Channel to tap

Study identifies key factors for stormwater capture and downstream reuse

Findings from San Diego County's Regional Stormwater Capture Feasibility Study reveal the potential for capturing and using stormwater in the region – as well as factors that hinder its adoption. **Lisa Skutecki** and **Hari Seshan** of Brown and Caldwell explain.

Legislation passed in California, United States (US), is promoting the use of stormwater as a resource; however, regulatory and cultural challenges continue to hinder the adoption of stormwater reuse. In 2014, the passage of California Senate Bill SB985 (Stormwater Resource Planning) established the requirement for all regions within the state to develop Stormwater Resource Plans (SWRP) and made available grant funds to support their development with the goal of promoting stormwater reuse.

San Diego County carried out the Regional Stormwater Capture Feasibility Study (SWCFS) to analyze the potential for capturing and using stormwater beneficially across the region – and to gain understanding of the factors that hinder its adoption. Among the many uses of stormwater identified and evaluated under SWCFS, the potential for flow augmentation to sewers to feed local water resource recovery facilities (WRRF, referred to as resource agencies in the County's SWCFS report), was evaluated. Two local sewersheds and their corresponding WRRFs were evaluated at a high level with the intention of serving as a template for subsequent evaluations at other locations.

Where would it work?

The study identified criteria that make stormwater capture for downstream recycled water use feasible, such as the availability of storage parcels in the WRRF's sewershed, and the need for additional source(s) of water to meet recycled water production goals. The San Diego County SWRP identified several parcels across the County that could be used for stormwater capture and storage. The process used here assumes the collection and storage of stormwater during rain events in such parcels within the sewershed of certain local WRRFs, followed by controlled discharge into the sanitary sewer system during periods of low wastewater flow after rain events, for subsequent flow augmentation to the downstream wastewater treatment plant (Figure 1).

Two major sewersheds and corresponding WRRFs within the County were selected for this evaluation: (1) the South Bay Water Reclamation Plant (SBWRP), operated by the City of San Diego, and a portion of its presumed sewershed; and (2) the Ray Stoyer Water Reclamation Facility (RSWRF), operated by the Padre Dam Municipal Water District (PDMWD, or Padre Dam, and a portion of its presumed sewershed. These two facilities were chosen for a sewer system evaluation owing to major recycled water production plans in the near future at both plants and to the fact that several storage parcels exist in the sewersheds of both these plants, as determined by the County's SWRP.

Among the challenges with this approach are the ability to load sewers with captured stormwater without exceeding their capacity after a storm event and the ability to accept this additional hydraulic load at a WRRF that is acclimated to treating wastewater, rather than a blend of stormwater and wastewater.

Sewer capacity evaluation

To answer the first challenge identified above, the sewersheds of the above two plants were matched – in terms of vicinity within 60 meters (m) – with the available storage parcels determined from the SWRP. Ten storage parcels were found to be feasible for stormwater capture and sewer discharge in the SBWRP sewershed, and seventeen such feasible parcels were identified in the Padre Dam sewershed. A simple and conservative sewer system model was built for each of these sewersheds to determine capacity when captured stormwater is metered in. The model assumed a base wastewater flow in each sewer segment occupying 50 percent of the given sewer segment's capacity and a total allowable capacity of 75 percent full in a given sewer segment. This configuration allows captured stormwater to be metered in at a rate that would fill the sewer segment to between 50 and 75 percent, including all discharges from upstream parcels. In force mains, a total flow resulting in a velocity of up to 2.4 meters per second

