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currents

XBAT
ION EXCHANGE-BASED ADVANCED TREATMENT
A GAME-CHANGER FOR SALINITY AND TOC TREATMENT

PLUS —

Harnessing Data and Information with Carollo's Digital Apps and Shops

Two Multi-Benefit Stormwater Projects in LA

EDITORIAL

NICK WEBBER, PE (nwebber@carollo.com)

Welcome to the first issue of ***Currents*** in 2024!

In our feature story, we introduce a new, groundbreaking technology that can be used for treatment of salinity and TOC without high-pressure membranes. It's called Ion Exchange-Based Advanced Treatment or XBAT, and combines two mature drinking water treatment technologies in one—suspended ion exchange (SIX) and lime softening. It's a sustainable and efficient process that can address salinity and TOC treatment concerns for water, wastewater, and potable reuse treatment.

You will also read about Carollo's digital apps and shops that can help utilities better manage and harness system data and information, all in user-friendly web browser programs. And lastly, we highlight two case studies in LA for stormwater capture projects that provide multiple benefits like environmental restoration, flood mitigation, and reduced reliance on external water supplies.

I hope you enjoy reading this issue and learning about some exciting projects we are involved in around the country. Please contact me or the primary authors with any questions or comments!

IN THIS ISSUE

CONTENT EDITOR
Nick Webber / 208-327-2619 / nwebber@carollo.com

GRAPHIC DESIGNER
Silvia Higuera-Backlund

TURNING DATA INTO DECISIONS

Using Digital Apps and Solutions

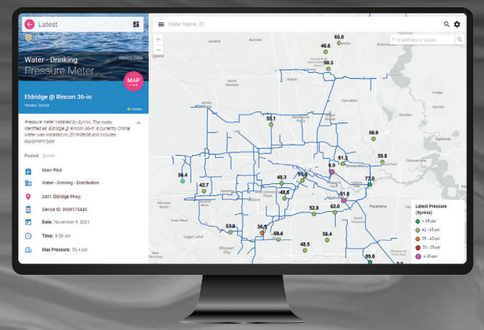
A Guide to Carollo's Digital Solutions for Water and Wastewater Utilities

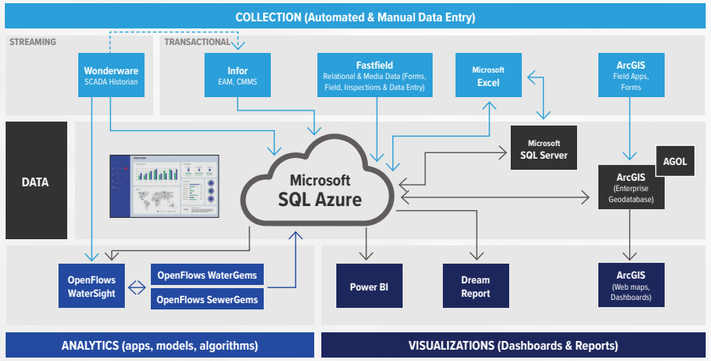
ANDY BALDWIN (abaldwin@carollo.com)

Aging infrastructure and growing demands are accelerating the need to replace facilities and assets. Utilities are actively planning and prioritizing infrastructure spending while accounting for deteriorating facilities, population growth, and environmental changes. Knowing the "where and when" is fundamental to building cost-effective capital improvement programs, which require the ability to forecast necessary upgrades to the sewer, water, and recycled infrastructure systems.

As agencies are exposed to increasing amounts of data and information, there is a growing need to use digital technologies to harness this data when making informed decisions that support planning, engineering, and operational activities. In addition, rapidly expanding software options can be overwhelming for agencies to select the best product that meets their needs. At Carollo, we recognize the pressing need for utilities to better manage data and information, and our CarolloDIGITAL team combines expertise in the water industry with innovative technology to guide water utilities through the selection and implementation of Digital Apps and solutions.

Interactive, real-time dashboards
All our apps feature accessible, beautifully designed dashboards that encourage your team to visualize, track, share, and update your digital projects and plans as changes occur.





