The Possessed Toilet Syndrome

Preventing toilet eruptions during sewer mains jetting

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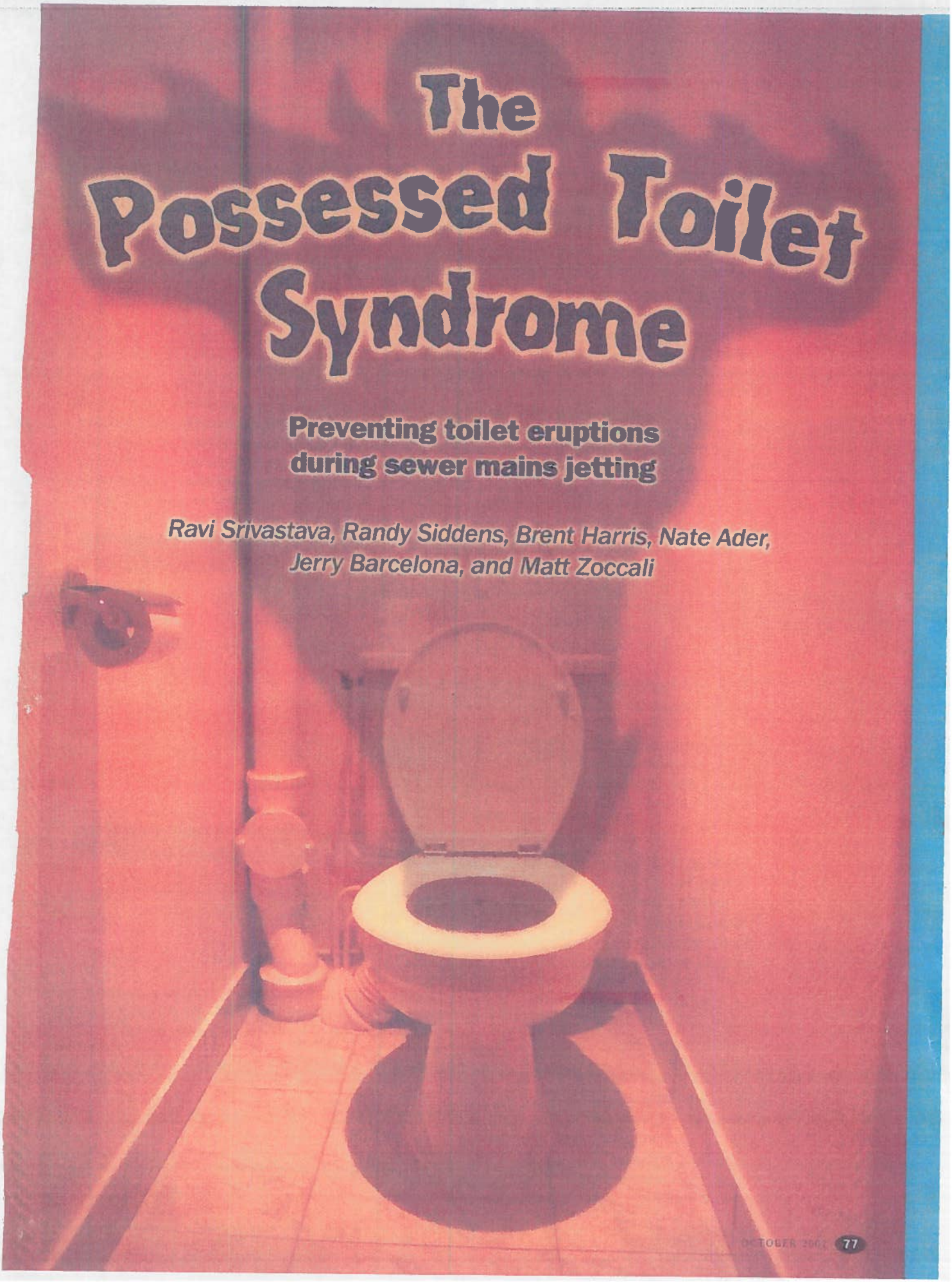


As any employee involved in the management of a wastewater collection system would acknowledge, operating and maintaining such a system has its tales of joy and discovery and its legends of nightmares and disasters.

For example, using jetting equipment to clean or deroot gravity sanitary sewer lines sometimes causes customers to complain of their toilets burping, gargling, or erupting like a volcano. Occasionally, customers have called in to voice their concern and fears of strange noises and air and water emanating from toilets — typically called *possessed toilet syndrome*.