Figure 2a. SBWRP Sewershed

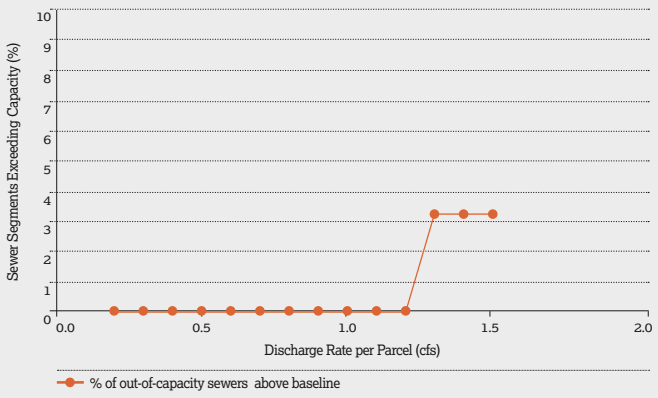

Figure 2b. Padre Dam Sewershed

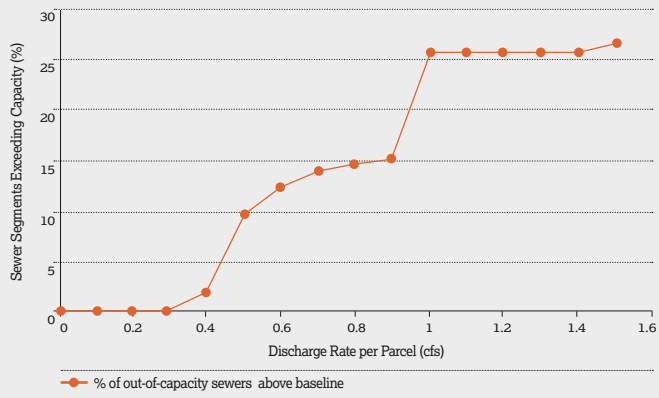

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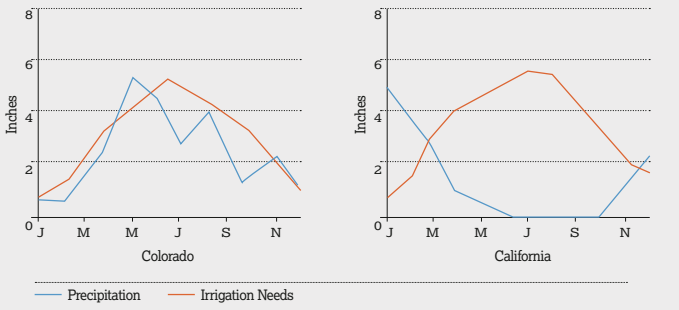
Figure 3. Precipitation patterns



THE STUDY IDENTIFIED CRITERIA THAT MAKE STORMWATER CAPTURE FOR DOWNSTREAM RECYCLED WATER USE FEASIBLE, SUCH AS THE AVAILABILITY OF STORAGE PARCELS IN THE WRRF'S SEWERSHED, AND THE NEED FOR ADDITIONAL SOURCE(S) OF WATER TO MEET RECYCLED WATER PRODUCTION GOALS.

(m/s) (8 feet per second, ft/s) was assumed to meet capacity requirements, accounting for all parcel discharges into gravity sewer segments upstream of the force main. This cumulative process helped determine which sewer segments in a sewershed would face capacity issues at varying discharge rates from storage parcels.

In the SBWRP sewer system, a discharge rate from parcels of more than 0.03 cubic meters per second (m^3/s) (1 cubic foot per second, ft^3/s) was found to be maintainable from each parcel without exceeding capacity in any of the segments in the sewer system (Figure 2a). In the Padre Dam sewer system, this figure dropped to approximately 0.01 m^3/s (0.3 ft^3/s) (Figure 2b).

Flow augmentation to WRRF

A 40-year San Diego hydrology model was used in conjunction with assumptions on parcel volume, capture during storms and discharge after storms, to develop a profile of the additional flow available for augmentation to the two WRRFs that were evaluated during a simulated wet year. In the SBWRP sewershed, an annual average flow of about 0.64 million liters per day (ML/d) (0.17 million gallons per day, mgd) was found to be available via stormwater capture, with a wet weather (October – May) average of 0.9 ML/d (0.24 mgd) and a peak day flow of 6.7 ML/d (1.8 mgd). SBWRP currently receives about 30 ML/d (8 mgd) of wastewater. Captured stormwater can account for an annual average of 3 percent of its total flow and up to 18 percent during a wet year. In the Padre Dam sewershed, an annual average flow of about 1.1 ML/d (0.3 mgd), a wet weather average of about 1.5 ML/d (0.4 mgd), and a peak day flow of about 11.3 ML/d (3 mgd) was found to be available from stormwater capture. Since RSWRF plans to operate as a scalping facility at about 23 ML/d (6 mgd) after a major expansion in the near future, this additional captured flow can account for an annual average of 5 percent of the facility's influent flow and up to 50 percent during a wet year.

