The Water Report™
Water Rights, Water Quality & Water Solutions in the West

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INTEGRATED INFRASTRUCTURE PLANNING

STATE AND LOCAL COLLABORATION ON CLEAN WATER ACT INVESTMENT
USING INTEGRATED PLANNING TO CHART A COURSE TOWARD ENVIRONMENTAL IMPROVEMENT

by Tom Stiles, Kansas Department of Health and Environment
& Aaron Witt, Johnson County Wastewater

Introduction

By the end of 2018, Congress had passed H.R. 7279, the Water Infrastructure Improvement Act (WIIA), which President Trump subsequently signed on January 14, 2019. The WIIA codified the US Environmental Protection Agency's (EPA's) 2012 Integrated Planning Framework as Section 402(s) of the federal Clean Water Act (CWA).

Applicable to municipal stormwater and wastewater management, the new CWA Integrated Planning provision (see sidebar, below) allows priority infrastructure investment to be implemented through CWA National Pollutant Discharge Elimination System (NPDES) permits (*see* sidebar below). As an alternative to Consent Decrees and Orders, the new planning provision poses both opportunities and challenges for municipalities faced with having to upgrade aging infrastructure.

This article describes how the new CWA Integrated Planning provision is being put to use in Kansas to address significant water quality management challenges.

New CWA Integrated Planning Provision

(s) INTEGRATED PLANS.—
(1) DEFINITION OF INTEGRATED PLAN.—In this subsection, the term 'integrated plan' means a plan developed in accordance with the Integrated Municipal Stormwater and Wastewater Planning Approach Framework, issued by the Environmental Protection Agency and dated June 5, 2012.
(2) IN GENERAL.—The Administrator (or a State, in the case of a permit program approved by the Administrator) shall inform municipalities of the opportunity to develop an integrated plan that may be incorporated into a permit under this section.
(3) SCOPE.—
(A) SCOPE OF PERMIT INCORPORATING INTEGRATED PLAN.—A permit issued under this section that incorporates an integrated plan may integrate all requirements under this Act addressed in the integrated plan, including requirements relating to—
(i) a combined sewer overflow;
(ii) a capacity, management, operation, and maintenance program for sanitary sewer collection systems;
(iii) a municipal stormwater discharge;
(iv) a municipal wastewater discharge; and
(v) a water quality-based effluent limitation to implement an applicable wasteload allocation in a total maximum daily load.
(B) INCLUSIONS IN INTEGRATED PLAN.—An integrated plan incorporated into a permit issued under this section may include the implementation of—
(i) projects, including innovative projects, to reclaim, recycle, or reuse water; and
(ii) green infrastructure.

Infrastructure Planning

Flexible Implementation

Sequencing

Plan Elements

Integrated Plan & NPDES Permit

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Background

EPA's 2012 Integrated Planning Framework

EPA cut its teeth on long-range planning and scheduling through its negotiations with many municipalities over their Long-Term Control Plans (LTCPs) to address Combined Sewer Overflows (CSOs – *see* sidebar). These LTCPs were often incorporated and enforced through Consent Decrees and Orders. The new CWA Integrated Planning provision allows priority infrastructure investment to be implemented through NPDES permits instead of relying on Consent Decrees. Such an approach was felt to be more flexible. Construction on large capital improvement projects intended to address water quality concerns from wastewater and stormwater proceeds over extended periods of time. Added flexibiliy can be crucial to expediting the process.

Large financial outlays are needed to bring larger municipalities into compliance with the Clean Water Act. EPA's 2012 Integrated Planning Framework recognized the need for sequencing and scheduling of work — in part to accommodate financing. The Framework included principles for integrated planning to include: State requirements; CWA obligations; alternatives analyses; sustainable approaches; community impacts; financial strategies; and stakeholder input.

The 2012 Framework identified six elements comprising an Integrated Plan:

- A description of the water quality, human health and regulatory issues to be addressed;
- A description of existing wastewater and stormwater systems under consideration and a characterization of their current performance;
- A process for community stakeholder communication and involvement;
- A process for identifying, evaluating and selecting alternatives and proposing implementation schedules;
- A process for evaluating the performance of projects identified in the plan; and,
- A process for improving the plan through evaluation of new projects or modifying the sequence of projects and schedules.

Regulatory Backdrop in Kansas

Under the original Integrated Planning Framework, one community in Kansas, the City of Lawrence (City), developed a Wastewater Facilities Master Plan in 2012. That plan became the basis for an Integrated Plan in 2013. This Plan sequenced the City's investments in capacity development in its collection system, a new wastewater treatment plant to accommodate growth, and eventual rehabilitation/ upgrading of its existing wastewater plant. The 2013 Integrated Plan was agreed upon between Lawrence and the Kansas Department of Health and Environment (KDHE) through a Memorandum of Understanding, signed at the beginning of 2014.

The 2013 Integrated Plan was incorporated into the City's NPDES permit as supplemental information. In this way, the Integrated Plan guided the requirements of the NDPES permit in the context of long-term planning, scheduling, and construction of the city's wastewater system. The permit retained the ability to be modified over time as priorities shifted and new projects were introduced. The recently re-issued permit (August 1, 2019) also retains these provisions.

Meanwhile, Johnson County, Kansas (County) in the southwest portion of the metropolitan Kansas City region, was in the midst of embarking on major capital expenditures in wastewater. Aiming to accommodate growth and redevelopment, County stewardship of the ratepayers' financial resources also included minimizing customer impacts and disruption.

The County consolidated the wastewater systems in most of its cities over a 50-year span, 1945 – 1995. The resulting wastewater system now covers 172 square miles and serves over 500,000 citizens in 16 cities, almost two-thirds of the County's population (Figure 1). The County operates six wastewater treatment plants with a total design flow of 65 **m**illion **g**allons per **d**ay (MGD). Thirty-one pump stations along 2,350 miles of sewer line make up the collection system. The age of the system spans decades and drives much of the emphasis the county has made on asset management, inflow/infiltration repair, and replacement of an aging sewer system (Figure 2).

Combined Sewer Overflows (CSOs)

Adapted from EPA website:

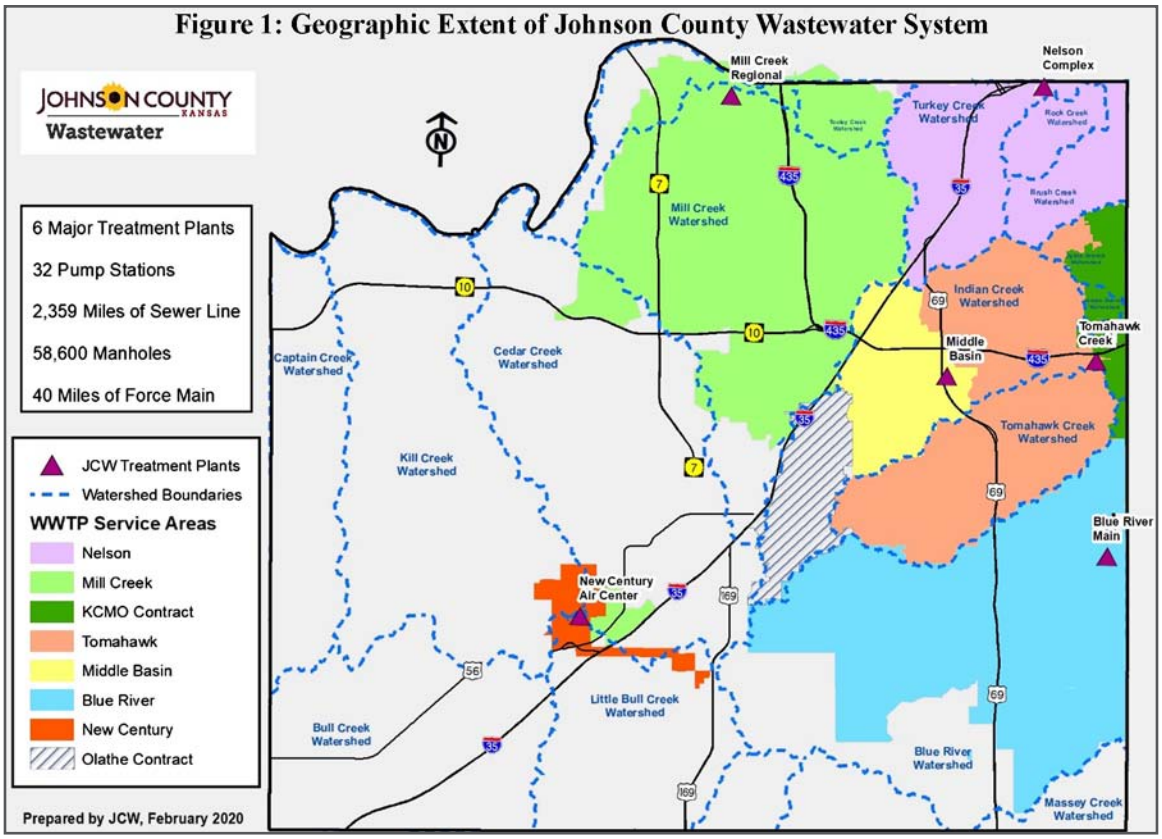
A **c**ombined **s**ewer **s**ystem (CSS) collects rainwater runoff, domestic sewage, and industrial wastewater into one pipe. Under normal conditions, it transports all of the wastewater it collects to a sewage treatment plant for treatment, then discharges to a water body. The volume of wastewater can sometimes exceed the capacity of the CSS or treatment plant (e.g., during heavy rainfall events or snowmelt). When this occurs, untreated stormwater and wastewater discharges directly to nearby streams, rivers, and other water bodies.

Combined **s**ewer **o**verflows (CSOs) contain untreated or partially treated human and industrial waste, toxic materials, and debris as well as stormwater. They are a priority water pollution concern for the nearly 860 municipalities across the US that have CSSs.

