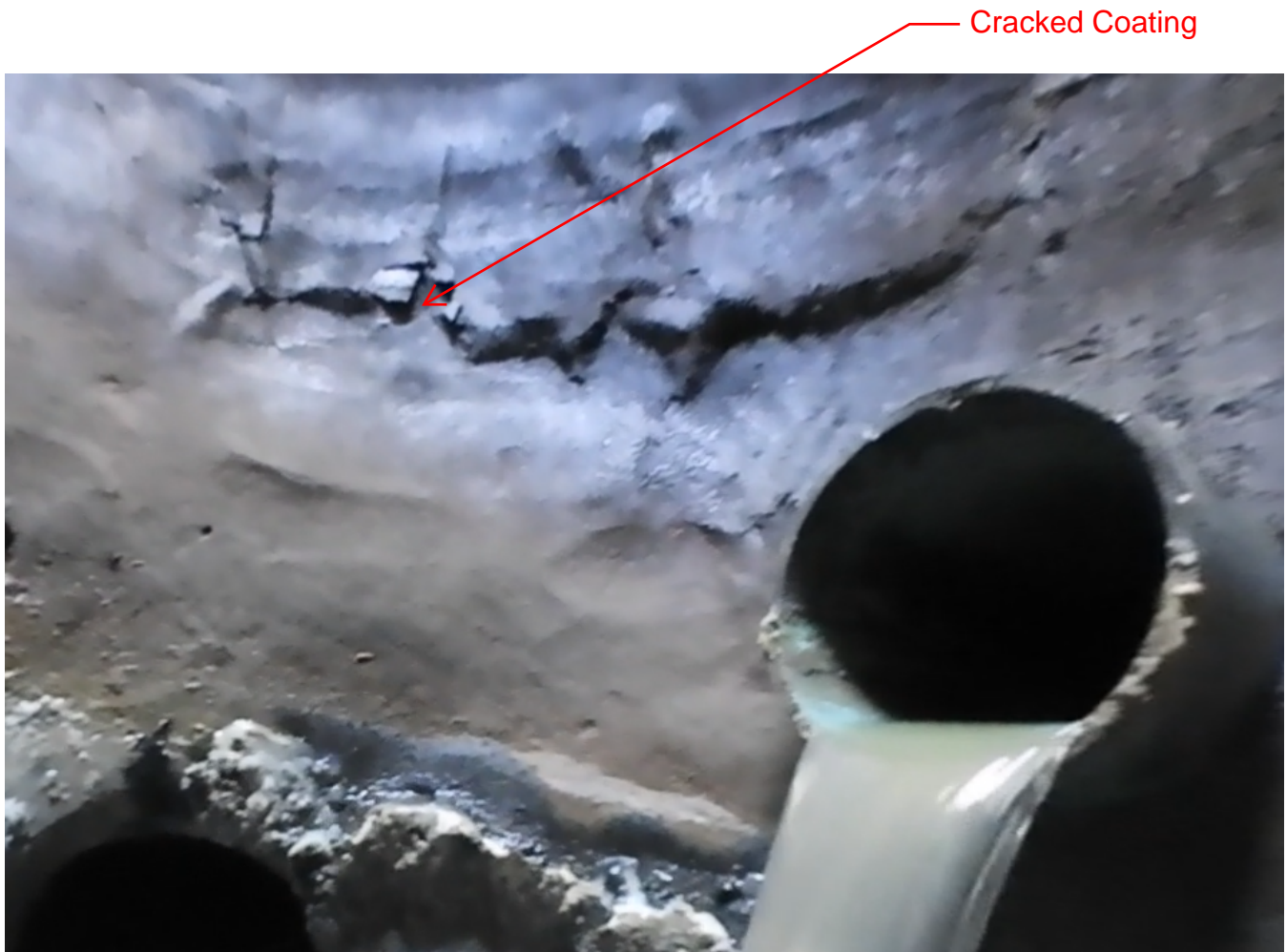
Example Manhole Condition Pictures

Severe Deterioration



B10-51 - River Drive

Coating Failure



B9-11 - 1st St SW

**2024 Sanitary Manhole Repairs
Dickinson, ND**

Engineer's Preliminary Opinion of Cost

<i>BID ITEM NO. & DESCRIPTION</i>	<i>UNIT</i>	<i>QUANTITY</i>	<i>UNIT PRICE</i>	<i>TOTAL</i>
<u>Base Bid</u>				
1. Mobilization	LS	1	\$60,000.00	\$60,000.00
2. Temporary Bypass Sewer System	LS	1	\$500,000.00	\$500,000.00
3. Traffic Control	LS	1	\$25,000.00	\$25,000.00
4. Sanitary Sewer Polymer Insert - 48"	VF	316	\$2,000.00	\$632,000.00
5. Site Restoration - Paved Surface	EA	7	\$5,000.00	\$35,000.00
6. Site Restoration - Non Paved Surface	EA	18	\$3,600.00	\$64,800.00
7. Sanitary Manhole Rehabilitate - 48"	VF	133	\$450.00	\$59,850.00
Construction Subtotal				\$1,376,650.00
Contingencies (~30%)				\$433,350.00
Total Construction Cost				\$1,810,000.00
Design & Construction Engineering (16%)				\$290,000.00
TOTAL PROJECT COST				\$2,100,000.00

Manhole Location Maps

Legend

 Project Location

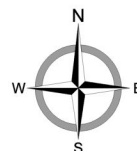
Start: Museum Dr.

End: East Villard St.

Project Location

CPU-5-983(069), PCN 24210
Dickinson, 10th Ave E from E Villard St. to Museum Dr
Stark County, North Dakota

Created By: BAS Date Created: 03/25/2024 Date Saved: 03/25/24 Date Plotted: N/A Date Exported: 03/25/24
Plotted By: brook.smith Parcel Date: N/A Aerial Image: 2023 County NAIP SIDS Elevation Data: Lidar
Horizontal Datum: N/A Vertical Datum: NAVD1988
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APPENDIX A: Various Manhole Locations





