

GLACIER PRECAST CONCRETE

H₂S Corrosion Protection for Sanitary Manholes

An Engineer's Options Guide

October 2026 | Precasting a Better Future

Purpose

Hydrogen sulfide (H₂S) corrosion concentrates in a small number of sanitary structures, and engineers can protect those structures at modest cost by specifying protection at design. This guide summarizes how the corrosion works, where it is critical, and the tools available to the design engineer, from a \$0 hydraulic change to a cast-in HDPE liner. Glacier Precast Concrete (GPC) prepared it as a reference for engineers in Northwest Montana, North Idaho, and Southern Alberta.

How the corrosion works

The damage is biological: bacteria on the concrete above the waterline turn H₂S gas into sulfuric acid. The sequence, as summarized in Purdue research ([Ding, 2015](#)):

1. Anaerobic bacteria in the wastewater produce dissolved sulfide.
2. Turbulence releases it as H₂S gas into the headspace.
3. Sulfur-oxidizing bacteria (*Thiobacillus* species) colonize the moist crown and walls and oxidize the H₂S to sulfuric acid.
4. The acid dissolves the cement paste and forms gypsum and ettringite. Aggregate loosens, the wall thins, and structural capacity is lost.

Two points drive design decisions:

- **The bacteria hand off in stages.** Fresh concrete sits near pH 12–13. Milder bacteria lower the surface pH first, and *T. thiooxidans* takes over only once the surface is very acidic ([ConSeal / ACI webinar](#)). Interrupting the early stages is far easier than resisting the late one.
- **Severity has a threshold.** In the Purdue tests, antimicrobial admixtures and calcium aluminate cement improved resistance under moderate conditions (concrete surface pH above 2.0). Below pH 2.0, no change to the concrete mix prevented degradation, and lower gas-phase H₂S concentration improved concrete resistance ([Ding, 2015](#)).

Where protection is critical

Corrosion concentrates where septic wastewater meets turbulence. Most gravity manholes on a fresh, well-aerated line need no special protection. These structures do:

Structure	Why it is high risk	Priority
Force main discharge manhole	The force main runs full and anaerobic, so sulfide builds in solution; the drop into the gravity line strips it out as gas	Critical
Lift station wet well	Long retention and turbulence at the inlet and pump cycling	Critical

Structure	Why it is high risk	Priority
Grease interceptor	Warm water, long retention, high organic load; fats also hydrolyze into fatty acids that lower pH directly	High
Drop manholes and hydraulic jumps	Turbulence releases dissolved sulfide	High where flow is septic
Manholes at the end of long, flat runs or low-flow lines	Long travel time lets sulfide build	Moderate
Junctions downstream of industrial or food-processing discharges	Higher sulfate and organic load	Moderate

Septic tanks: residential septic tanks vented through the building's plumbing stack are typically low risk, because the house sewer and roof vent give the tank continuous airflow. Risk rises for pump tanks and dosing chambers, large commercial or community systems with long retention, and tanks that are sealed or have no vent path.

Risk indicators to check at design: force main retention time, wastewater temperature, a measured headspace H₂S reading at an existing comparable structure, a rotten-egg odor history, and visible crown damage on nearby structures. A one- to two-week data logger reading at an existing discharge manhole is the most direct way to size the protection.

The engineer's five options

An engineer has five ways to protect a concrete sanitary structure. They work in different ways: reduce the H₂S, make the concrete hostile to the bacteria, or put a barrier between the acid and the concrete. They stack, and the strongest designs combine at least two.

1. Design it out

H₂S that never reaches the headspace cannot corrode anything.

- Bring force main discharges in at or below the water surface instead of dropping and splashing.
- Minimize drops, hydraulic jumps, and sharp direction changes at the discharge.
- Size force mains and wet wells to limit retention time.
- For severe force mains, consider source chemical control at the pump station (magnesium hydroxide, nitrate, iron salts, air or oxygen injection). It stops sulfide from forming but carries an ongoing operating cost.

Hydraulic changes cost almost nothing at design and cannot be retrofitted cheaply after construction.