See: www.epa.gov/npdes/combined-sewer-overflows-csos

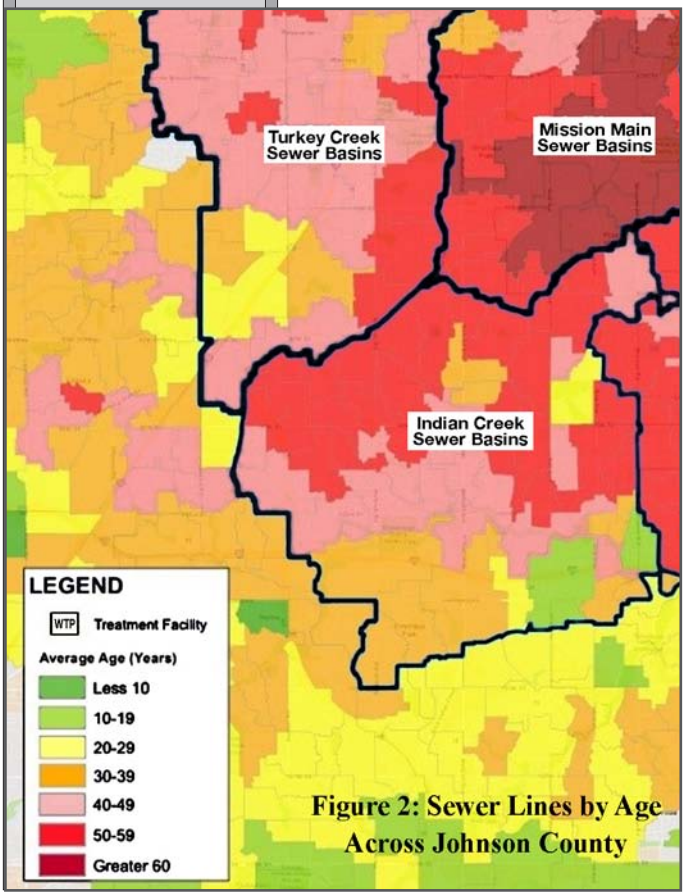
Infrastructure Planning

County Wastewater System



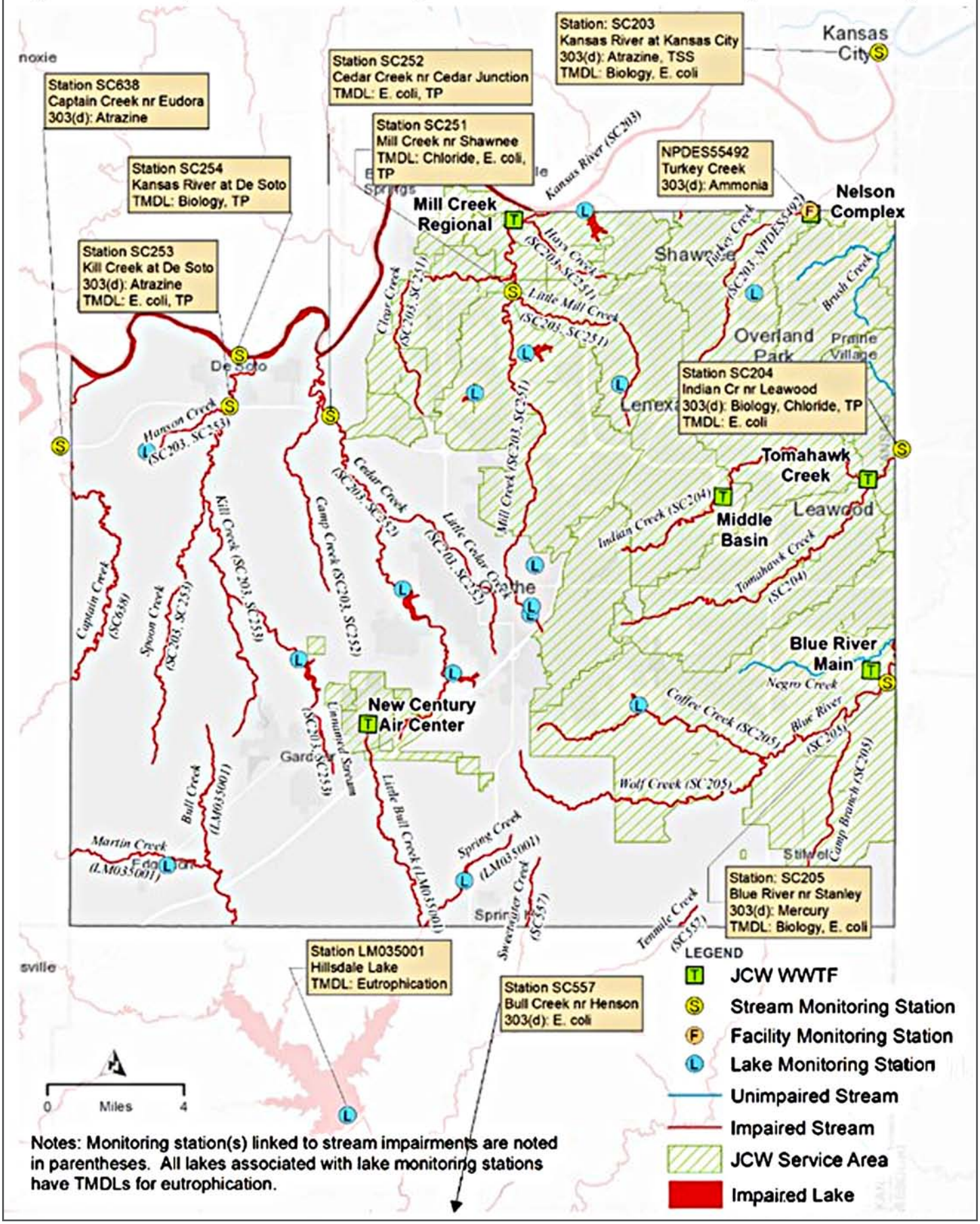
Nutrient Reduction

External regulatory pressure on the County came from both KDHE and EPA. KDHE, as part of its long-term Nutrient Reduction Framework, was pushing major (> 1 MGD) wastewater treatment plants to install Biological Nutrient Removal technology to meet goals of 1 **m**illi**g**rams per **l**iter (mg/l) of total phosphorus and 10 mg/l of total nitrogen. KDHE, as part of the Nutrient Reduction Framework, had been listing streams for total phosphorus impairments and subsequently, developing Total Maximum Daily Loads (TMDLs) for phosphorus on those streams (*see* Figure 3, next page). One such stream was the Kansas River, into which two Johnson County plants discharged. Those plants, the Mill Creek Regional plant (Mill Creek) and the Nelson Complex (Nelson), received Wasteload Allocations for phosphorus of 156.6 and 125.3 pounds per day, respectively. Over 2008-2015, the output of phosphorus averaged 235 pounds per day for Mill Creek and 359 pounds per day from Nelson. They are the next two largest dischargers of phosphorus into the lower Kansas River, behind the City of Lawrence's Kaw River wastewater plant. Additionally, in 2018 Kansas adopted EPA's 2013 Ammonia criteria, thereby requiring wastewater treatment plants to meet more stringent acute and chronic ammonia limits in their effluent.



On their eastern flank, the County had two wastewater treatment plants — Middle Basin and Tomahawk Creek — discharging into Indian Creek before it flowed into Kansas City, Missouri. KDHE had flagged Indian Creek for excessive phosphorus and had already established a TMDL for nitrate in 2008. Middle Basin had undergone some upgrades in treatment in past years, but Tomahawk Creek continued to load the stream with nutrients. Additionally, during wet weather, wastewater flows in excess of the plant's capacity were shunted by pipeline to Kansas City, Missouri's wastewater treatment plant on the Blue River, prior to its confluence with the Missouri River. Permits for both plants had previously been objected to by EPA, principally because of inadequate management of wet weather flows which overwhelm the plants' hydraulic capacity.

Figure 3: Overlay of Surface Water Impairments on the Johnson County Wastewater System



Notes: Monitoring station(s) linked to stream impairments are noted in parentheses. All lakes associated with lake monitoring stations have TMDLs for eutrophication.

Infrastructure Planning

Expanded Treatment Plant

Through negotiations between the County, KDHE, and EPA, plans were made to build a new, expanded treatment plant at the Tomahawk Creek site. The new plant would reconcile the wet weather flow issue by incorporating auxiliary treatment of such flows and discontinuing sending excess flows to the Kansas City, Missouri, wastewater treatment plant. In lieu of establishing a phosphorus TMDL on Indian Creek, KDHE accepted plans by the county to install Enhanced Nutrient Removal (with goals of 0.5 mg/l phosphorus and 5 mg/l nitrogen). This upgrade in technology also addressed anti-degradation concerns for Indian Creek stemming from the increased capacity and loading from the new plant (from 10 MGD to 19 MGD). Subsequently, EPA removed its objection to the NPDES permit and KDHE issued a new permit to capture the details of the new wastewater plant. Johnson County initiated a $340 million capital improvement project to tear down and rebuild the Tomahawk Plant, the largest capital outlay in the County's history.

Wet Weather Management

Further complicating the situation, EPA had objected to the NPDES permit for the Nelson Complex and that permit, as of 2019, had been administratively extended for 15 years. EPA's objections centered on wet weather management, specifically four Peak Extraneous Flow Treatment Facilities (PEFTFs), which would divert excessive high flows in the sanitary sewer, hold that waste, disinfect it with chlorine then de-chlorinate the wastewater before discharging to local tributaries within the county (*see* Figure 4). In EPA's view, those four facilities were Sanitary Sewer Overflows which are illegal and could not be sanctioned by a NPDES permit. However, the PEFTFs were necessary to maintain the integrity of the collection system and receiving wastewater plants, while reducing wet weather basement backups. The impasse could not be resolved within the terms of a five-year NPDES permit.

Extraneous Flow Facilities

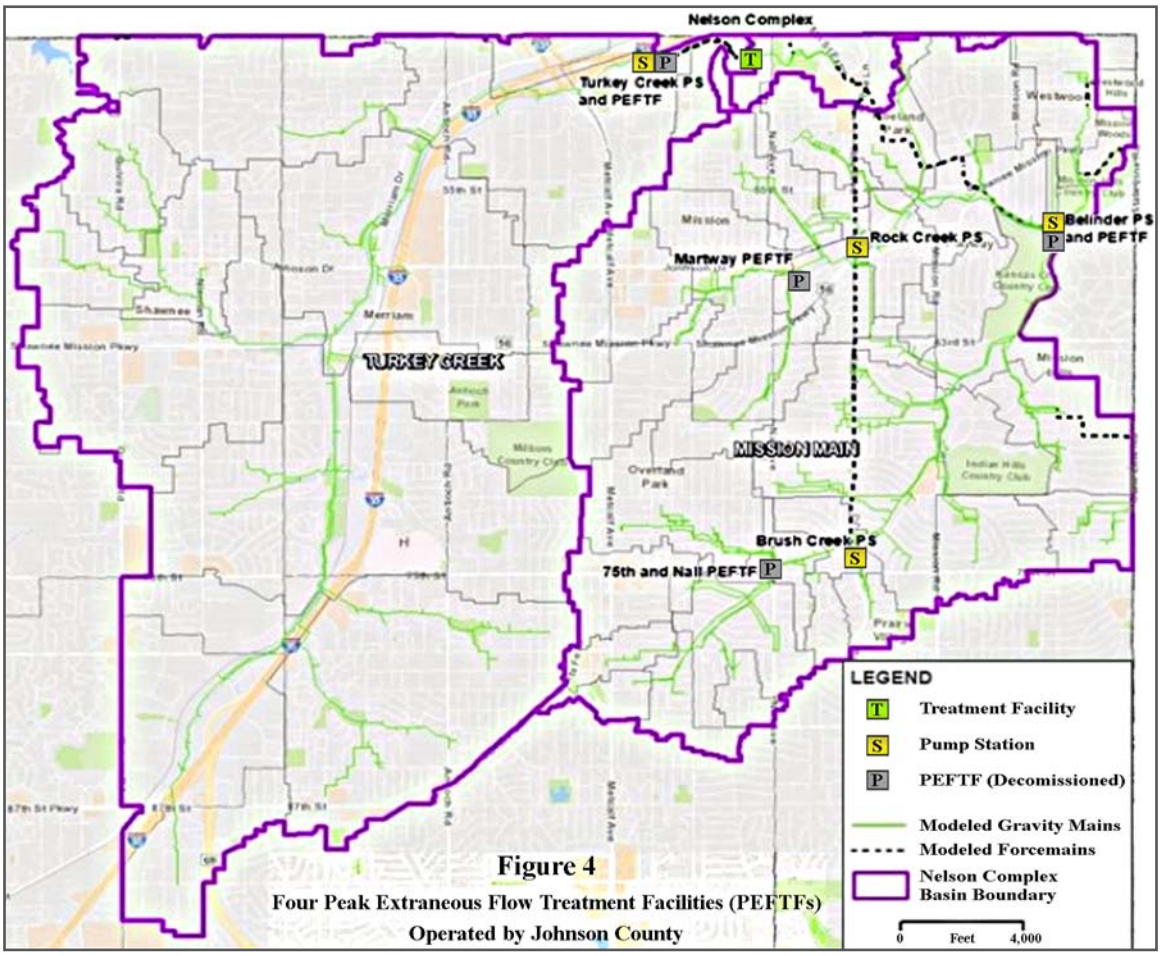


Figure 4
Four Peak Extraneous Flow Treatment Facilities (PEFTFs) Operated by Johnson County

Development of the Integrated Plan

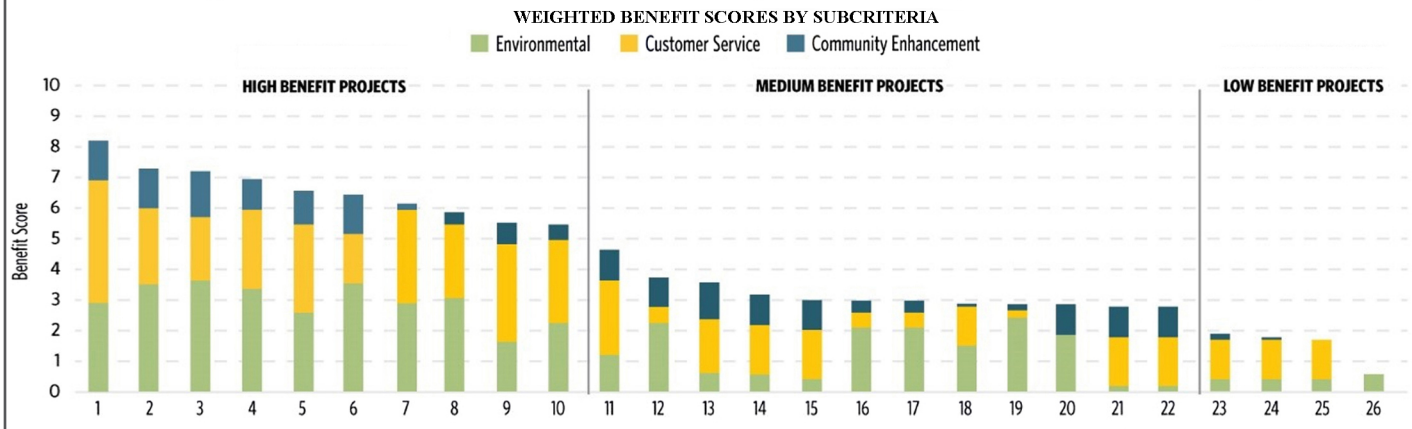
Major Costs

The combination of local needs for asset management — while meeting the regulatory and environmental demands of the state and Federal water quality agencies — required large capital expenditures to be accomplished in a short time. Meeting these simultaneous demands did not appear to be socially, politically, or technically feasible.

Myriad Demands

Johnson County began an analysis and study into how to orchestrate multiple infrastructure projects to meet the myriad of demands placed on the utility. The County's consultant, HDR Engineering, was versed in Integrated Planning due to its work with Jefferson City, Missouri. The County's study was bifurcated to look at: 1) upgrading the treatment capacity of the wastewater system; and 2) managing and replacing the vulnerable aspects of the large regional collection system.

