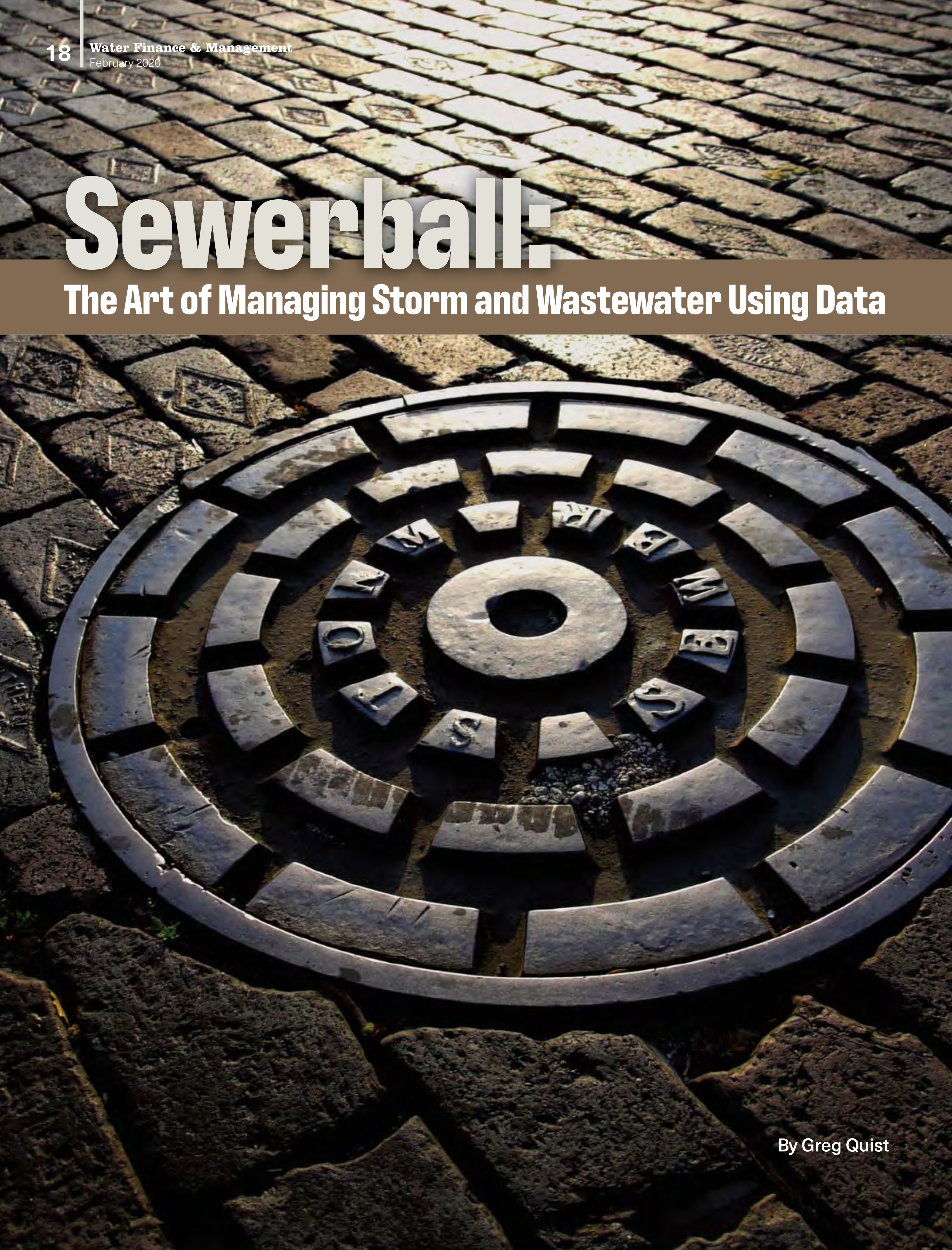


Sewerball:

The Art of Managing Storm and Wastewater Using Data

By Greg Quist

Hawthorne, California is the home of SpaceX, which launched in to orbit the Iridium Satellite network, linking sewer monitors with their customers even in the midst of extreme weather events.