Resilient O&M relies on multiple software systems to capture an accurate picture of system performance and deliver recommendations for timely response.

Digital Apps: Enhancing Operational Efficiency

Digital Apps are at the forefront of Carollo's digital deliverables, providing our clients with access to data, information, and decision-making through rich, graphical interfaces easily accessed from standard web browsers. Applications ranging from field data collection apps, dashboards, and digital master plans to custom GIS web applications, and business decision support systems are delivered through dedicated **Digital Shops**.

ProjectSHOP – Digital Apps for Program Managers

Efficiently managing intricate projects requires a robust Project Management Information System (PMIS). Carollo PM, a proprietary PMIS solution built on the Microsoft platform, addresses this need by integrating seamlessly into existing IT systems, using SharePoint, Teams, and Power Platform tools. Beyond PMIS, our digital tools extend to tracking Capital Improvement Projects (CIP) through customizable dashboards, reflecting project costs, drivers, and priorities. This adaptive system allows end-users to effortlessly adjust input data, providing substantial benefits for long CIP horizons, and ensuring accurate project scheduling and financial projections.

AssetSHOP – Digital Apps for Asset Managers

As utilities actively plan and prioritize infrastructure spending, CarolloDIGITAL's cloud-based asset management tools enable the efficient collection, organization, and management of asset condition data. Additionally, our team collaborates with clients to select and implement other asset management and work order management software systems such as NEXGEN, Infor®, and Cityworks®.

PlanSHOP – Digital Apps for Planners

Traditional master plans, which have used desktop-based technologies for decades, are evolving into digital master plans with information and results delivered through web browser and cloud-based platforms. Through Carollo's infrastructure and water resource planning teams, we deliver digital master planning software applications to promote collaboration and to track and update master plans. This enables clients to evaluate demand projections, find hydraulic deficiencies, validate model calibrations, and review proposed CIP projects and their associated cost projections.

DataSHOP – Digital Apps for Data Managers

Digital data and information are collected and processed using multiple software and hardware systems including sensor and measurement devices, databases and cloud-based systems, analytical and modeling software, dashboards, GIS, visual displays, and network and wireless communication technologies. Navigating this complex landscape requires a streamlined approach. Our **Digital Water Roadmap** guides utilities in defining their needs, selecting software solutions, and configuring their systems. Data and software systems integration is paramount. Our digital solutions are built on a deep understanding of water-related engineering data sources and formats, including meter data, SCADA protocols, modeling data, and more. When linked, these deliver concise information to engineering and operational teams.

Get Started with CarolloDIGITAL

Whether you're at the initial stages of digital integration or seeking advanced intelligence solutions, our team of experts is ready to guide you through the digital transformation journey.

ANDY BALDWIN
CAROLLO DIGITAL SERVICES LEAD,
PLANSHOP
abaldwin@carollo.com

DAN BAKER
PROJECTSHOP
dbaker@carollo.com

ANN CASEY
ASSETSHOP
acasey@carollo.com

SHAWN DENT
DATASHOP
sdent@carollo.com

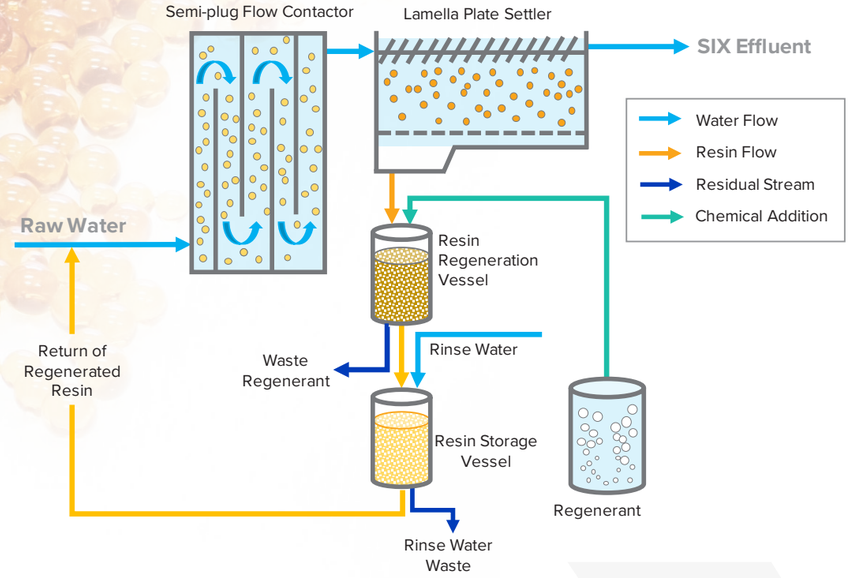
XBAT
ION EXCHANGE-BASED ADVANCED TREATMENT

