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TO BOLDLY GO WHERE NO MAN HAS GONE BEFORE

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ABSTRACT: The Vallejo Sanitation and Flood Control District is performing CCTV inspections on pipes that do not have a record of such inspections. This effort was triggered by a settlement with Baykeeper, who alleged that broken pipe or pipe about to collapse would remain undetected and lead to sanitary sewer overflows. The actual result of the CCTV inspection turned out to be quite different. Instead of broken pipe, what was discovered were issues of collection system maintenance criteria and database management.

1. INTRODUCTION

The Vallejo Sanitation and Flood Control District (VSFCD) has recently completed a Closed Circuit Television (CCTV) inspection of sanitary sewer mains for which no such inspection records were on file. Hence the title "To Boldly Go Where No Man Has Gone Before", borrowed from Star Trek.

As work proceeded, a quote from the Sorcerer's Apprentice ("Der Zauberlehrling", poem written in 1797 by Johann Wofgang von Goethe) became more appropriate as a subtitle: "Die Geister die ich rief werd' ich nun nicht los!", which can loosely be translated as "Now I can't get rid of the spooks I called up with my spells!". What started as a search for defective pipes ended up as a lesson in database integrity and asset management.

2. BACKGROUND

In 1999, VSFCD settled a suit by Baykeeper, a local environmental group. The terms of the settlement agreement required VSFCD to reduce its frequent wet weather sewer overflows to a 20 percent chance in any given year (5-year event). Six years and $60 million later, VSFCD accomplished this task and demonstrated its success during the subsequent three years, fulfilling the settlement requirements in August, 2008.

In 2009, Baykeeper approached VSFCD again, this time with the assertion that VSFCD's dry weather sewer overflows could be somewhat reduced in number. After lengthy and difficult negotiations, VSFCD entered into another settlement agreement with Baykeeper in September, 2009. The terms of the settlement agreement were as follows:

VSFCD must CCTV all sanitary sewers 15 inches or less in diameter that do not have CCTV records on file. This work must be completed by March 2011. By March 2011, VSFCD must have established a routine that would ensure that all its sanitary sewers 15 inches or less in diameter are CCTV-inspected at least once every eight years.

VSFCD must demonstrate that it follows its Fats, Oils and Grease (FOG) Program.

VSFCD must clean at least 200 miles of sanitary sewers 15 inches or less in diameter every year. Based on the results of the cleaning operation, VSFCD must adjust the preventative maintenance schedule as necessary. Eighty of the 200 miles of sanitary sewer must be comprised of pipes that are not on the preventative maintenance schedule and must be "jet-inspected", a process by which the lines are flushed and the water leaving the lines visually observed for potential problems.

This paper concentrates on the results of the CCTV inspection of lines which, according to VSFCD records, had not been CCTV-inspected before.

3. CCTV INSPECTION EFFORT

Less than 5% of VSFCD's total sanitary sewers fit the criteria for CCTV inspection, i.e. have a diameter of 15 inches or less and do not have a record of a previous CCTV inspection in VSFCD's Hansen asset management database. The Baykeeper settlement requires that the pipe defects found be categorized and repaired according to the following matrix:

Table 1. Rating and repair schedule for pipe defects.

Rating	**Condition Assessment Action Matrix**	
	Condition Description	**Remedy**
8-9 Failure imminent	Structural defects that may lead to complete failure and blockage of the pipe at any time	Repair within 30 days
6-7 Severe	Severe structural defects such as deformed pipe, holes in pipe, broken pipe, and large joint offsets	Repair within 1 year or, if periodic maintenance can keep pipe in working order, re-assess condition within 1 year
4-5 Major	Structural defects such as multiple fractures, medium joint offsets, and major sags	Repair within 5 years, re-assess condition within 2 years
2-3 Moderate	Structural defects such as fractures, cracks, medium joint offsets, and sags	Re-assess condition every 5 years
1 Minor	Structural defects such as slight sags, cracks, and small joint offsets	Re-assess condition every 8 years

The CCTV inspection revealed hardly any defects rated "1" unless stubbed-in laterals are counted. There were relatively few stubbed in laterals and they were concentrated on even fewer line segments, indicating that these were line segments dating back to times when stubbing in laterals was accepted practice.