In a typical year, the Boxelder Sanitation District (Fort Collins, Colo.) receives about a half-dozen of these telephone calls. Staff traditionally ascribe these reports to poorly designed or maintained sewer service laterals (house sewer lines) that are too shallow or somewhat clogged, causing high-velocity cleaning water from the jet nozzle to rush up the house sewer lateral and possess toilets.

But the district staff's assumptions were literally blown out of the water when jetting a recently constructed sewer line led to nearly 30 calls of toilets burping, erupting, or otherwise displaying signs of possession. The residents of the retirement community where the mass possession occurred were quite cross and readily displayed their displeasure.

Finding the Demons

Initial investigation of the subdivision revealed that there were only two models of homes being built along this segment of line, and all of the problems occurred in only one of the models. Visual inspection of homes under construction revealed that while both models had essentially the same number of plumbing fixtures, the models experiencing problems had fewer plumbing vent stacks. It is important to note that all of the homes met local plumbing codes and were inspected by appropriate local permit authorities. This led district staff to postulate that even though the homes may have had code-compliant plumbing, venting was probably playing a vital role in the problems.

Intrigued by this unusual rash of toilet misconduct, the district staff decided to investigate the underlying phenomenon to understand why these toilets behaved differently than most.

Testing the Waters

To obtain a better understanding of the underlying phenomenon, staff obtained access to a newly installed 8-in. (200-mm) gravity sanitary sewer line in the same retirement community. The line served a number of house sewers on lots that were yet to receive houses. The sewer line and the house sewers were as shown in Figure 1 (below).