A Game-Changing Salinity and TOC Treatment Approach for Drinking Water, Wastewater, and Reuse Applications

ROSA YU, PhD, PE (ryu@carollo.com) / **MELANIE PICKETT, PhD, PE**
EVA STEINLE-DARLING, PhD, PE / **VINCENT HART, PE**

SIX PROCESS FLOW DIAGRAM

Unlike conventional ion exchange in a fixed-bed configuration, SIX is a steady-state ion exchange process that keeps the resin fluidized in a reactor.



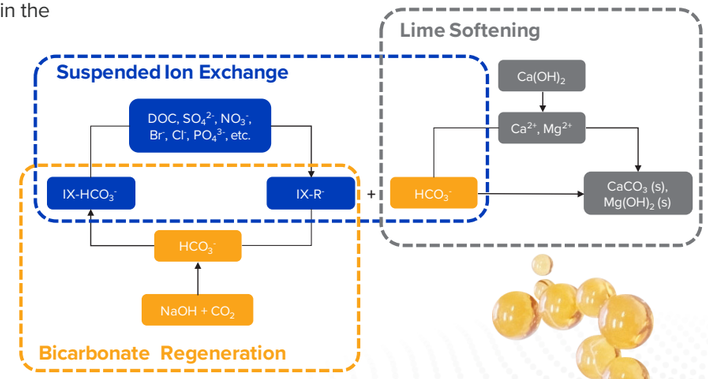
Water and wastewater professionals face a persistent challenge in managing salinity, a critical aspect of water quality that is often characterized through the measurement of total dissolved solids (TDS). Salinity is due to a complex mix of dissolved anions and cations, including chloride (Cl^-), sulfate (SO_4^{2-}), bicarbonate (HCO_3^-, or alkalinity), sodium (Na^+), potassium (K^+), calcium (Ca^{2+}), and magnesium (Mg^{2+}). In addition, dissolved organic matter (DOM), or total organic carbon (TOC), is an important constituent that must be managed in many water treatment applications to prevent the formation of disinfection byproducts or reduce oxygen demand in receiving waters.

Conventional water treatment methods don't address salinity because most physicochemical and biological treatment processes don't remove inert ions such as chloride, sulfate, and sodium. In fact, some chemical treatment processes (e.g., coagulation) add anions to the treated water. Combined with the copious use of salts in household, commercial, and industrial enterprises, this can elevate salinity in the community-wide water cycle.

Salinity removal is currently achieved through the use of reverse osmosis (RO), a highly effective, pressure-driven membrane process that removes almost all dissolved solutes, including salts. However, RO is not without challenges due to its concentrate waste stream that must be handled. This waste stream poses an issue, particularly for inland communities where ocean discharge is inaccessible or when deep well injection is not permittable, as well as for any communities where 8-15% water loss in the form of a brine waste stream is unacceptable.