Challenges to overcome

While flow is available for WRRF augmentation without substantially impacting sewer system capacity, several challenges continue to pose obstacles to the future of stormwater capture for reuse in California. Among the issues is the inconsistency in stormwater availability: unlike in other parts of the United States, it rains in Southern California when reuse demand is lowest, and vice versa (Figure 3). This occurrence results in the need for larger storage to provide long-term stormwater capture during the wet season and flow augmentation potential to meet reuse demand during the dry season. The two regional examples evaluated here did not account for large, long-term storage.

Another challenge to stormwater capture for reuse is the perception in the WRRF community that stormwater hinders the wastewater treatment process and that it particularly has the potential to affect biological secondary treatment. The abundance of data on the ability of WRRFs to perform during wet weather indicates that stormwater (without capture and storage) may not severely compromise the wastewater treatment process. However, the impacts on wastewater treatment processes of the low relative volumes described above, discharged to a WRRF over long periods, have not been tested rigorously.

Stormwater capture in Southern California

Stormwater cannot be ignored as a potential resource for recycled water use, given the significant potential for future drought in Southern California and push toward reuse. Several agencies in the vicinity of San Diego, including Los Angeles and Orange County, are studying or implementing stormwater capture for groundwater recharge (in addition to other uses). San Diego County's SWCFS has had to look at a diverse range of beneficial use options for captured stormwater, owing to the fact that the local hydrogeology does not support substantial groundwater recharge. These options include groundwater injection, wetlands, and rain barrels in addition to sewer augmentation for reuse at WRRFs.

While there is clearly potential for reuse, as the examples described in this article reveal, the limitations presented above make the channel-to-tap concept a long-term strategy rather than a short term one for the region. Neither the City of San Diego nor Padre Dam is currently considering stormwater capture as a source for reuse. Additional research, complemented with studies such as the County Regional Stormwater Capture Feasibility Study, may help change these considerations and make stormwater capture a long-term target for major agencies in drought-affected regions around the world.

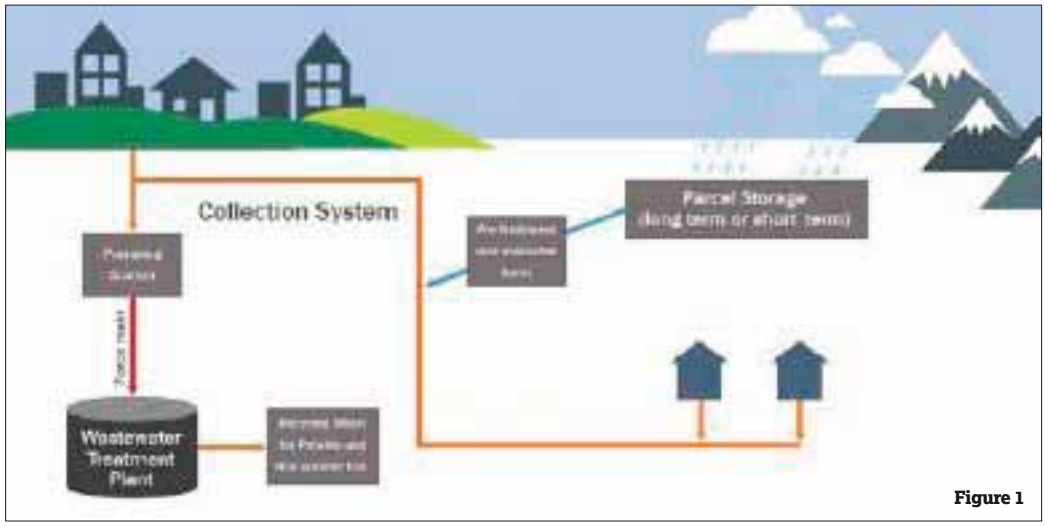


Figure 1

Author's Note

Lisa Skutecki, a civil and environmental engineering consultant, is the Southern California Water Resources Group Manager at Brown and Caldwell, located in the San Diego area, California, United States. Hari Seshan, also a civil and environmental engineering consultant with Brown and Caldwell in the San Diego area, specializes in wastewater process engineering and planning, and led the technical evaluation for this study. Watershed Protection Program Coordinator in the County of San Diego, Stephanie Gaines is the project manager for the Regional Stormwater Capture Feasibility Study.