Figure 5: Scored & Ranked Wastewater Improvement Projects in Johnson County



1 - Gravity Sewer R&R
2 - Nelson Complex WWTF - Upgrade
3 - Tomahawk Creek WWTF - Upgrade
4 - All WWTF Facilities - R&R
5 - Capacity Enhancements Outside Nelson Watershed
6 - Mill Creek Regional WWTF - Upgrade
7 - Mission Main Capacity Enhancements
8 - Turkey Creek Capacity Enhancements
9 - Backup Prevention Program and Plumber Private I/I Reduction
10 - Stream Crossings
11 - Outside Contractor Collection System Repairs
12 - PEFTF Elimination - Martway
13 - Mill Creek Capacity Enhancements
14 - System Expansion (Gravity Sewer and Pump Stations)
15 - Blue River WWTF - Expansion
16 - PEFTF Elimination - Brush Creek
17 - PEFTF Elimination - Belinder
18 - Manhole I/I Reduction
19 - PEFTF Elimination - Turkey Creek
20 - Middle Basin WWTF - Wet Weather Treatment
21 - Mill Creek Regional WWTF - Expansion
22 - New Century WWTF - Expansion
23 - Nelson Complex WWTF - Waste Acceptance
24 - Middle Basin WWTF - Resource Recovery
25 - Nelson Complex WWTF - Resource Recovery
26 - New Century WWTF - Upgrade

Priorities Sequencing

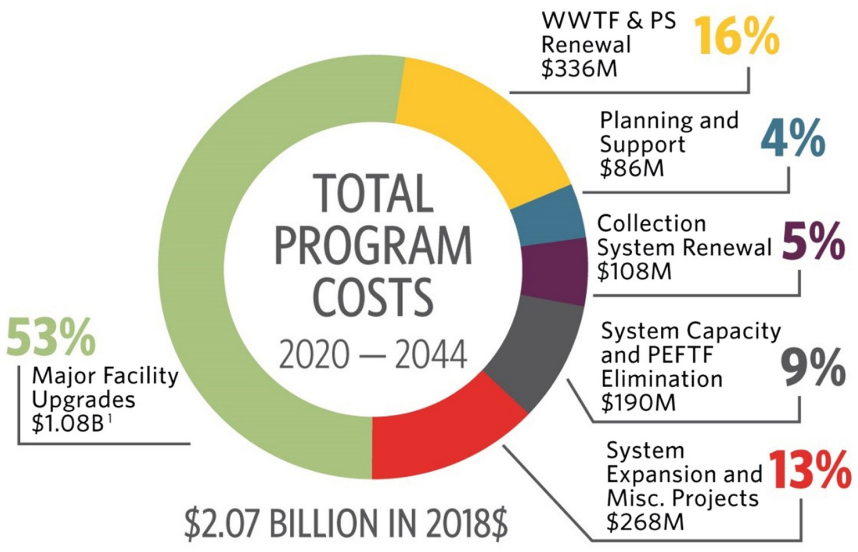
The analysis began to outline a sequence of priorities, starting with the large construction project already underway at Tomahawk Creek. As that project would wind down in the coming years, the County had an eye toward next rehabilitating the Nelson Complex. Prioritization was driven by the need to: replace the oldest sections of the county's collection system; eliminate basement backup during times of intense rains; install BNR technology to address state nutrient and ammonia reduction demands; and to resolve the impasse over the PEFTFs.

Consequently, upgrades to the Mill Creek plant, particularly to implement the Kansas River TMDL, would need to be deferred until the other two large capital projects neared completion. However, studies and analysis on how those upgrades might be accomplished could be accommodated during the interim time. In all, some $3 Billion (in 2018 dollars) of needs were identified (Table 1). Integrated Planning presented a means to schedule those expenditures over a 25-year period.

Benefits Prioritized

The county evaluated the potential projects based on the community-supported mission statement that focused on environmental benefits, customer service, and community enhancement. The projects began to align in a queue of declining benefits with several notable breakpoints to delineate high priority projects from those that were medium or low in near-term benefits (Figure 5). The three wastewater treatment plant upgrades scored very high, as did projects to enhance collection system capacity and sewer repair and replacement. Notably, elimination of the PEFTFs tended to be medium beneficial projects and would be deferred until the middle of the planning horizon. At that time, the Nelson treatment facility upgrade will be completed and will allow for additional wet weather flows to be transported to the treatment facility.

Figure 6: Total Cost of Johnson County 25-Year Integrated Plan



1 Cost includes $173 million expenditure for Tomahawk Creek WWTF prior to 2020.

Through a series of public meetings and work sessions with the Johnson County Commission, a Capital Investment Plan for the next 25 years was developed. The plan anticipates over $2 Billion in expenditures, with wastewater treatment plant upgrades and renewal of the collection system and its pump stations comprising three-fourths of those costs (Figure 6). The investments are scheduled in five-year increments, which aids in the affordability and rate structure required to support the long-term plan (Figure 7).

Infrastructure Planning

Projects & Costs

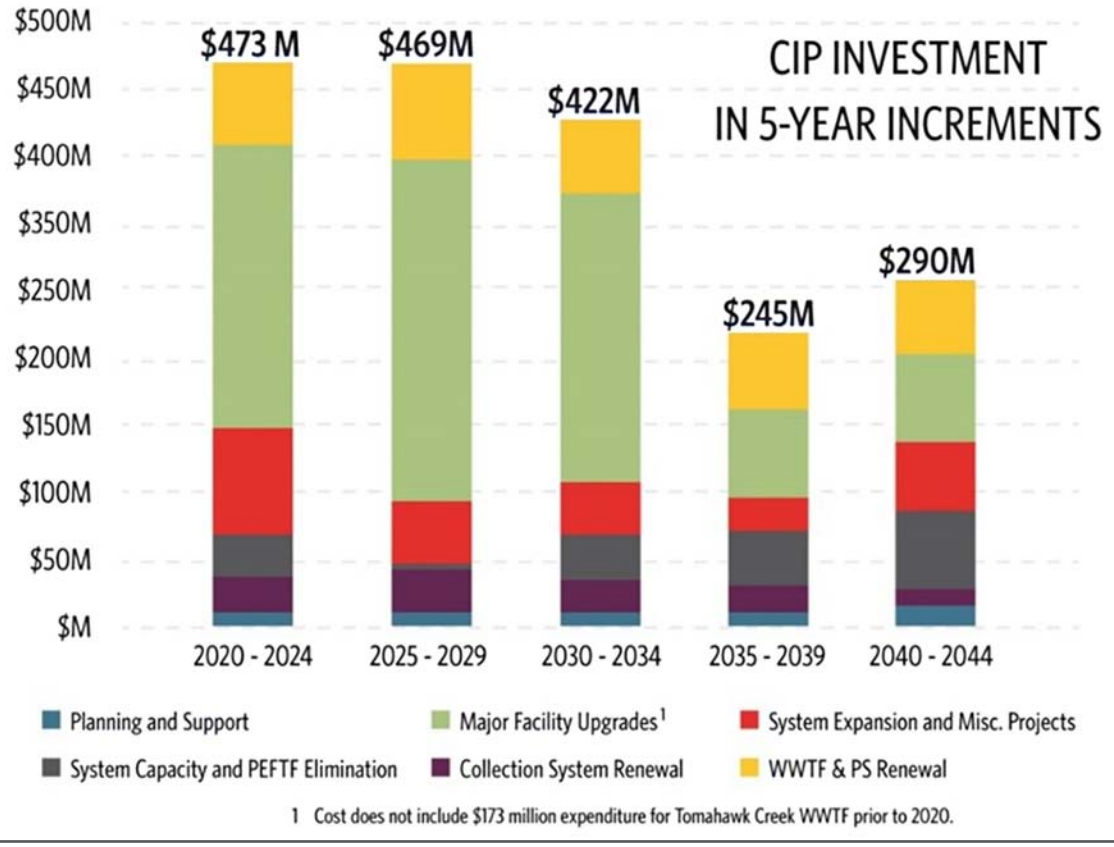
Table 1: Necessary Wastewater Treatment & Collection System Projects & Costs for Johnson County

Category	Project and Estimated Cost (in 2018$)	
Major Facility Upgrades[3]	? Tomahawk Creek WWTF Upgrade - $334 M ? Nelson Complex WWTF Upgrade - $350 M ? Mill Creek WWTF Upgrade - $250 M	? Blue River WWTF Expansion - $150 M ? Mill Creek WWTF Final Expansion - $200 M ? Blue River WWTF Final Expansion - $90 M
WWTF and PS Renewal (1, 2, 3)	? Nelson Complex WWTF Resource Recovery (Biosolids) Improvements - $7.5 M ? Nelson Complex WWTF Renewal - $ 4 M ? Turkey Creek Pump Station Renewal - $4 M ? Belinder Pump Station Renewal - $3 M ? Brush Creek Pump Station Near Term Renewal, and Long Term Replacement - $7 M	? Dyke's Branch Forcemain Improvements - $6 M ? Middle Basin WWTF Near Term Renewal - $3 M ? Middle Basin WWTF Solids Improvements - $15.5 M ? Mill Creek WWTF Near Renewal - $2 M ? Additional Ongoing WWTF, Pump Station, and Forcemain R&R - $450 M ? PEFTF Interim Upgrades - $6 M
Collection System Renewal (1)	? Gravity Sewer R&R - $60 M (CIPP Program and Outside Contractor Repairs) ? Stream Crossing Program - $31 M	? Manhole I/I Reduction Program - $22 M
System Capacity and PEFTF Elimination (1,3)	? Turkey Creek PEFTF Elimination and Capacity – $73 M ? Martway PEFTF Elimination and Capacity – $ 36 M ? Brush Creek PEFTF Elimination and Capacity – $34 M ? Belinder PEFTF Elimination – $ 85 M ? Mill Creek Capacity Enhancements - $49 M	? Tomahawk and Lower Indian Creek Capacity – up to $300 M ? Leawood and Dyke's Branch Capacity – up to $75 M ? Dykes Branch Pump Station Capacity – $ 5 M ? BUPP and Plumber Private I/I Reduction Programs - $3.4 M
System Expansion and Misc. Projects (1)	? Future Districts Expansion - $136 M ? Leawood Service Area Pump Station s and Forcemain - $16 M ? Little Bull Creek Pump Station - $5 M ? Street and Storm Program - $ 17 M ? Middle Basin WWTF Regulatory (Wet weather Treatment) - $21 M ? Blue River WWTF Wet weather Capacity - $20 M	? New Century WWTF Expansions - $6 M ? New Century WWTF Upgrade - $5 M ? SCADA and Network Improvements - $3 M ? Near Term Large O&M Vehicle Purchases - $ 3M ? Lab Equipment - $1.5 M ? Other Misc. Needs – $ 34 M
Planning and Support	? Near Term Studies and Integrated Plan Development - $ 5 M ? Asset Management Program Implementation Support - $12 M	? Integrated Plan Delivery Support and Adaptive Management - $70 M

(1) R&R cost forecasts and ongoing programs do not include projected needs outside 25-year planning period.
(2) Defined near term WWTF, Pump Station and Forcemain R&R projects are specifically listed. Future R&R projects and near term needs that have not been incorporated into specific projects are included in additional ongoing R&R needs.
(3) Includes projects scheduled to be completed outside the 25-year planning period.

Capital Investment

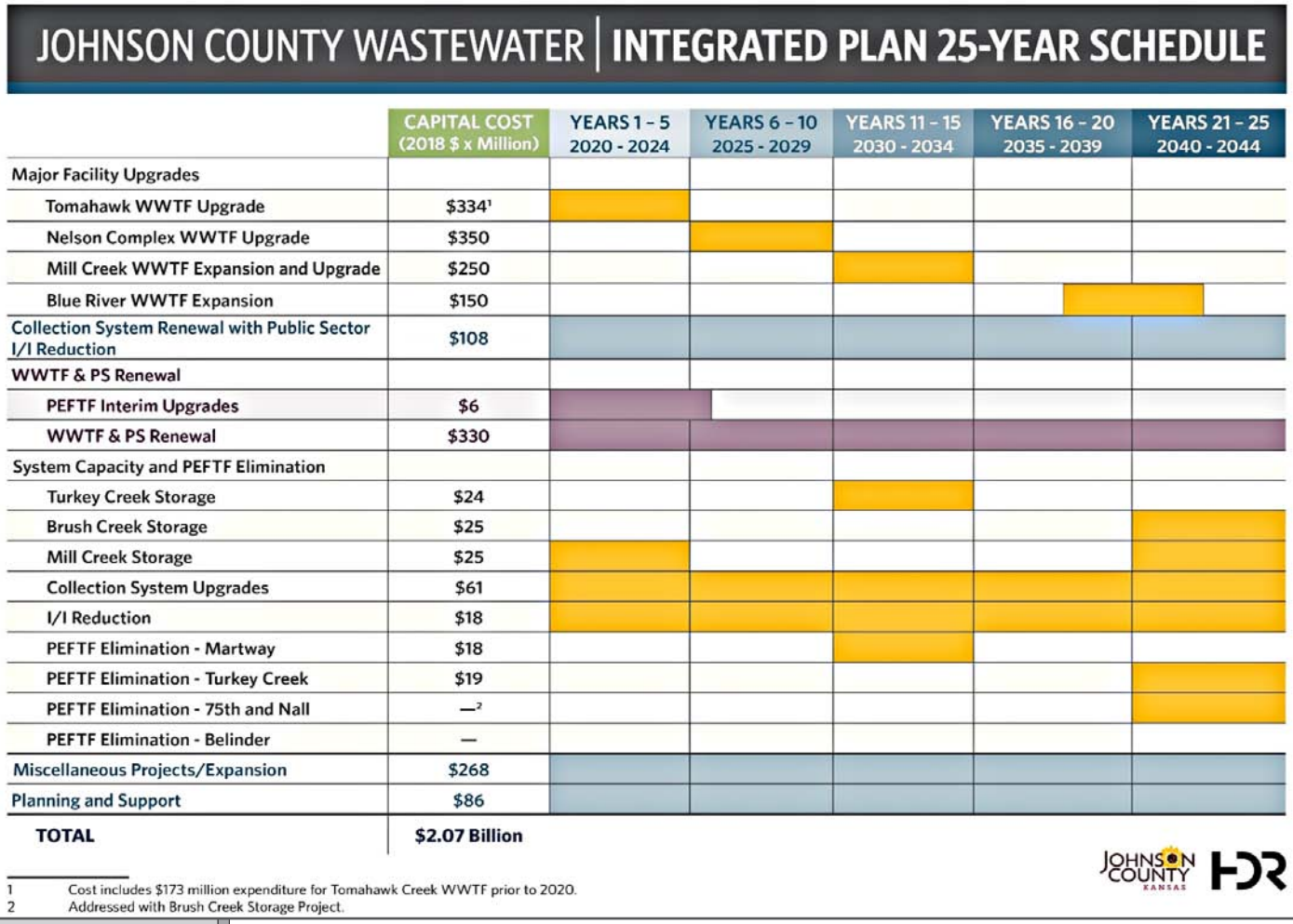
Figure 7: Incremental Capitol Investment in Five-Year Blocks in Johnson County



Infrastructure Planning

In 2019, the county began briefing KDHE on the underlying assumptions and analyses data going into optimizing project selection for the largest net benefits for customers. The county concluded that eventual elimination of the PEFTFs was economically sound and provided more sustainable community service over the long run. The plans sequenced the completion of upgrades to the wastewater treatment plants in five-year increments with Tomahawk Creek completed by 2024, Nelson Complex completed by 2029, and Mill Creek completed by 2034 (Figure 8).