Enter **Ion eXchange-Based Advanced Treatment (XBAT)**, a groundbreaking alternative method to reduce salinity. XBAT consists of a combination of two mature drinking water treatment processes: **(1)** suspended ion exchange (SIX) for the removal of negatively charged constituents (i.e., TOC, chloride, sulfate, bromide, nitrate, phosphate, etc.). Ion exchange resin regeneration, using bicarbonate as the counter ion, is key to the success of this approach and sets the stage for the second process **(2)** lime softening for cation removal (i.e., calcium and magnesium) as well as excess bicarbonate removal through calcium carbonate ($CaCO_3$) precipitation.

The schematic diagram below illustrates the overall XBAT chemistry and the removal mechanism for dissolved anionic and cationic solutes.



A distinctive feature of SIX is its high resin regeneration frequency, which regenerates the spent resin after every single pass through the reactor. This keeps the resin's ion exchange capacity only slightly utilized, allowing the resin to be regenerated by a weaker regenerant, such as bicarbonate, and at a much lower strength (3 percent) compared to a saturated sodium chloride solution typically used for resin regeneration.

Resin regeneration using bicarbonate as the counter ion adds alkalinity to the SIX effluent, making the treated water more suitable for lime softening and maximizes salinity reduction through calcium carbonate precipitation. Bicarbonate regeneration is the heart of XBAT, which synergizes the SIX and lime softening processes.

Compared to RO, SIX produces a regeneration waste stream that is only 0.8% of the total feed water flow. With XBAT, the bicarbonate nature of the waste regenerant also makes this residual stream more treatable and manageable than a concentrated chloride-based brine waste. For instance, bicarbonate, sulfate, phosphate, fluoride, arsenic, silica, and TOC in the waste brine stream could be further removed via softening reactions with magnesium hydroxide and calcium carbonate precipitation. It could also potentially serve as a beneficial amendment for alkalinity addition in biological nutrient removal processes in wastewater treatment applications, saving the costs associated with the addition of external chemicals.

Bench-scale testing of XBAT with secondary and tertiary wastewater effluents has demonstrated a remarkable TOC removal rate of 50%, regardless of effluent type and initial TOC concentrations. High removal rates were also observed for sulfate (99%), nitrate (90%), bromide (94%), and chloride (74%). Subsequent lime softening resulted in 92% calcium removal, 96% magnesium removal, and an overall 50% net TDS reduction. These results are promising indicators of XBAT's potential to reduce or prevent salinity upcycling in potable reuse systems.

Carollo is currently scaling up our evaluations of XBAT with an advanced wastewater treatment pilot at the City of Tampa, Florida, and a direct potable reuse treatment feasibility evaluation at Aurora Water, Colorado, with a pilot to follow soon.

XBAT is poised to reshape the industry by unlocking the potential of potable reuse in inland communities, including areas in Colorado, Arizona, Utah, Texas, and beyond, where moderate salinity would otherwise pose challenges in selecting an advanced treatment approach that does not include RO.

XBAT marks a significant shift in the water-wastewater paradigm, offering a sustainable and efficient solution for addressing salinity concerns and advancing the future of responsible water management.

City of Los Angeles' Multi-Benefit Stormwater Capture Projects

Improving Stormwater Quality and Increasing Water Supply

SUNSHINE SAUCEDO (ssaucedo@carollo.com) / **CAROLINE BURGER, PE** (cburger@carollo.com)

Throughout Los Angeles' (LA, City) history, imported water has been a necessity, making up a significant portion of the City's water sources. LA's current infrastructure is unable to fully utilize the occasional storm events for beneficial use or for much needed groundwater replenishment. With the City's Green New Deal aiming to source 70% of its water supply locally by 2035, city leadership has placed an emphasis on multi-benefit stormwater capture projects. These projects will aim to improve water quality, replenish LA's groundwater basins, alleviate localized flooding, and increase recreational benefits.

Over the past several years, the City of LA's Bureau of Sanitation and Environment (LASAN) has developed innovative projects that address LA's growing stormwater quality challenges and dwindling drinking water supply, while also supporting and investing in communities that especially need it most. These projects have varying goals for water and environmental management. However, significant financial support and funding are required to complete them, which can be a challenge to secure. Over the course of four funding rounds, LASAN has secured $186.9M from the prestigious LA Regional Safe Clean Water (SCW) Program's Regional Infrastructure Program, including: $25.2M for the Hollenbeck Park Lake Rehabilitation Project and $5M for the Sylmar Channel Project.