Defects rated “2” to “3” were found approximately every 400 feet on the average, most of them off-set or cracked joints.

Defects rated “4” to “5” were found approximately every 4,000 feet on the average. Defects rated “6” to “7” approximately every 8,000 feet.

Only three defects were rated “8” or “9”. One of the defects has been repaired. Another, upon excavation, was found to be patched on the outside and did not require repair. The last one was a change in pipe size, mislabeled as imminent failure.

4. INTERPRETATION OF RESULTS

It is interesting but by no means surprising that the defects found during the CCTV inspection of pipes with no CCTV records is less than the average density of defects in a collection system as old as Vallejo’s. After all, pipes without CCTV inspection records tend to be the pipes that have not experienced blockages or overflows.

On the other hand, VSFCD’s inspection found five manholes that were in dire need of reconstruction. Defective manholes do not generally reveal themselves through blockages and overflows, so they can remain undetected until an inspection is performed for other reasons. VSFCD has awarded a contract for the re-construction of these five manholes.

It is in general a good idea to perform CCTV inspections of the entire collection system within a rotation of 10 years or so. Accordingly, the inspections performed by VSFCD in response to the Baykeeper settlement agreement were beneficial. However, it is doubtful whether the CCTV inspection contributed in any significant way to the reduction of dry weather overflows. Dry weather overflows are primarily due to root intrusion and grease accumulation. Sewers which are subject to roots and grease are on the preventative maintenance schedule and generally have CCTV inspection records on file. It is a fallacy to expect that a first-time CCTV inspection will reveal a significant number of collapsed pipes or pipes in danger of imminent collapse which would cause blockages and overflows.

In VSFCD’s experience, the only surprises discovered in the past by CCTV inspections were construction problems. One incident was the discovery of a large diameter concrete pipe which had the upper half of its cross-section blocked to accommodate a large diameter gas line which passed over it. Another incident, which actually occurred several time, was the discovery of a fiber-optic cable, installed by directional drilling, which punched through the wall of the pipe and right out the other side.

5. REASONS WHY CCTV RECORDS DID NOT EXIST FOR CERTAIN SEWERS

Several specific characteristics of the sewers identified for CCTV inspection led to interesting conclusions as to why CCTV inspections were never performed on these pipes.

As mentioned in the previous section, the fact that these lines did not have any operational problems was one reason.

Another reason was that some pipes were oversized and, even so they were subject to grit deposition and other partial obstructions, had never suffered a blockage or overflow. It should be noted that this fact was not the rationale behind the decision that pipes larger than 15 inches in diameter were excluded from the settlement agreement. During the settlement negotiations, it was decided that larger diameter pipes were generally made of more durable material and, if they were constructed recently, did not have any CCTV records on file because they were inspected by other means.

Some of the pipes without CCTV records were just too hard to access. Interestingly, the defective manholes were found mainly on these segments.

Two management decisions from the past had the unintended consequence of preventing full coverage of the collection system by CCTV inspection; one was the expectation of a certain minimum daily production and the other was cleaning by drainage basin.

Under previous management, there was an expectation that 2000 feet of CCTV inspection per day was a good rate of production. CCTV crews gained the praise and respect of their supervisors if they met or exceeded this quota. In order to do so, the crews favored sewers with easy set-ups, such as quiet residential streets. Sewers in easements with difficult access were neglected as were sewers in streets with heavy traffic. Because setting up can require a lot of time, there is also a noticeable bias towards longer pipe segments and multiple segments accessed through one manhole.