Figure 8: Five-Year Stages of the Johnson County Integrated Plan & Associated Projects



	CAPITAL COST (2018 $ x Million)	YEARS 1 – 5 2020 - 2024	YEARS 6 – 10 2025 - 2029	YEARS 11 – 15 2030 - 2034	YEARS 16 – 20 2035 - 2039	YEARS 21 – 25 2040 - 2044
Major Facility Upgrades						
Tomahawk WWTF Upgrade	$334[1]					
Nelson Complex WWTF Upgrade	$350					
Mill Creek WWTF Expansion and Upgrade	$250					
Blue River WWTF Expansion	$150					
Collection System Renewal with Public Sector I/I Reduction	$108					
WWTF & PS Renewal						
PEFTF Interim Upgrades	$6					
WWTF & PS Renewal	$330					
System Capacity and PEFTF Elimination						
Turkey Creek Storage	$24					
Brush Creek Storage	$25					
Mill Creek Storage	$25					
Collection System Upgrades	$61					
I/I Reduction	$18					
PEFTF Elimination - Martway	$18					
PEFTF Elimination - Turkey Creek	$19					
PEFTF Elimination - 75th and Nall	—[2]					
PEFTF Elimination - Belinder	—					
Miscellaneous Projects/Expansion	$268					
Planning and Support	$86					
TOTAL	**$2.07 Billion**					

1 Cost includes $173 million expenditure for Tomahawk Creek WWTF prior to 2020.
2 Addressed with Brush Creek Storage Project.

State Agreement

KDHE, for its part, had to accept deferred implementation of its TMDLs and corresponding nutrient reduction to the Kansas River across multiple NPDES permit cycles. KDHE was willing to abide by this reality, recognizing the tremendous cost burden necessary for that implementation while gaining a commitment that the goals of the TMDLs would be met over the long run. The Integrated Plan asserted long-term, system-wide progress in asset improvement and environmental benefits while moderating the stand-alone priority of individual projects, e.g., PEFTF elimination; and Biological Nutrient Removal (BNR) technology installation (BNR is a process used for nitrogen and phosphorus removal from wastewater).

Delay Factors

EPA was briefed on the plan and its recommended schedule of activities several times in mid-2019. The Integrated Plan detailed the elimination of three of the four PEFTFs in the next 15 – 25 years. The decision to delay the elimination of Belinder PEFTS was driven by: its costs; its marginal improvement to system sustainability; and to defer disruption to the most established neighborhoods in the county. Delaying this project will also allow the County to evaluate the effectiveness of the numerous planned Infiltration/Inflow removal, storage, and relief sewer projects that are tributary to the Belinder PEFTF.

Log-Range Commitment

Aligning with KDHE, EPA accepted a long-range commitment to achieving its objectives, which addressed EPA's original objections to the Nelson Complex NPDES permit over a decade ago. The Integrated Plan was completed as Phase 1 in September of 2019 and institutional arrangements with the regulatory agencies were made to incorporate the Integrated Plan into the permitting process.

Infrastructure Planning

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Enforcement

25-Year Span

EPA Objections

Dual Operations

Permit Features

The KDHE Consent Order

The Integrated Plan will be revisited in five-year increments with possible revisions to reflect altered priorities and conditions. KDHE agreed to incorporate the Integrated Plan within a Consent Order. Kansas law limits the terms of Schedules of Compliance in NPDES permits to five years. Consent Orders, however, allow for an expanded timeline of accomplishments across permit cycles. KDHE's Consent Order, executed on October 23, 2019, requires Johnson County to implement the Integrated Report (attached as an Appendix to the Order) in phases, pursuant to the schedules described within the Integrated Plan.

The Consent Order specifically requires Johnson County, over the next five years, to:

- Establish an implementation schedule for nitrogen removal at Mill Creek to achieve final ammonia limits and a total nitrogen goal of 10 mg/l;
- Establish an implementation schedule for adding total phosphorus removal at Mill Creek to achieve the Wasteload Allocation assigned to Mill Creek at 156.6 pounds per day, with an effective total phosphorus goal of 1 mg/l;
- Establish an implementation schedule for nitrogen removal at the Nelson Complex to achieve ammonia limits and the 10 mg/l total nitrogen goal;
- Establish an implementation schedule for total phosphorus removal at the Nelson Complex to achieve the Wasteload Allocation of 125.3 pounds per day at that facility; and
- Establish an implementation schedule for the interim improvement in PEFTF disinfection and dechlorination at all four PEFTFs prior to their eventual elimination.

The Consent Order states:

> The IP [Integrated Plan] shall be the basis for subsequent agreed upon improvements and schedules between JCW [Johnson County Wastewater] and KDHE, with annual reports on progress provided to KDHE. Such reports shall be in addition to any other reports required by JCW's permits.

Each January 31st, Johnson County will report on:

- Major work activities performed during the prior year;
- A summary of any sampling results per discharge event from each PEFTF for E. coli and total residual chlorine;
- Any proposed updates to the approved Integrated Plan; and
- Major work activities planned for the next three years.

Additionally, "[Johnson County] will submit Integrated Plan updates for KDHE's review and approval at least every five years. Such updates shall be based upon greater system understanding, results of program and project implementation, and any updated program/project benefit evaluation. The first 5-year Integrated Plan update will be required no later than December 31, 2024."

The Integrated Plan becomes an enforceable part of the Consent Order as do any KDHE-Approved updates to the plan. Furthermore, the County shall continue to operate the Mill Creek Facility and Nelson Complex Facility in accordance with the applicable permits issued by KDHE. In this manner, the Consent Order remains fixed in force over the 25-year span of the Integrated Planning horizon, with the plan itself (as an Appendix to the Order) being the only item that changes as time goes on.

With the development of the Integrated Plan and its incorporation into an enforceable Consent Order, EPA held a hearing to address its original objections to the Nelson Complex NPDES permit. They subsequently found that while the PEFTFs are still in existence, the Integrated Plan detailed an approach to their ultimate demise. EPA removed their objections to permitting the Nelson Complex, clearing the way for KDHE to finally permit the Nelson Complex as well as the Mill Creek Facility which had its NPDES permit administratively extended for over a year.

KDHE NPDES Permits for Mill Creek and Nelson Facilities

KDHE issued NPDES permits for both the Mill Creek and Nelson Facilities on February 1, 2020. The Nelson permit reflects the existing dual treatment operations from adjoining sewer drainages in the County with a design flow of 15 MGD. The permit describes the future upgraded facility, including peak instantaneous design flow capacities of 52 MGD initially, up to 122 MGD at the final phase of expansion.

Additionally, BNR activated sludge will be installed along with anaerobic digestion of biosolids prior to land application. Final limits are in place for: ammonia; **b**iological **o**xygen **d**emand (BOD); **t**otal **s**uspended **s**olids (TSS); E. coli; total residual chlorine; as well as a mass limit for total phosphorus that is consistent with the Wasteload Allocation of 125.3 pounds per day established by the Kansas River TMDL. Whole effluent toxicity testing and scans for priority pollutants are required at times during the five-year term of the permit.

Infrastructure Planning

Compliance Schedule

Mill Creek NPDES Permit

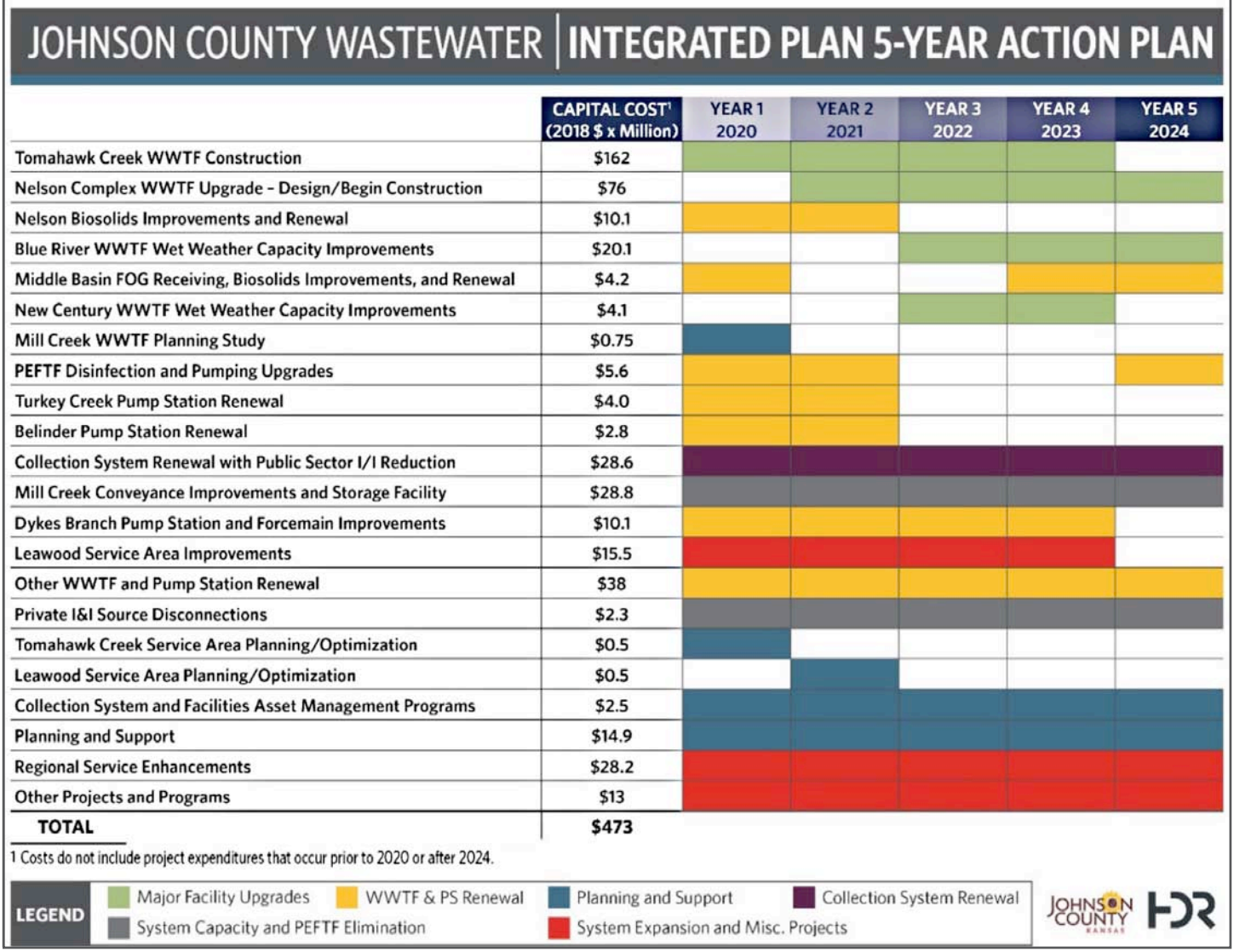
Current Period Activities

A Schedule of Compliance is placed in the permit that links achievement of the permit limits to the schedules outlined by the Integrated Plan. Within one year following substantial completion of the project to upgrade the Nelson Complex treatment plant as addressed by the Integrated Plan and the Consent Order [19-E-5 BOW], the County shall achieve compliance with the final permit limits at the outfall of the upgraded plant.

The NPDES permit for Mill Creek covers both its on-site aerated lagoon and its activated sludge system operated in parallel. A combined design flow of 18.75 MGD is slated for the plant with capacity to deal with peak flows up to 108 MGD, mostly by detention at the aerated lagoon. Similar final limits for the typical pollutants are established in the permit as is 156.6 pounds per day mass limit for total phosphorus. Those permit limits are couched by the Schedule of Compliance (SOC) in the permit. The SOC is similar for that of the Nelson Complex permit and tied back to the scheduling of the Integrated Plan under the purview of the Consent Order.

Both permits expire on January 31, 2025, after the next iteration of the Integrated Plan and Consent Order outlines the next suite of activities to occur over the following five-year period. During the current five-year period (2020 – 2024), activities will include: construction at the Tomahawk Creek plant; design and initial construction at the Nelson Complex; biosolids improvement; expansion of wet weather capacity at several plants; initiation of the planning study at the Mill Creek plant; renewals of pump stations; and force main improvements and improvements at the PEFTFs (Figure 9).

Figure 9: First Five Years of Projects under Johnson County Integrated Plan



Infrastructure Planning

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Drinking Water Integration

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Detailed Development

Conclusion

PROSPECTUS OF INTEGRATED PLANNING IN KANSAS

KDHE is bullish on using integrated planning to establish long-range commitments to its regulatory mission under the Clean Water Act, particularly for those major metropolitan areas whose wastewater discharges comprise a majority of the pollutant loading into Kansas waters. Integrated planning allows for sequential scheduling of large capital improvement projects for wastewater treatment. Additional incorporation of: collection system improvements; asset management; wet weather treatment; and urban stormwater management is easily accommodated under the guise of an Integrated Plan. Kansas' approach with Integrated Planning — using Consent Orders as the regulatory and enforcement vehicle to oversee implementation of those plans — is flexible because of the orders' expanded regulatory horizon beyond the typical five-year cycle of NPDES permits and their Schedules of Compliance. Integrated planning creates regulatory certainty for the permittee by committing to projects over that extended horizon, e.g., 25-years.