Stormwater and sanitary sewer systems may be some of the least technologically sophisticated systems in the utility's arsenal. Most often, these systems are gravity-based and out of sight. As a result, operational assessments are limited to the occasional visual inspection when an operator lifts a manhole to check conditions, or worse when called out due to backups, overflows or odors. With this lack of visibility, operators are left to use their experience, intuition and instincts to operate these vital systems.

In addition, storm and sanitary sewer systems are often "build and forget" projects. With no data to support real-time assessments, these systems are assumed to be operating to specification unless there is a major problem. Or they are subjected to routine but perhaps unnecessary cleaning programs or other capacity management activities. Both these conditions create the perception of efficiency, and absent an external impetus, such as EPA-enforced consent decrees or significant property or public health impacts, the budgets for fire, police, and roads often command more financial attention than do storm and sanitary systems.

The relative invisibility of these systems and a lack of continual investment means that the managers of storm and sanitary sewer systems must be able to operate at increasingly proficient levels within the financial constraints of their budgets. In the past this was based on experience. Today, these managers have a powerful tool at their disposal to achieve this: information. Through the use of data-driven analytics and remote sensing and communication tools, the operators of storm and sanitary sewer systems can elevate the performance of their systems even in the face of scarce financial resources.

In some ways, we could call this the *Sewerball* equivalent of the Moneyball. For those not familiar with the book, "Moneyball: The Art of Winning an Unfair Game," by author Michael Lewis takes the reader on a journey to discover how the Oakland Athletics maximized the potential of their undercapitalized team by focusing on data. Sabermetrics, a term coined by Bill James, can be defined as the use of statistical analysis to analyze baseball records and make determinations about player performance. Sabermetrics allowed Oakland to build a team within an existing (and minimal) budget, that in aggregate could compete with teams with comparatively unlimited resources.

In our Sewerball story, however, we apply statistical analysis to understand the performance of our storm and sanitary sewer infrastructure and use that information to maximize its operational availability and capacity within a constrained budget.

The Transition to Data-Driven Decisions

In the 1980s, Bill James pioneered the concept that the traditional baseball data was in fact not representative of the performance of players and the sport. While statistics in baseball have been around for generations and the availability of data staggering, according to James the statistics being employed were not meaningful assessments of team or individual performance. They also failed to provide any guidance or insight into the operations of the teams. For example, the number of hits achieved by a player is not truly reflective of the effectiveness of a hitter. James' notable insight was existing data could be combined in new ways to generate something more useful than traditional metrics. In this case, James proposed a mathematical formula to determine how many runs a hitter creates:

$$Runs\ Created = \frac{[(Hits + Walks) * (Total\ Bases)]}{(At\ Bats + Walks)}$$

From the perspective of the game, this is a more effective "stat." If the object of baseball is to score runs to defeat your opponent, then the batter who creates more runs is a more valuable player.

Interestingly, this concept has a direct parallel in the water and wastewater sector: it is data rich, but information poor and oftentimes we are not calculating the correct performance indicators to truly understand the game, or in our case, the performance of our underground system.

However, the water and wastewater sector is now amassing vast troves of data that, when combined in unique ways, can be used to derive important relationships. Large internal and external data sets can be combined and

Since installing 50 sensors across its sewers, the City of Hawthorne, California, has eliminated 99.9 percent of sewer spills.

compared against a physical model of operations that can inform the process and maximize efficiency.

As an example, using a set of sophisticated sensors within a sewer system, patterns of normal conditions and indicators of abnormal situations become apparent. By combining this level of understanding with external data sets such as NOAA's rainfall and tidal information, the utility can make predictive assessments of how externalities are impacting the physical operations of the system — and adapt operationally. This creates a system that takes the guesswork out of understanding the real-time condition of the storm and sanitary sewer systems and allows operational decisions to be made in a timely and cost-effective manner.

The result is that for the first time, these often-ignored systems can be elevated and operated in a manner that not only guarantees compliance but can have significant fiscal benefits.

By using a data-driven decision support platform combining the data from 50 sensors and providing insight into the real-time conditions in the collection system, the City of Hawthorne, California, has reduced sanitary sewer overflows by more than 99 percent and saved more than $2.5 million in fines and mitigation costs over the past 13 years. Similarly, the City of South Bend, Indiana, installed a real-time monitoring system consisting of more than 120 sensors and automation to stormwater retention basins to control the release of stormwater. This resulted in the elimination of dry weather overflows and reduced combined sewer overflows by 70 percent (1 billion gallons per year) over the period of 2008 to 2014, according to EPA data.