Figure 1. Schematic of Sewer Line for Study

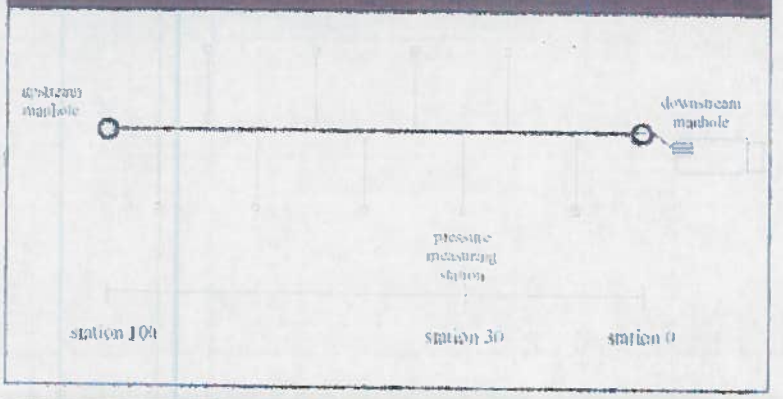


Figure 2. Schematic Pressure Variation due to Travel of Jet Nozzle

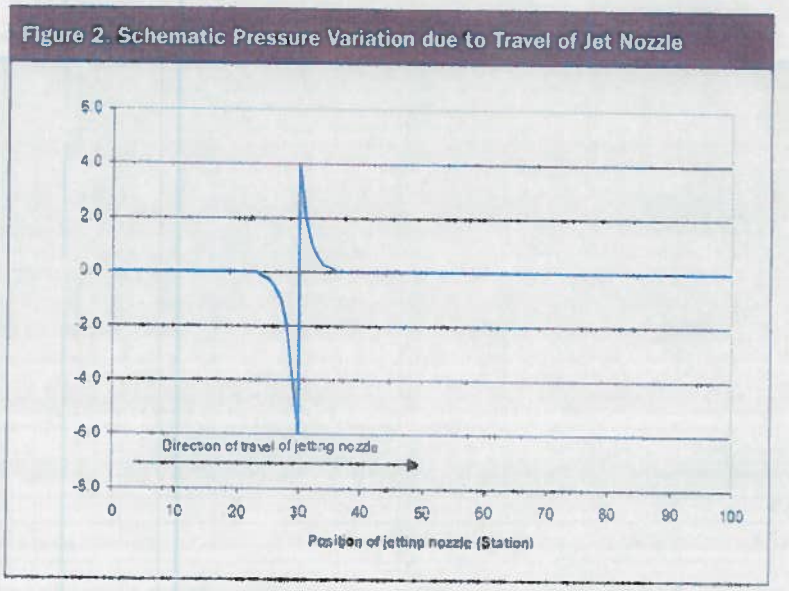
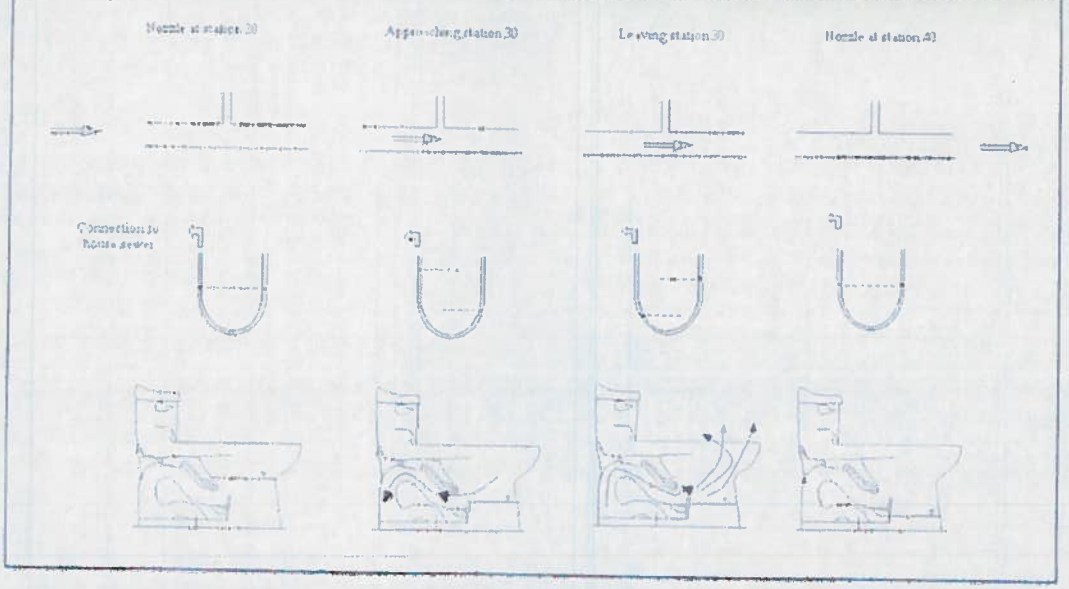


Figure 3. Schematic Depicting Cause of Toilet Eruption



The fact that water was blown out of the toilets of newly constructed homes in this subdivision led district staff to suspect that strong air and water pressure changes were being exerted in the house sewer lines as the jetting nozzle approached, crossed, and went past the house sewer connection in the sewer main. Staff suspected that different jetting nozzles, the closing or venting of the upstream manhole, closing or venting of the house sewer via a cleanout, and the water pressure in the jetting nozzle could contribute to the level of pressure exerted on the house sewer and, thus, the toilet.

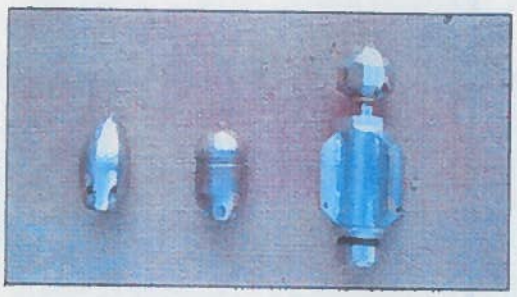
To test these theories, staff positioned the district's jetting machine, a 2005 SECA Model 80011, at the downstream manhole with 1000 ft (305 m) of 1-in. (25-mm) diameter hose and used a set of three different jet nozzles — a bullet, a SECA, and a warthog. The nozzles were impelled at line pressures of 1000, 1500, or 1900 lb/in.^{2} (6895, 10,340, or 13,100 kPa), with the upstream manhole closed or open, the service lateral cap closed or vented, and the jetter pushing upstream or being pulled (by winch) downstream. A U-tube manometer was constructed at a residential service lateral stub to serve as a pressure monitoring station. The levels of variables tested are depicted in Table 1 (below). The response variable was the pressure in inches of water (negative or positive) at the pressure measuring station.