Integrated planning commitments assure the regulatory agencies that progress will continue in a deliberate and steady manner. By being patient, regulatory agencies see an improved probability that their regulatory objectives — permit limits, nutrient reduction, TMDL achievement, etc. — will be successfully achieved. Integrated planning invokes a sense of adaptive management by allowing for experimentation with certain approaches, observation of the effects, and revisiting those approaches at each five-year review and revision stage of the planning and permitting process.

At the local level, the customer base is assured of avoiding rate spikes to cover the annualized capital costs of each project. By allowing utilities to develop an affordable long-term plan that includes system reinvestment and meeting water quality needs, the political-reaction to regulatory mandates becomes less contentious. In time, Integrated Planning may be expanded in scope by utilities to manage competing interests for revenue. Stormwater management and Combined Sewer Overflows are already considered as likely candidates for Integrated Planning to balance their capital costs with those of the wastewater operations.

The growing demands under the Safe Drinking Water Act might be ripe for integration with their counterparts on the wastewater side as municipalities grapple with the costs of compliance for both Federal water laws. Integrated Planning might also be used to allow wastewater and stormwater treatment programs to explore market-placed solutions — such as water quality trading, watershed management, and subsidized best management practice implementation — for cost-effective pollutant load reduction on a watershed scale.

Not all situations warrant an Integrated Planning Approach. Some environmental issues demand more immediate action. Some utility staff are loath to commit future staff or city councils to improvement projects beyond the immediate planning and budget horizons of city hall. Some regulatory agencies may also be driven by the political need to expedite action on priority environmental issues.

Nonetheless, based on the Johnson County experience, KDHE is receptive to using Integrated Planning to implement environmental improvement beyond the scope of traditional command-and-control permitting. As such, there must to be a commitment of leadership and dedicated staff to see an Integrated Plan is developed in sufficient detail to outline the scheduled expectations of investment, improvement, and compliance within the context of the permitting process. For example, the Johnson County Integrated Plan involved KDHE staff with permit writing, compliance and enforcement, engineering review, water quality standards, and TMDL development. On top of that, agency leadership must make the accommodation of an Integrated Plan a priority of accomplishment for staff to remain invested in the process.

In this situation, the effort paid off handsomely at the Federal, State, and local levels, with the resolution of long-standing regulatory issues and a committed investment in the Kansas environment.

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Aaron Witt serves as the Chief Engineer at Johnson County Wastewater, in Kansas, and oversees engineering services and standards, asset management program, capital improvement program, and the sewer district creation process. He has been with the County for 20 years. He holds a B.S. in civil engineering and a master's in environmental engineering, both from the University of Kansas. He is a registered professional engineer in Kansas and Missouri.

Uncertainty Planning

Different Approaches

PLANNING & UNCERTAINTY

INCORPORATING UNCERTAINTY INTO WATER MANAGEMENT PLANNING
(WITH ALBUQUERQUE CASE STUDY)

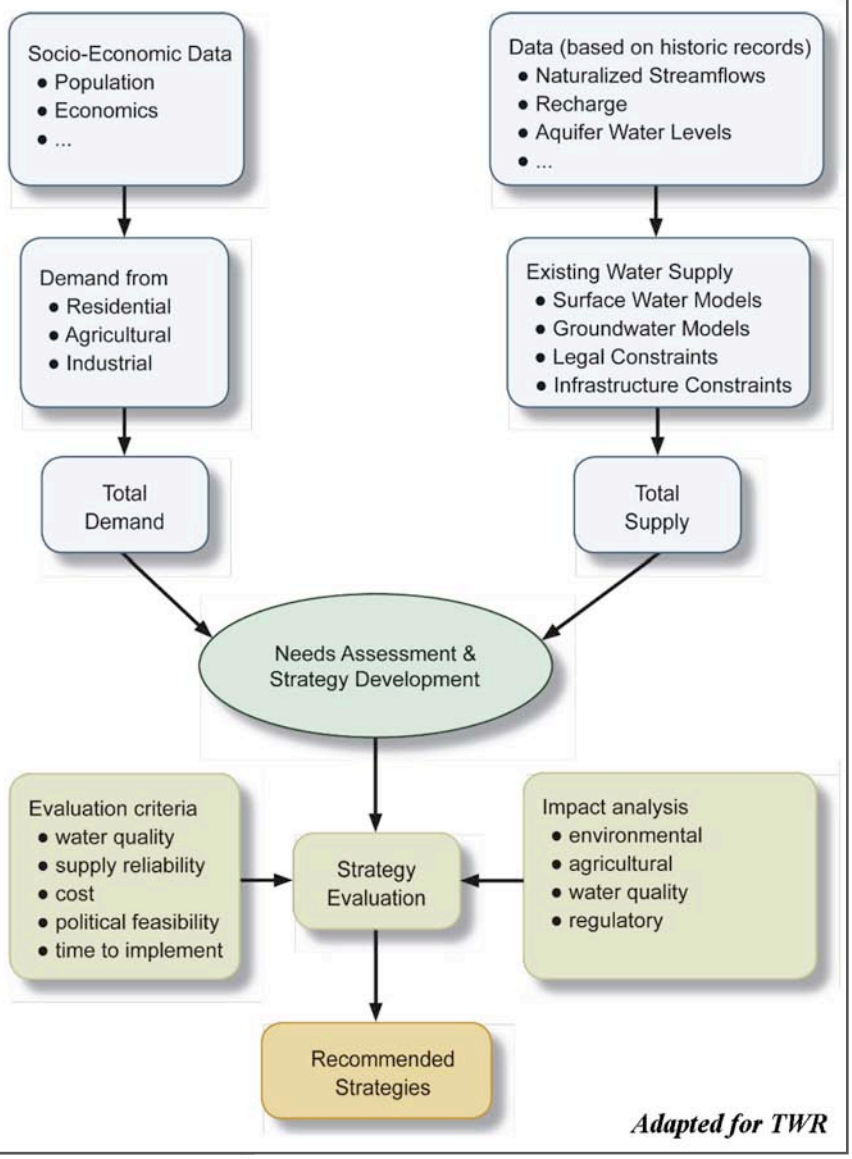
by Abhishek Singh, PhD, PE, Vice President – Western Region
INTERA Incorporated (Torrance, CA)

Introduction

Planning with certainty is a rare luxury. Planning under uncertainty is often a necessity and most of us do so routinely. Be it crossing the road, driving a car, applying to college, or saving for retirement, we frequently navigate through situations where our understanding of the past, present, and future is incomplete or inaccurate. Despite these uncertainties, we routinely make decisions and take actions even when the consequences of these decisions and actions are not perfectly known.

While planning under uncertainty is the norm, the approaches to handling uncertainty run the gamut. There are those who essentially ignore uncertainties and follow a relatively "deterministic" path of working towards a defined goal. A milder example of this would be decision-makers who avoid uncertainty by inherently seeking out more certain outcomes, irrespective of the outcomes over more uncertain scenarios. The risk-averse among us account for uncertainties and associated downsides and work to minimize losses. At the other end of the spectrum, the more risk-tolerant or risk-seeking among us seek to maximize gains or profit across future uncertainties. [The interested reader is referred to Daniel Kahneman and Amos Tversky seminal work on "Prospect Theory" (Kahneman and Tversky, 1979), which built the foundations of our current understanding on how individuals make decisions under uncertainty (and won Kahneman the 2002 Nobel Prize in Economics).]

Figure 1: Schematic of the Water Planning Framework (Singh et al., 2010)



Regardless of how one approaches uncertainty, implementing a rational approach to incorporating uncertainty into the planning process provides upsides with respect to both gains and losses. An article on "*Strategy Under Uncertainty*" in the Harvard Business Review (Courtney et al., 1997) makes the point convincingly: Underestimating uncertainty can lead to strategies that neither defend against the threats nor take advantage of the opportunities that higher levels of uncertainty may provide. In one of the most colossal underestimations in business history, Kenneth H. Olsen, then president of Digital Equipment Corporation, announced in 1977 that "there is no reason for any individual to have a computer in their home." The explosion in the personal computer market was not inevitable in 1977, but it was certainly within the range of possibilities that industry experts were discussing at the time.

Figure 1 shows a schematic of a typical water resources planning framework. Water resources planning entails: estimating future water demands and supplies (based on current sources); identifying gaps between demands and supplies; and proposing water projects or management strategies to "fill the gaps" (either by bringing in new supplies or decreasing demands). Future demands are driven by: population/economic growth; agricultural and irrigation practices; and water usage rates — among other things. Supplies are driven by: climate; basin hydrology; and water management practices including reservoir operations, diversions,

Uncertainty Planning

Key Uncertainties

and groundwater pumping. Several of these factors on both the demand and supply side are beset with uncertainty. For example, population projections are estimates at best and can be impacted by future socio-economic conditions. Water supplies can be impacted by long-term climate change as well as the natural hydrologic variability. Finally, future water projects and management actions also have uncertainties driven by regulatory, environmental, and socio-political uncertainties.

This article lays out a framework for incorporating key uncertainties into the water planning process. We first discuss the basic principles of the planning process (with an emphasis on water planning), contrasting the planning process with and without uncertainty. Next, we lay out a five-step approach to handling uncertainty in the planning process. Finally, a case study based on Albuquerque Bernalillo County Water Utility Authority's 100-year water plan is presented to demonstrate the concepts and the value provided by incorporating uncertainty into the water planning process.

Figure 2: Schematic Showing the (Deterministic) Planning Process

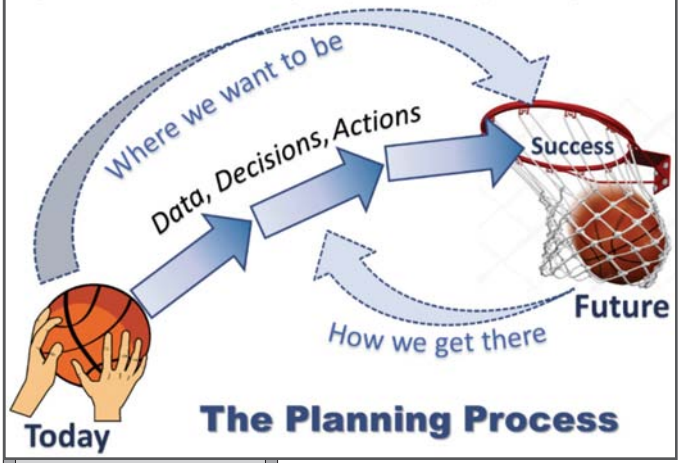


Figure 3: The Cone of Uncertainty (ABCWUA, 2016)

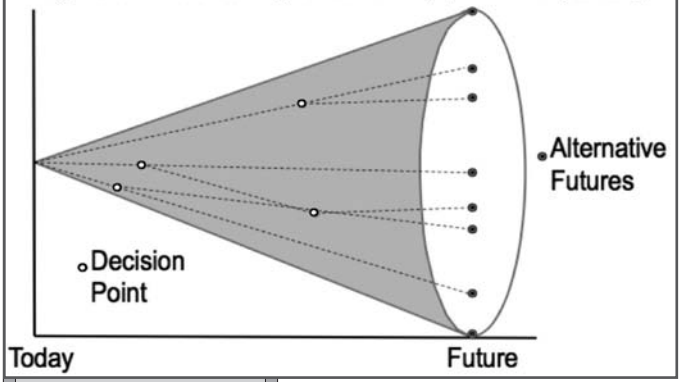


Figure 4: Schematic Showing Planning Under Uncertainty

Planning: With and Without Uncertainty

Before addressing the impact of uncertainty on the planning process, it would be useful to deconstruct the planning process itself. **Figure 2** shows a schematic of the planning process. The act of planning entails defining a path from a current state to a future desired state. In water resources planning, this may take the form of projecting future water supplies and demands and identifying projects or management actions to meet future water needs. A well-defined plan identifies current conditions (where we are) and clearly articulates goals defining success in the future (where we want to be). The plan then defines a series of decisions and actions that will need to be taken to accomplish the goal. Ideally, these decisions and actions are based on data collected before and during plan implementation; hence, successful plans should also have a data collection component. The plan should lay out the process for collecting data, identify and monitor performance metrics, and establish triggers that would necessitate making changes to decisions and actions. Typically, the plan itself is revisited at a regular frequency (5 or 10 years, in most cases), and updated based on the best available information at the time. As such, most plans implicitly account for changing (uncertain) conditions between the present and the future. They do this by formulating an "adaptive" strategy wherein the decisions, actions, and the plan itself are adjusted during the plan implementation phase. Such (deterministic) planning approaches do not explicitly account for uncertainty, tend to focus more on the short-term, and rely on reacting/adapting to changing conditions in the future.

When planning under uncertainty, one needs to acknowledge and account for the fact that the future is inherently uncertain. The range of uncertainty can be described as a cone, where near events are relatively well-known, and uncertainty grows further out in time (**Figure 3**). The purpose of the plan becomes to identify a range of options available for future water managers to respond to changing situations and *maximize the chance of success given everything one does not know about the future*.

Figure 4 shows a schematic of the planning process under uncertainty. As can be seen, uncertainty-based planning builds on the deterministic planning framework. However, now the plan needs to account for multiple alternative futures (scenarios), with varying degrees of success, and different decisions and actions (still based on data collected in the interim) to reach planning goals under the alternative future conditions. In the water planning process, this translates to multiple water demand and supply scenarios with water projects or management actions identified to maximize the likelihood of meeting future water needs while also being socio-economically viable.