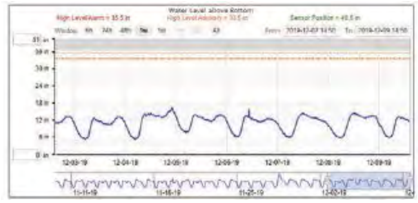
Data-driven services can also be used to better deploy resources. For example, the San Antonio Water System (SAWS) uses trend analysis from 200 remote sensors to manage a real-time sewer cleaning optimization program. This program has allowed SAWS to strategically identify areas needing cleaning and resulted in an overall reduction of cleaning operations by 95 percent and projected saving more than $3.4 million in three years, according to SAWS data.

Finally, data can also be deployed to drive significant savings in capital expenditures. This was the case in Mt. Crested Butte, Colorado, where state regulators threatened to cancel the town's operating permits if the sewer overflow problems could not be solved. While one traditional solution considered the investment in a $10 million project to replace the sewer main, the town was able to optimize the utility of their existing infrastructure by better understanding the way in which the system operates. With real-time visibility into their collection system — at a cost of $96,000 in sensors — the town was able to comply with the regulatory requirements and avoid the requirement to construct new facilities.

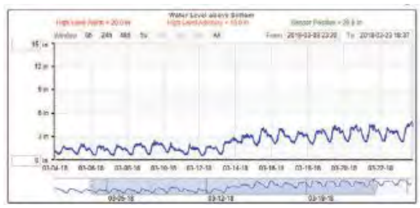
The Move to Artificial Intelligence

At the time, James was pioneering Sabermetrics and demonstrating that the methods and analysis were often correct, he was mostly ignored. This may be attributed to baseball's traditionalist roots — one where the primary senses and gut intuition determined the flow of play of the players, the teams and the sport. The same situation exists in storm and sanitary sewer systems: their relative invisibility results in their being operated by intuition based on past experience rather than on actual operating conditions assessments.

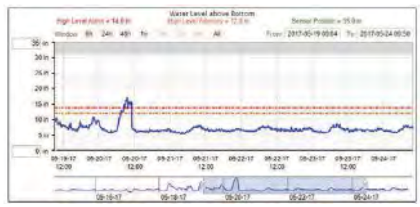
However, with real-time visibility into the conditions of these systems, that veil of intuition is being lifted and



Normal sewer flow pattern.



Grit build-up pattern.



Blockage upstream pattern.

replaced by actual understanding. As the availability of highly granular, accurate and validated data increases, storm and sanitary sewer system operations can leverage the analytic tools of artificial intelligence to improve assessments. For example, SmartCover Systems (Escondido, California) has collected more than 200 million hours of sewer and stormwater monitoring data, which are now used in machine learning pattern recognition routines to identify common issues with our collection system infrastructure – issues that are rarely evident to operators who are "popping a manhole." Companies such as SmartCover, EmNet, Innovyze, Echologics and OptiRTC are leveraging sensor and data technologies to create an advantage for operators who can rely on a data-driven understanding of their underground infrastructure systems for the first time in decades.

Most importantly, these technologies are more than the sensors. Data is integrated into real-time decision support tools that offer full service operational insights to provide operators and utility management staff with advanced warning of potential issues and allows them to operate the system with confidence and effectiveness.

Looking Ahead

Moneyball, the rise of data analytics in baseball, allowed for parity of performance in an increasingly divergent financial landscape. For our storm and sanitary sewer systems, Sewerball provides information about the real-time condition of a sewer system and allows for strategic deployment of resources to maximize the utility of our existing infrastructure. With this information, operators can identify blockages before they overflow onto the street; detect storm water infiltration before it overwhelms the defenses; and can locate surging sewers before they back up into homes and businesses. All while providing detailed understanding of how these critical systems operate.

> **With real-time visibility into the conditions of systems, the veil of intuition is being lifted and replaced by actual understanding.**

Greg Quist, Ph.D., is the CEO and co-founder of SmartCover Systems.