2. Antimicrobial admixtures

An antimicrobial admixture is added at batching and becomes a permanent part of the cement matrix, so it cannot be punctured, delaminate, or wear off the way a surface product can. It works by stopping the early bacterial stages before the surface becomes acidic. Several EPA-registered products are on the market, including ConBlock MIC (ConSeal), Bio-San C500 (Xypex), and ConShield (ConShield Technologies). Two are compared below:

Property	ConBlock MIC (ConSeal)	Bio-San C500 (Xypex)
Chemistry	Quaternary ammonium silane that bonds to the cement matrix	Bioactive mineral solids plus Xypex crystalline waterproofing
EPA registration	No. 87907-1	No. 92393-2
Dosage	12–24 oz per 100 lb of cementitious material (liquid); reduce mix water gallon-for-gallon	1% by weight of cementitious material (powder)
Key test data	ASTM C1904: treated concrete held pH 4.3 vs. control falling to 2.06; 99.9% kill of <i>Thiobacillus</i> species in 24 hours (ASTM D4783)	10-year field exposure (samples hung in the headspace of a high-H ₂ S tank): 9 times less concrete mass loss than control. Lab antimicrobial testing per ISO 22196 (modified).
Added benefits	Also available as a surface treatment for field-cut penetrations, patches, and existing structures	Crystalline technology reduces permeability and seals static hairline cracks up to 0.5 mm

Sources: [ConBlock MIC technical data sheet](#); [Bio-San C500 product data sheet](#).

GPC uses ConBlock MIC as our default antimicrobial because it delivers the protection these structures need at a lower cost than the alternatives we have evaluated. When an engineer specifies another product, we supply it.

Limits: independent testing shows antimicrobials lose effectiveness once concrete surface pH falls below 2.0 ([Ding, 2015](#)). Admixtures do not address odor or gas exposure, and in grease interceptors they do not fully address direct fatty-acid attack.

3. Passive venting

A vent stack exhausts H₂S and moisture. A dry crown starves the acid-producing bacteria, and lower H₂S concentration improves concrete resistance.

- **Size:** a 4 in. stack moves roughly 15–35 cfm passively, depending on wind. That is about one air change every 2–4 minutes in a 4 ft diameter, 5 ft deep manhole (63 ft³). These are GPC first-order estimates, not tested values.
- **Height:** terminate about 12 ft above grade. In simple dispersion models, ground-level concentration falls roughly with the square of release height, so a 12 ft stack gives on the order of 9 times lower ground-level H₂S than a 4 ft vent. This is a GPC first-order estimate, not a measured value.
- **Make-up air:** the structure needs an inlet path (lid pick holes, an inlet pipe, or the upstream line). A single opening with no inlet exchanges very little air.
- **Limits:** the passive draft weakens on calm summer days, when sulfide production peaks. Where vent odor could reach homes, provide for a carbon canister. A vent reduces corrosion; it does not stop it at high sulfide.

4. Embedded plastic liners

Studs formed on the back of an HDPE or PP liner anchor it into the concrete. The fabricator places the liner against the form before the pour and extrusion welds the seams after stripping, forming a continuous barrier ([AGRU Sure-Grip](#)).

- **Material:** HDPE, PP, PVDF, or ECTFE, 2–12 mm thick; 13 mm V-shaped anchor studs for new precast; a coextruded signal layer is available for damage detection.

- **Performance:** HDPE is essentially inert to sulfuric acid at any pH, so the liner covers the severe cases where admixtures fall short. It also resists fatty-acid attack in grease interceptors.
- **QC:** every seam is spark (holiday) tested. Integrity depends on weld quality and penetration detailing.
- **Limits:** highest first cost of the concrete-side options. The precast plant installs a cast-in liner during production; field crews cannot retrofit one.

5. Applied coatings

- **Field- or plant-applied coatings** (epoxy, polyurethane, acid-resistant cementitious): an effective barrier, but bond and holiday (pinhole) quality control matter, and coatings typically need recoating over the structure's life.
- **Calcium aluminate cement mortars:** better acid resistance than portland cement under moderate conditions ([Ding, 2015](#)).

A note on all-plastic structures

HDPE and other thermoplastic manholes avoid acid attack entirely, but they trade it for structural limits. Thermoplastics creep under sustained load, so long-term deflection under soil and traffic loads governs the design. They depend heavily on backfill quality, need anti-flotation measures in high groundwater, and have lower load capacity than reinforced concrete at depth or under traffic. For most buried sanitary structures, protected concrete combines acid resistance with structural capacity.