Figure 5: Comparison of Deterministic Planning and Planning Under Uncertainty Frameworks (Singh et al., 2010)

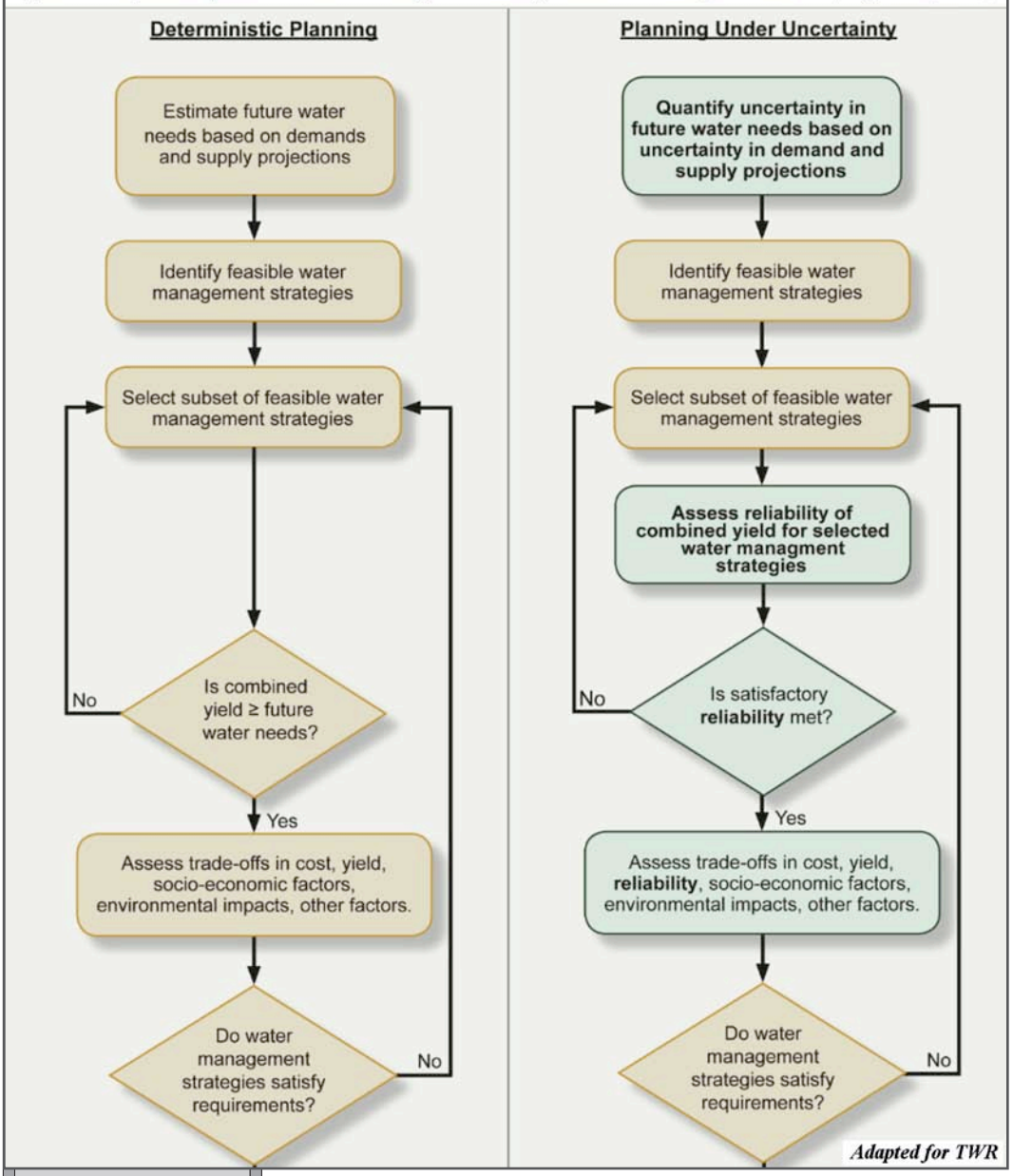


Figure 5 (Singh et al., 2010) compares the traditional deterministic water planning framework with water planning under uncertainty. The fundamental difference between the deterministic planning framework and planning under uncertainty is that a range of plausible future water demands, supplies, needs, and strategies are identified. The planning process typically maximizes the likelihood (the reliability) of the selected strategies meeting the range of (likely) future water needs instead of a single (deterministic) projected future water-need. The goal of planning under uncertainty becomes to identify strategies that have an acceptable level of reliability (i.e., there is a sufficiently high likelihood of meeting future water needs) while also accounting for other important criteria like cost, yield, environmental impacts, socio-economic factors, political feasibility, etc.

Planning under uncertainty often establishes future goals in terms of *risk, reliability, resilience*, and *robustness*. While all of these relate to managing uncertainty there are key differences that may lead to different approaches in the planning approach.

Negative Outcome

Success Likelihood

Constancy

Recovery

As such, it is instructive to define these terms:

Risk is the likelihood of a loss or negative outcome (unmet water needs or deficits, from a water planning perspective). The term encapsulates both the probability and the consequence of the undesirable outcome. Hence, risk-based plans seek to mitigate future risks and minimize the likelihood and magnitude of future losses. Water plans that focus on minimizing risks, may base decisions and actions on 'worst-case' demand and supply scenarios.

Reliability is the converse of risk and is defined as the likelihood of success or desired outcomes. A reliable plan is one that maximizes the probability of meeting goals and objectives, despite underlying uncertainties.

Robustness is a related term and is associated with how sensitive the plans are to uncertainty or variability. A robust plan is one that is consistent in the face of uncertainty and is minimally impacted by changes to underlying conditions.

Resilience is yet another closely aligned term and defines how easily a system can recover from adverse or disruptive events. For example, a resilient water plan is one that allows a community to withstand a drought (albeit with some shortages) and recover back to normal without prolonged adverse impacts once the drought is over.

Uncertainty Planning

Planning Process

Key Uncertainties (Examples)

Demand & Supply

Randomness

Knowledge Lack

"Unknown Unknowns"

Quantification

Multiple Scenarios

Projections v. Data

Methodology

The overall methodology for incorporating uncertainty into the planning process can be split into five steps and is shown in **Figure 6**. Each of these is described in more detail below.

Figure 6: Five-Step Process for Incorporating Uncertainty into Planning

Step 1 - Identifying Uncertainties

The first step in uncertainty-based planning is identifying key uncertainties that are likely to impact planning goals, strategies, and outcomes. The uncertainties identified in this phase set the stage for the rest of the planning process. Hence, careful consideration must be given to identifying uncertainties in the most important planning parameters. Examples of uncertain demand parameters in the water planning process include: population projections; future water usage rates; future land-use; agricultural irrigation practices/efficiencies; and future industrial water use. Examples of uncertain supply parameters in the water planning process include: rainfall; streamflows; reservoir operations; groundwater conditions and production; evaporative losses; and urban and agricultural return flows.

When identifying uncertainties, it helps to think of two basic categories of uncertainties — "aleatory" and "epistemic."

Aleatory (from the Latin word for "dice player") **uncertainty** is related to the intrinsic randomness or variability of the system. Examples of aleatory uncertainty include natural variability in daily rainfall or per-capita water usage rates. Aleatory uncertainty is driven by chance or randomness and can, typically, not be reduced by additional data collection.

Epistemic (from the Greek word for "knowledge") **uncertainty** is driven by lack of knowledge, representation, or information about a system. Examples of epistemic uncertainty include the uncertainties associated with future climate or population projections. Errors or uncertainties in models created of natural hydrologic systems (that may be used to predict future water supplies) are also Epistemic in nature. Epistemic uncertainty may be reduced by better data or knowledge. Since epistemic uncertainties are related to the state of knowledge, it becomes even more important to consider different perspectives and states of knowledge about the system.

To borrow a quote from former US Secretary of Defense, Donald Rumsfeld, "[T]here are known unknowns; and there are unknown unknowns." Careful consideration and collaborative discussion incorporating viewpoints from multiple stakeholders are often needed to move some of the "unknown unknowns" to the "known unknown" category.

Step 2 - Quantifying Uncertainties

Once key uncertainties have been identified they need to be characterized or quantified. This is essential if the plan needs to address these uncertainties in a systematic and quantitative manner. The approach for quantifying uncertainty depends on the uncertain parameter and the data available to quantify its uncertainty.

Three approaches for quantifying uncertainty are now described:

1) *Develop multiple scenarios with different assumptions for underlying factors* and use these to quantify uncertainty in future estimates. This approach is suitable for characterizing the uncertainty in epistemic planning parameters such as future water supply and population, which are typically estimated using mathematical or numerical models. When assessing impact from climate change, for example, multiple global circulation models (GCMs) and emission scenarios can be combined to create future climate variables (such as precipitation and temperature) that drive future hydrology and water supplies. Often, historical data can be used to assess the "goodness of fit" of the models and ascribe likelihoods for future projections based on how well the model replicates the past.

2) *Compare past projections to actual data* and use the "mismatch" to bound the uncertainty of projections. In effect, this quantifies the error in projections and works well for uncertain parameters that have historical projections and data to compare with. For example, this approach may be used to estimate the uncertainty/error in per capita water usage rates, where past projections and actual data are typically available.

Uncertainty Planning

Historic Variability

Water Needs & Deficits

Decision Analysis

Simulations

Relative Importance

Reducing Uncertainty

3) *Assess the historic variability for a planning factor* (based on available data) and use this to quantify the uncertainty in the projections. This approach works well for "aleatory" planning parameters such as water usage rates or daily precipitation, where the variability may be difficult to predict.

In general, two approaches exist to represent the uncertain parameters: 1) using discrete scenarios (with associated likelihoods); or 2) continuous probability distributions. Most water planning approaches rely on discrete scenarios since these are easier to use and explain to stakeholders.

Step 3 - Relating Uncertainties to Strategies/Outcomes

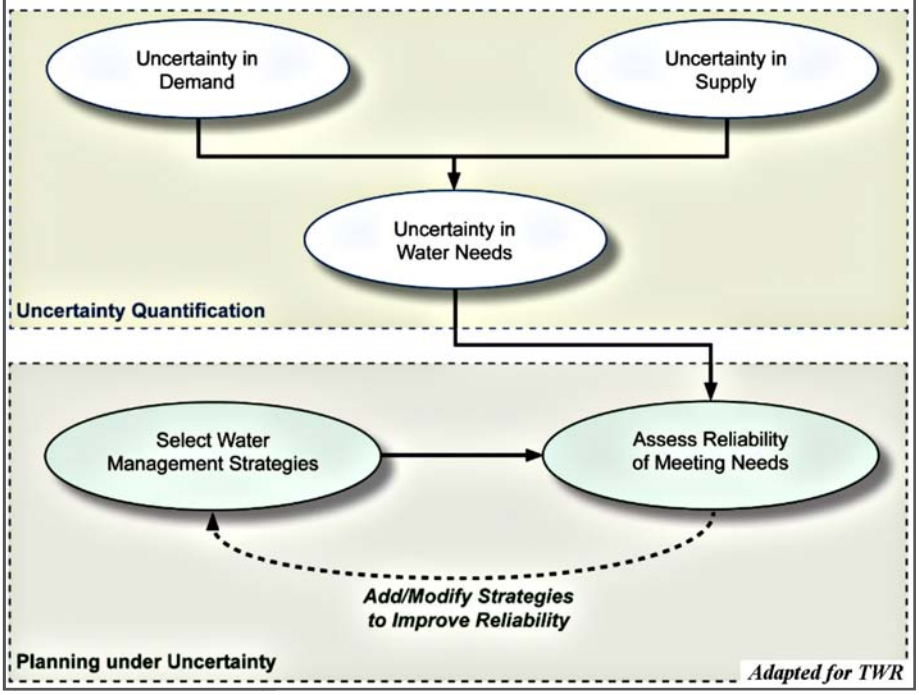
Once the uncertainty in key water demands and supply parameters have been quantified, they can be analyzed to estimate the uncertainty in future water needs/deficits (volumes and periods when supplies are not sufficient to meet water demands). If multiple scenarios for demand and supply parameters have been created, then these need to be combined to create an ensemble of water need projections. Depending on the number of parameters and scenarios involved, the combinatorics of such an exercise can often become overwhelming (for example, three uncertain supply parameters, three uncertain demand parameters, with three scenarios each, would yield a total of eighty-one combinations). In practice, representative scenarios that cover the range of water demands, supplies, and needs can be used to keep the number of scenarios feasible.

With representative water need scenarios identified, the planning process needs to step through the analysis of relating key planning decisions and actions to the range of water need identified. **Figure 7** shows a schematic that relates the uncertainty in demand, supply, and needs to water management strategies. This can be an involved process entailing going through several water project portfolios (collection of projects) with different costs and yields to assess how each portfolio does against the range of future water needs. Depending on the complexity of the water system, computer simulations may need to be undertaken at this stage to assess the reliability (likelihood of meeting water needs), feasibility, and costs of the proposed water project portfolios.

Step 4 - Assessing Uncertainty Importance/Sensitivity

With multiple uncertain parameters impacting the eventual reliability metric, it is often useful to assess the relative importance of uncertain parameters (or which uncertain parameters the plan strategies/outcome are most sensitive to). This exercise provides valuable information on where to focus future data-collection and monitoring efforts, so as to reduce uncertainty in the most important planning parameters. The importance of or sensitivity to uncertain parameters can be assessed by repeating steps 2 and 3 using a deterministic value (usually the most likely scenario for the parameter) for the parameter. The difference in the outcome with and without the uncertain scenarios for the given parameter demonstrate the sensitivity of the plan's strategies/outcome to that parameter. As an example, consider a water plan that incorporates uncertainty in both population projections and hydrology (driven by climate change). The reliability of the optimal project portfolio considering both sources of uncertainty is 75%. The reliability of the same project portfolio considering uncertainty in only population projection is 95%, while the reliability with only uncertainty in hydrology is 80%. In this case, the uncertainty in hydrology is more critical to the overall reliability of the plan. Hence, it makes sense to monitor and improve the characterization of the hydrology of the basin.