Table 1. Variables and Their Levels Studied

Variable	Setting #1	Setting #2	Setting #3
Jet nozzle	Bullet	SECA	Warthog
Upstream manhole	Closed	Vented	-
Linepressure	1000 lb/in.^{2}	1500 lb/in.^{2}	1900 lb/in.^{2}
Cleaning direction	Moving upstream	Moving downstream	-
Service lateral	Closed	Vented	

Table 2. Conclusions Drawn by Boxelder District Staff

Parameter	Status	Effect
Upstream manhole	Vented	Facilitates ventilation, reduces eruption potential.
	Closed	Increases eruption potential.
Cleanout on house sewer	Vented	Facilitates ventilation, reduces eruption potential.
	Closed	Increases eruption potential.
Jetting nozzle type	Varies	Some jetting nozzles produce higher pressure swings than others, generating greater eruption potential.
Travel direction of jetting nozzle	Upstream	Decreases eruption potential.
	Downstream	Increases eruption potential.



BOXELDER SANITATION DISTRICT

During its investigation of toilets erupting during line cleaning, the Boxelder Sanitation District (Fort Collins, Colo.) experimented with various jetting nozzles, such as the bullet, SECA, and warthog models pictured.

Revealing the Truth

The most enlightening finding was the variation in pressure at the house sewer lateral as the jetting progressed. Figure 2 (see p. 78) depicts in a schematic manner how the pressure varies in a house sewer lateral (station 30) as the nozzle approaches it from downstream and is impelled upstream due to the water pressure. The house sewer lateral senses little pressure until the jetting nozzle is quite close to its connection to the sewer main. As the jetting nozzle approaches the service connection, a suction (negative pressure) is experienced, the magnitude of which increases rapidly as the nozzle nears the connection, peaks (negatively) as the nozzle passes the connection, then instantly peaks to a positive pressure, which rapidly decays as the nozzle moves away from the connection.

This is understandable, because the high-velocity water jets emanating from the nozzle as it travels from the downstream to the upstream manhole are directed in the downstream direction. These water jets entrain and draw the air in the pipeline to travel downstream and exit from the open downstream manhole, resulting in a reduced pressure near the nozzle.

As the nozzle approaches the connection, the suction increases in magnitude, causing the sewer main to draw air from the vents in the house plumbing and from the upstream manhole. If the upstream manhole is closed, the suction must be relieved solely by the vents in the house plumbing. In those instances where the house plumbing is poorly ventilated, the suction affects plumbing fixtures, such as toilets, bathtubs, and sinks located most proximate to the house sewer connection. Thus, as the jetting nozzle approaches the house sewer connection, if the house plumbing is poorly ventilated, it could aspirate the water out of the toilet and make it flow into the house sewer (see Figure 3, p. 79).

As soon as the jetting nozzle passes the house sewer connection, the flood of water from the nozzle exerts a positive pressure on the water column in the house sewer and potentially discharges its water into the house sewer, causing the water already in the house sewer to rush out of the nearest available opening — the toilet — and creating the burps, belches, and fountains of a possessed toilet.

What are the contributing or mitigating factors that affect the potential for toilet eruptions during jet-cleaning of sewer lines? On the basis of its investigation, the district staff drew several conclusions, which are summarized in Table 2 (see p. 79).

The last parameter (direction of travel of jetting nozzle) is also important. When the jetting nozzle is pulled downstream (while flowing), it causes more water to accumulate at a given location in the sewer main than if the nozzle were traveling upstream, away from the direction of the water jets impelling the nozzle.

Exorcizing the Demons

Following this rash of possessed toilets and the subsequent investigation, including conversations with others who jet-clean gravity sanitary sewer lines, district staff learned that toilet eruptions are commonplace, but not well acknowledged in the industry.

The causes of toilet eruptions invariably are either poorly ventilated house sewers or poorly designed house sewer lines, even though the plumbing within the homes may be compliant with the appropriate plumbing code.

The staff also identified many operating practices that can help mitigate the potential to blow up toilets. Those practices include

- venting upstream manholes,
- venting cleanouts on house sewers,
- reducing the flow from the jetting nozzle when traveling downstream, and
- using appropriate jetting nozzles.

By using a combination of these practices, district staff has substantially reduced its encounters with possessed toilets.

The Boxelder Sanitation District provides sanitary sewer service for about 8500 residents near Fort Collins, Colo. ***Ravi Srivastava*** *is the general manager;* ***Randy Siddens*** *is the district engineer, and* ***Nate Ader*** *and* ***Jerry Barcelona*** *are collection system operators for the district.* ***Brent Harris****, who is now construction supervisor for Crow Creek Construction (Greeley, Colo.), was the collection system manager for the district at the time of this project.* ***Matt Zoccali****, who is now an industrial pretreatment specialist for Fort Collins Utilities, was a collection system operator for the district at the time of this project.*