Selecting the right level of protection

Match the protection to the severity. ConSeal frames it as three severity levels, from low bacterial population and activity (Level 1) to high population and high activity (Level 3) ([ConSeal / ACI webinar](#)). The H₂S ranges below are GPC's working guidance for local structures, not a published standard.

Tool	Low (Level 1)	Moderate (Level 2)	Severe (Level 3, sustained 100+ ppm H ₂ S)	Relative first cost (4 ft MH)	Ongoing cost
Design it out	Recommended	Recommended	Recommended	Near zero at design	None
Vent stack, 12 ft	Optional	Recommended	Recommended, with other tools	Low	None (carbon media if added)
Antimicrobial admixture	Recommended	Recommended	Supplement only	Low	None
Cast-in HDPE liner	Not needed	Optional	Recommended	High	None
Coating	Not needed	Optional	Option	Moderate to high	Recoat over life
Source chemical dosing	Not needed	Case by case	Often needed	Equipment	Ongoing chemical cost

For grease interceptors, treat the structure one step more severe than its H₂S reading suggests, because fatty-acid attack adds to the sulfide attack.

GPC recommendations and options

GPC's standard sanitary mix is self-consolidating concrete (SCC) at a 0.36 water-to-cementitious ratio. That is below the strictest maximum in ACI 318 Table 19.3.2.1 (0.40, for severe freeze-thaw class F3, chloride class C2, and one option under very severe sulfate class S3) and below the 0.45 limit for severe sulfate exposure (S2). Confirm the limits against the code edition your jurisdiction has adopted. SCC

needs no vibration, so it fills tight corners and the areas around penetrations without voids or honeycombing, which is where acid attack usually starts. The result is a dense, low-permeability matrix straight out of the form. Mix quality improves resistance at moderate severity, but it does not stop attack once the concrete surface falls below pH 2.0, so the five options above remain the primary protection.

GPC recommends an antimicrobial admixture as the minimum protection for every force main discharge manhole and lift station; our default is ConBlock MIC. GPC does not include these options by default; we provide them when the engineer of record specifies them. The tiers below are a starting point for that specification:

Tier	What it includes	Best fit
Recommended minimum	Antimicrobial admixture (ConBlock MIC default)	Force main discharge manholes and lift stations at low to moderate severity
Enhanced	Antimicrobial admixture plus a 12 ft vent stack with provision for a carbon canister	Moderate severity, or where odor and worker exposure also matter
Premium	Cast-in thermoplastic liner, with or without an antimicrobial admixture	Severe sulfide, grease interceptors, or where the specification requires a liner

Both admixture manufacturers publish specification language. For ConBlock MIC, ConSeal publishes a [CSI specification \(Section 03 05 00\)](#) and a [standard specification](#). For liner projects, contact us early so we can confirm materials and lead time.

GPC is an NPCA-certified plant, Montana-owned and owner-operated, producing in Kalispell since 1989. For project-specific questions, call (406) 752-7163.

References and white papers

- [ConBlock MIC product page](#), Concrete Sealants, Inc.
- [ConBlock MIC technical data sheet](#) (version 12 February 2026): dosage, test results, application.
- [ConBlock MIC CSI specification, 03 05 00](#) and [standard specification](#).
- [ConBlock MIC installation instructions](#) and [quality assurance plan](#).
- [Microbially Induced Corrosion of Concrete: Efficacy of Antimicrobial and Colloidal Silica Admixtures](#), S. Lines, ConSeal, ACI webinar: MIC stages, ASTM C1898/C1904, severity levels, and solution options.
- [Assessing the performance of antimicrobial concrete admixtures in concrete subjected to microbially induced corrosion](#), L. Ding, M.S. thesis, Purdue University, 2015: independent lab and field testing.
- [Xypex Bio-San C500 product data sheet](#), Xypex Chemical Corporation: dosage, 10-year exposure data, permeability and chemical resistance testing.
- [AGRU Sure-Grip concrete protective liners](#), AGRU America.
- [SST Installation Guide](#), USDA Forest Service: background on passive vent stack design.

Codes and test standards cited: ACI 318 Table 19.3.2.1 (exposure-class limits on w/cm), ASTM C1904 (biogenic acidification of concrete with antimicrobial additives), ASTM C1898 (sulfuric acid resistance), ASTM D4783, ISO 22196.