Figure 7: Relating Uncertainties to Planning Strategies/Outcomes (Singh et al., 2010)



Step 5 - Managing/Reducing Uncertainties

Every plan should have a monitoring and data-collection element that is geared towards managing and reducing uncertainties during the plan implementation phase. The data collected should serve two purposes: 1) reduce the range of uncertainty in key planning parameters by refining estimates and projections as new data becomes available; and 2) validate the plan's underlying assumptions and recommended strategies and make necessary refinements and revisions to the plan as necessary.

Uncertainty Planning

100-Year Plan

Prudent Options

Plan Objective

Water Portfolio

Groundwater Decline Reversed

Case Study

This case study — used to demonstrate the concepts detailed above — is based on a 100-year water plan developed (ABCWUA, 2016) by the Albuquerque Bernalillo Water Utility Authority (Water Authority). [Note, the case-study is presented for demonstration purposes only and this article does not profess to speak on behalf of the Water Authority.]

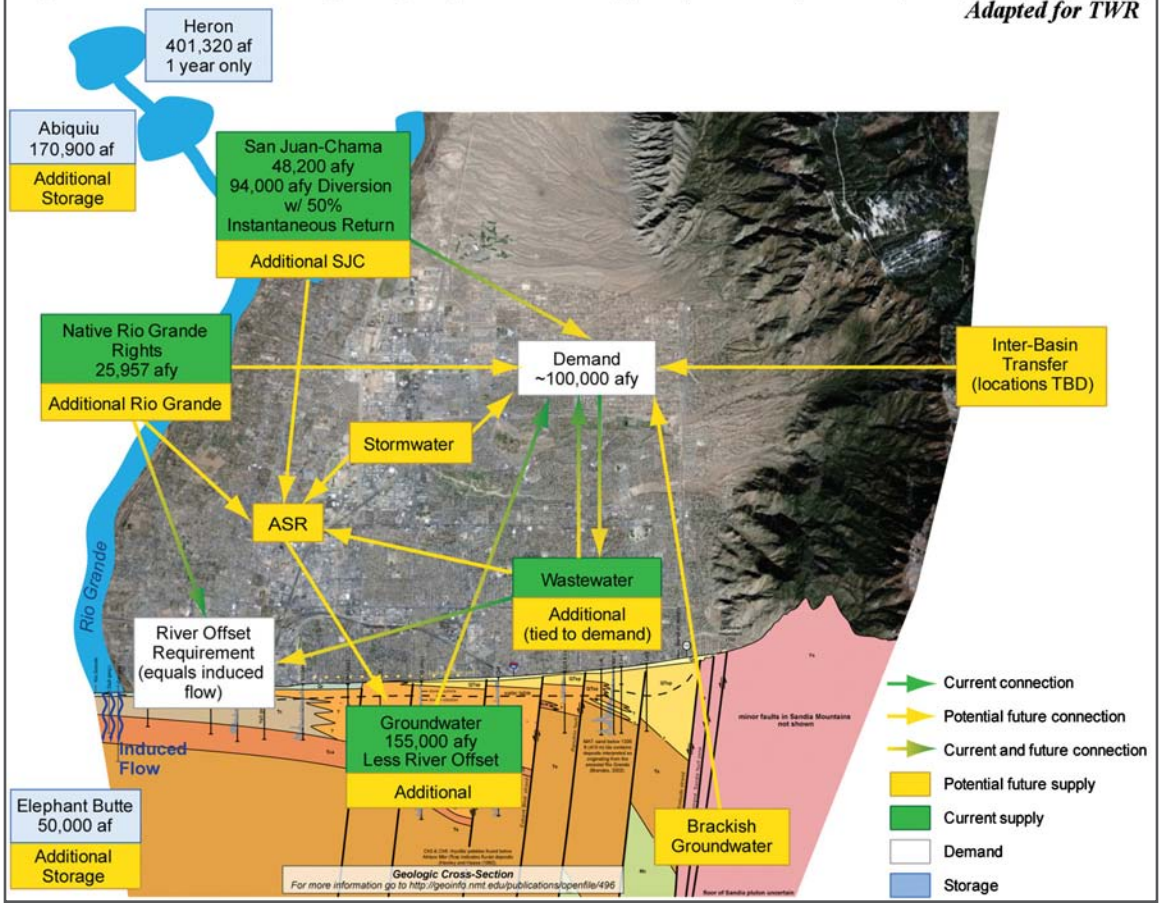
The Water Authority provides water to nearly 700,000 people in and around the City of Albuquerque, New Mexico. The 100-year plan — referred to as "Water 2120" (Plan) — looks at the current water situation in Albuquerque and projects the community's needs based on various scenarios of climate variability and population growth. The Plan builds on the Water Authority's prior successes in water conservation and integration of surface water from the Rio Grande River into their supply portfolio — both of which have allowed significant recovery of the groundwater aquifer that was previously the sole source of supply. The Plan aims to extend this success into the future by identifying prudent future investments in:

- Conservation
- Aquifer Storage and Recovery (ASR)
- Stormwater Capture
- Watershed Restoration
- Wastewater Reuse

In so doing, the Plan aims to provide a sustainable and resilient water supply in the face of an uncertain future, while managing the groundwater aquifer as a drought reserve.

The Water Authority's diverse water portfolio is shown in the schematic in **Figure 8**. Water demand averages approximately 100,000 **a**cre-**f**eet per **y**ear (AFY). Albuquerque's drinking water comes from two sources: the aquifer beneath the City; and San Juan-Chama surface water which is imported from the Colorado River Basin into the Rio Grande Basin from the headwaters of the San Juan River in southern Colorado. Historically (through the 1990s), the City primarily relied on groundwater for most of its supplies, which led to rapid declines in water levels in the aquifer. The completion of Albuquerque's $500 million San Juan-Chama Drinking Water Project along with two water reuse and reclamation projects allowed direct use of surface water, which allowed the Water Authority to diversify its portfolio and reverse the declines in groundwater levels.

Figure 8: Schematic Showing Albuquerque's Water Supplies, Demands, and Projects (ABCWUA, 2016)
Adapted for TWR



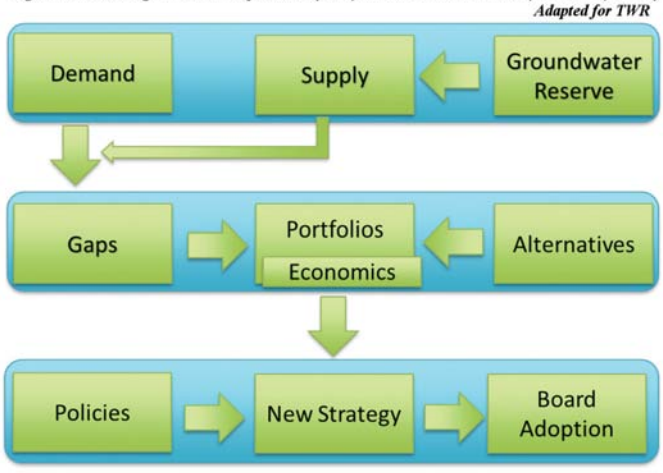


Figure 9: Planning Framework for Albuquerque's Water 2120 Plan (ABCWUA, 2016)
Adapted for TWR

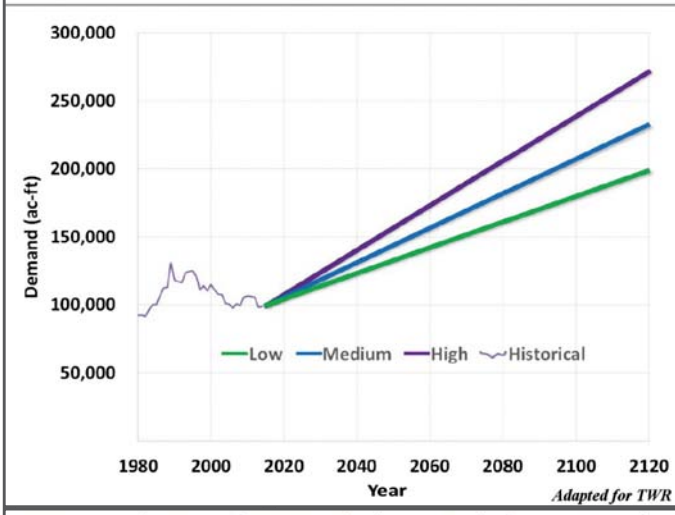


Figure 10: Actual and Projected Annual Water Demands (ABCWUA, 2016)

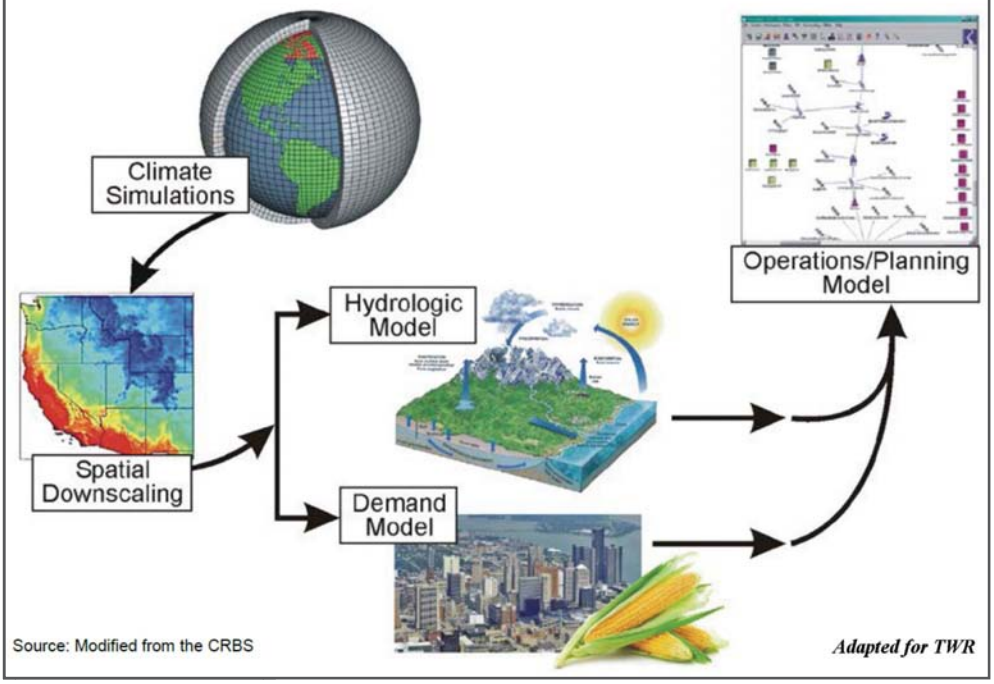


Figure 11: Schematic Showing Linked GCM, Hydrologic, Demand, and Operations/Planning Models Used to Assess Future Supplies (ABCWUA, 2016)

The overall planning framework adopted by the Water 2120 Plan is shown in **Figure 9**. The Plan identified and quantified uncertainty in demands and supplies using multiple scenarios. It established groundwater reserves to supply water under drought conditions and recommended several water portfolios to fill future supply gaps while maintaining sustainable groundwater conditions. The different steps of the uncertainty-based planning process are described in more detail in the following paragraphs.

Municipal water demands comprise a majority of Albuquerque's water demands. The Water 2120 Plan identified several key uncertainty parameters that would drive future water demands. Key Uncertainty Parameters included:

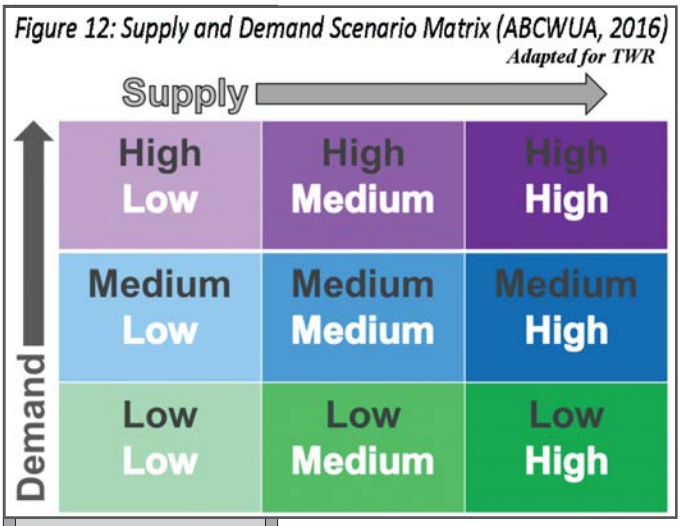
- Future Population Projections
- Per-Capita Water Use Forecasts
- Future Landscape Practice and Water-Use Efficiencies
- Increased Outdoor Irrigation Requirements driven by higher temperatures from climate-change

These uncertainties were analyzed and combined to develop three future scenarios for water demands (**Figure 10**).