The Regional Infrastructure Program requires all proposed efforts to describe how they intend to plan, build, and maintain multi-benefit watershed-based projects to improve water quality, increase supply, and enhance communities. More specifically, the program ultimately scores projects according to the following criteria to determine eligibility for SCW funding:

- **Water Quality Benefits:** This criterion is scored through an evaluation of water quality needs; municipal separate storm sewer systems (MS4) permit compliance; 24-hour storm capacity, event-based design details; and long-term performance.
- **Water Supply Benefits:** This criterion is scored through an evaluation of water supply needs; stormwater or urban runoff captured, infiltrated, or diverted to a separate groundwater recharge facility, a water treatment plant, or a sanitary sewer for conversion into recycled water; and the cost-effectiveness of the generated benefits.
- **Community Investment Benefits:** This criterion is scored through an evaluation of community investment and local support needs of a watershed area and the actual investment and support of local, community-based organizations gained through a project's outreach and engagement.
- **Nature-based Solutions:** This criterion is scored through an evaluation of project elements that leverage nature-based solutions such as use of natural processes, use of natural materials, and removal of impermeable areas.
- **Leveraged Funds and Community Support:** This criterion is scored through an evaluation of the percentage of funding matched and a demonstration of strong local, community-based support.

CASE STUDIES

LASAN's Hollenbeck Park and Sylmar Channel Projects

LASAN's Hollenbeck Park Lake Rehabilitation Project (Hollenbeck) and Sylmar Channel Project (Sylmar) are both multi-benefit stormwater projects that use nature-based solutions to improve water quality, increase water supply via groundwater recharge, and benefit the local communities. Hollenbeck Park, within LA's Boyle Heights neighborhood, is a 21-acre park with a 4.3-acre lake at the center. The lake receives several influent stormwater flows from residential LA City and LA County storm drains, and from a nearby freeway storm drain. Sylmar Channel, an approximately 0.5-mile-long open channel, located in LA's San Fernando Valley, transports flow through the residential neighborhood to an LA County storm drain. Hollenbeck and Sylmar have been developed

***Figure 1** - Existing Project Locations: Hollenbeck Park (left) and Sylmar Channel (right)*

to comply with the MS4 Permit's Enhanced Watershed Management Program (EWMP) Plans, meeting best management practice (BMP) performance goals and compliance targets for metals and bacteria. Additionally, these projects promote water conservation, flood risk management, aesthetic improvements, recreational opportunities, and public education.

The pollutant reductions for Hollenbeck and Sylmar were simulated using LA County's Water Management Modeling System 2 (WMMS2), which comprises two primary continuous simulation models: Loading Simulation Program in C++ (LSPC) and System for Urban Stormwater Treatment and Analysis Integration (SUSTAIN). LSPC simulates rainfall/runoff and pollutant build-up/wash-off. These simulated flows and pollutant loads are then routed through SUSTAIN to simulate BMP performance. LSPC is parametrized by spatially defining arrays of land uses, soil parameters, and slopes.

WMMS2 utilized 96 combinations of land characteristics to simulate inflow to the projects. Spatially variable pollutant loads can be attributed to land use variability within the drainage area. The land use parameters have been calibrated for the LA region and have undergone peer review and regulatory input. The 85th percentile, 24-hour storms were simulated in SUSTAIN using LA County's four-day banding time series. Load reduction conditions were simulated over a 10-year period to estimate the average annual performance. The annual water supply benefit or infiltration volume was modeled using long-term continuous simulation with SUSTAIN. The infiltration volume was modeled using rainfall data over a 20-year period.