Another management decision was to schedule cleaning and CCTV inspection on a drainage basin by drainage basin basis, whereby each basin was cleaned from upstream to downstream so that debris would be flushed through the entire system rather than settling in the next downstream pipe segment or wherever the pipe slope flattened out. This approach has its merits and VSFCD will still apply this concept to its cleaning schedule. Within 10 years or so, VSFCD would have cleaned and CCTV-inspected all sewer which did not have previous CCTV inspections. However, the basin-by-basin approach meant that some sewers in basins scheduled for a later date were still recorded as lacking a CCTV inspection. The Baykeeper agreement disrupted the basin-by-basin approach by forcing the inspection of these sewers prior to expiration of the settlement agreement.

Some of the sewers turned out to be force mains, which generally are not CCTV-inspected.

Another reason for pipes without CCTV records was new projects and subdivisions which were CCTV-inspected by the contractor or the developer. Tapes/DVDs were available but had not been logged into Hansen.

Finally, several of the sewers were found to be private according to VSFCD regulations.

6. PHANTOM PIPES

The most surprising result of the CCTV inspection effort was the discovery of many “phantom” pipes that existed only in VSFCD’s Hansen database and not in reality.

Some of these phantom pipes were due to obvious operator errors, such as neglecting to remove an abandoned pipe, inserting but not deleting dummy pipes for certain purposes, and performing database training on the actual database rather than a duplicate. While these are operator errors that certainly should be avoided, they are not serious errors if the database is used only for scheduling preventative maintenance and storing information about existing sewers. This explains an operator’s focus on entering new sewers into a database and delay and possibly forget the deletion of abandoned pipes from the database. However, if the database is also used for statistical analyses and calculation of certain performance criteria, the presence of phantom pipes will skew the results. In general, there is a tendency for a collection system database to over-represent the number of pipe segments due to the presence of phantom pipes but to under-represent the total length of pipes in the system because pipe segment length are missing for some pipes.

One source of phantom pipes in the database is specific to VSFCD and due to VSFCD’s policy to assume ownership of lower laterals when a District clean-out is present. An early version of the Hansen database, i.e. WCMS, did not provide for the entry of service lines. VSFCD staff developed a work-

around and entered service lines as mainline assets with a special designator. This turned out to be a problem later on when VSFCD migrated the WCMS database into Hansen 7.

Going even further back in time, phantom pipes have been added when the original system maps were first converted into electronic asset management databases and abandoned pipes that were carried along on the paper maps were inadvertently entered into the database as an existing asset.

Database conversions and migrations can very often be a significant source of phantom assets. This can occur if a new kind of software is introduced or merely an upgrade of the existing software. A designator for a certain asset that had never been a problem in the day-to-day use of the software can be misinterpreted in a database migration because of simple errors such as capital letters instead of lower case and the insertion of blank spaces.

Another source of phantom pipes is uniquely related to the current economy. In some cases, approved subdivisions were entered into the database in anticipation of testing and inspection records to be stored. However, construction of the subdivision was subsequently delayed to an unspecified date.

VSFCD's pipe rehabilitation prioritization is mainly driven by the maintenance record of the individual pipe segments. VSFCD staff retains the maintenance record of a rehabilitated pipe in case questions arise later. This is done by keeping a virtual pipe with the old record. Often, the information on the pipe is selectively transferred to the new pipe if it could be relevant to the rehabilitated pipe. If this process is not executed correctly, the virtual pipe can remain real in the database.

Finally, the construction of an additional manhole turned out to be a source of phantom pipes. The construction of an additional manhole creates an additional pipe segment in the database. Technically, because pipe segments are identified by upstream and downstream manhole, it eliminates an existing pipe segment and creates two new ones. Since only the manhole was reconstructed and not the pipe, it is important to retain information on the segment and the maintenance history of the pipe. Accordingly, the empty fields in the database for the two new pipe segments is selectively populated with information from the abandoned pipe segment. This is a convoluted process that is prone to operator errors.

The problem of phantom pipes is a subset of the larger database integrity issue. Maintaining the accuracy of an asset management database is an important task that requires well designed procedures to minimize errors, the designation of a single person as database administrator, and frequent queries of the database designed to uncover errors.

The purpose of this paper is to alert database administrators to these potential problems. The presence of problems similar to those outlined above can be discovered by spot checks and intelligently designed queries.