Design of each project's infiltration volume is optimized to capture as much of the 85th percentile, 24-hour storm or to achieve 80-percent pollutant reduction, whichever proves to be most cost efficient. Although the goal is to capture all of the project's design storm runoff, a cost-effective approach can allow a project to significantly decrease localized flooding and still meet—or even exceed—necessary compliance goals.

Hollenbeck Park Improvements

Hollenbeck plans to implement diversions from influent storm drains, diverting flows to a subsurface storage unit that allows for storage and infiltration, as well as pumping flows to the lake. Lake enhancements consist of in-lake treatment, constructed wetlands, and perimeter bioswales. Along with the implementation of nearby drywells and green street elements, the project is expected to capture 347.7 acre-feet of runoff annually, removing pollutants through treatment, including an 81-percent reduction of the primary pollutant zinc and a 100-percent reduction of trash from captured runoff.

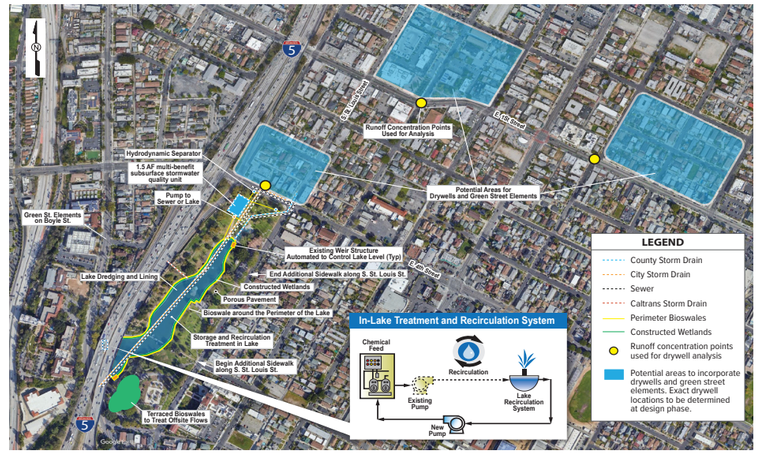


***Figure 2** - Hollenbeck Park Lake Rehabilitation Project Proposed Concept Layout.*

Through these stormwater diversions, capture, and treatment BMPs, along with park and lake enhancements, the project will improve water quality and increase water supply within the much needed Upper LA River watershed.

Sylmar Channel Improvements

Sylmar's scope includes improvements to the channel for inline bioretention and additional green street network components, such as drywells and bioswales. Similar to Hollenbeck, this project also demonstrates significant benefits in improved water quality, with an over 80-percent reduction of zinc and a 100-percent reduction in trash from captured runoff. Additionally, this project expects an annual capture of 206 acre-feet of water for aquifer recharge, enhancing LA's water supply. By implementing various improvements and BMPs, flood mitigation and environmental restoration are also promoted, ensuring improved public safety and increased recreational opportunities for the neighborhood.

ACHIEVING SUCCESS

for LA's Water Supply and Communities in Need

By leveraging the funding opportunities provided by LA County's SCW Program, LASAN is able to address many critical water needs across the City. Through this Regional Infrastructure Program, LASAN has improved water quality, reduced reliance on external sources of water supply, and provided localized flood risk mitigation, environmental restoration, expanded recreational opportunities, and other impactful benefits. These improvements are fulfilling the City's sustainability and equity goals, as well as LA's Green New Deal and One Water LA plans. LASAN will continue to implement these projects for at least the next five years, contributing to the SCW Program's current estimated 56,915 acre-feet per year of average annual stormwater capture.

The number is tiny.
But its impact is massive.

Introducing XBAT, a cutting-edge technology that is poised to transform water and wastewater treatment. Conceived and developed by Carollo Engineers, XBAT combines suspended ion exchange and softening to remove organics and anions, resulting in a minimal waste brine (only 0.8% of total feed water flow). This revolutionary technology will empower more communities to embrace potable reuse, obtain sustainable reductions in disinfection byproducts, and achieve effective nutrient management. Efficient, sustainable, and cost-effective technology that removes organics, nutrients, and salinity—that's Carollo Innovation.

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