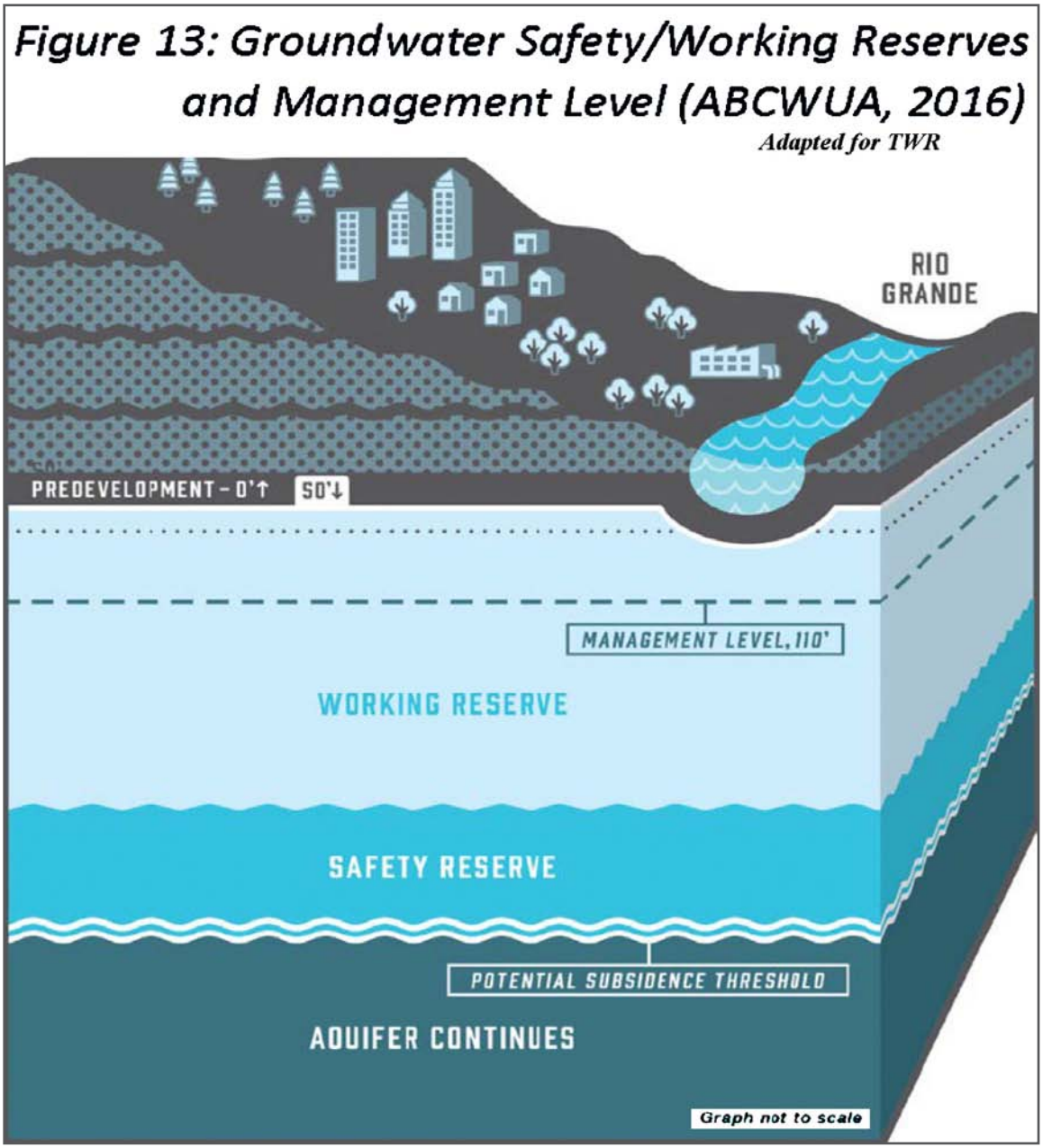
Key uncertainties in future surface water supplies were related to: hydrologic variability and climate change impacts on San Juan-Chama Supplies; native flows; and reservoir losses (due to higher temperatures). As **Figure 8** shows, Albuquerque has a complex water portfolio consisting of managed surface water (diversions and storage projects) as well as groundwater wells. Predicting these supplies under future conditions entailed developing models of the surface and groundwater hydrologic systems linked to an operations/planning model which allowed for different water management strategies to be tested (**Figure 11**). The computer model allowed Albuquerque's water plan to account for wet periods and the water storage opportunities they represent while also being prepared for sustained dry periods. Sustained drought would reduce the City's available surface water supplies and require greater reliance on groundwater reserves. The Water 2120 Plan incorporated climate simulations done by the US Bureau of Reclamation (Reclamation) to develop three (high-, medium-, and low-flow) projections for Albuquerque's water supply, incorporating the effect of future climate change.

The three demand and supply scenarios were combined to create a total of nine future water need scenarios (**Figure 12**). Three representative scenarios (high demand/low supply, medium demand/medium supply, and low demand/high supply) — covering the range across all nine scenarios — were chosen for planning purposes. Since the underlying uncertainty parameters were all considered equally plausible, all scenarios had equal likelihood.

Groundwater was considered to be relatively resilient to drought conditions. As such, groundwater provided a critical and relatively low-



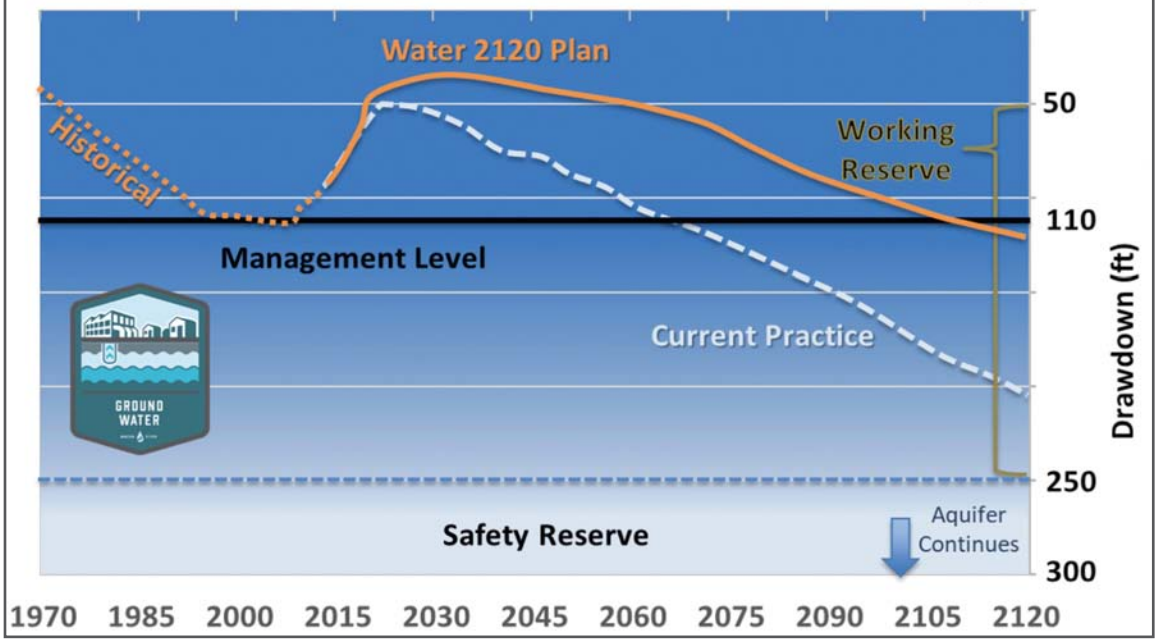
cost resource that could be utilized when surface water was scarce. However, instead of drawing on groundwater in an unlimited fashion, the Water 2120 Plan treated the groundwater system as a "drought reserve," establishing thresholds and targets for groundwater declines (**Figure 13**). For example, 300 feet (ft) below pre-development conditions was established as the absolute lower-bound on future groundwater levels to prevent irreversible subsidence. A safety reserve, corresponding to groundwater levels 250 to 300 ft below pre-development water levels, was established to ensure adequate water supplies in a worst-case scenario, such as a multi-year interruption in surface water supplies. A working reserve, corresponding to 50 to 250 ft below pre-development water levels, was established to allow for groundwater to be withdrawn (within the working reserve) during dry times and refilled when adequate surface water supplies become available. A groundwater level 110 ft below predevelopment conditions was established as the "sustainable" target and all planning scenarios were optimized to maintain groundwater levels at or above that threshold (**Figure 14, next page**).



Uncertainty Planning

Groundwater Levels

Figure 14: Historical and Water 2120 Groundwater Levels Compared to Safety/Working Reserves and Management Levels (based on ABCWUA, 2016)
Adapted for TWR



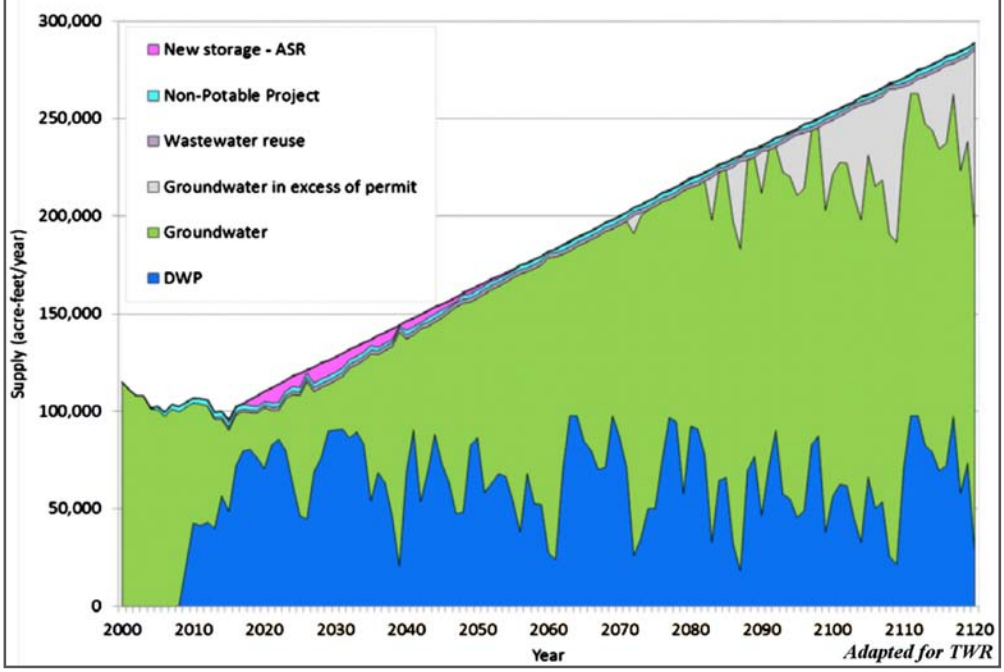
Supply Gaps

Portfolio Options

The Plan utilized the linked surface, groundwater, and operations/planning model to match water demands with surface and groundwater supplies as well as assess the impact of water management strategies on groundwater levels across multiple scenarios (**Figure 9**). Water supply gaps corresponded to periods with limited surface supplies (drought conditions) when groundwater withdrawals in excess of management levels would be needed to meet demands. The Plan then identified a range of water portfolios to fill these supply gaps. These portfolios provided future decision-makers with a broad range of options to consider in both the near-term and the long-term as an approach to meeting or avoiding future supply gaps. **Figure 15** shows the simulated supplies needed to meet demands for one of the scenarios (high-demand/low-supply). Note that any groundwater withdrawals above sustainable levels would be identified as "supply gaps" that would need to be filled by the water portfolio(s).

Supply Options Simulation

Figure 15: Simulated Supplies to Meet Demands for the High-Demand/Low-Supply Scenario (ABCWUA, 2016)

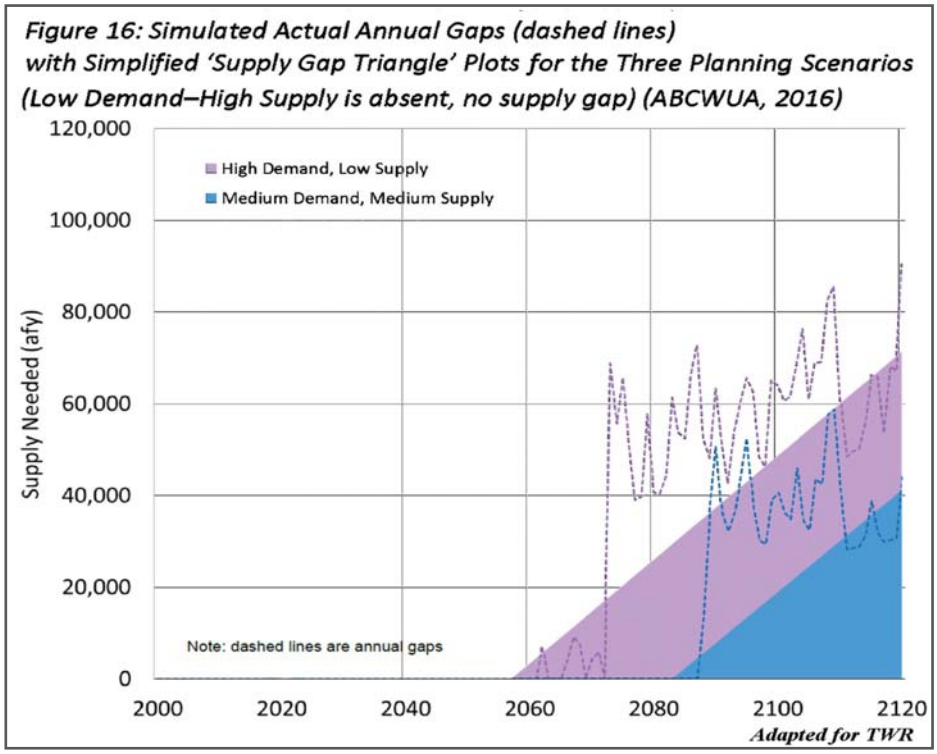


Uncertainty Planning

New Supply Needs

Figure 16 shows the water gaps that needed to be filled for each of the three planning scenarios (the low-demand/high-supply scenario did not have any gaps). The annual supply gaps have been simplified as the triangle plots to show general trends and magnitudes in gaps. Based on these plots, new supplies are needed as early as about 2060 for the high-demand/low-supply (worst-case) scenario, 2080 for the medium-demand/medium-supply scenario, and not at all in the low-demand/high-supply (best-case) scenario. The average supply gap from 2100 to 2120 for the medium-demand/medium-supply scenario was 38,000 AFY, while the average supply gap for the same period for the high-demand/low-supply scenario was 65,000 AFY.

Figure 16: Simulated Actual Annual Gaps (dashed lines) with Simplified 'Supply Gap Triangle' Plots for the Three Planning Scenarios (Low Demand–High Supply is absent, no supply gap) (ABCWUA, 2016)



Alternatives Identified

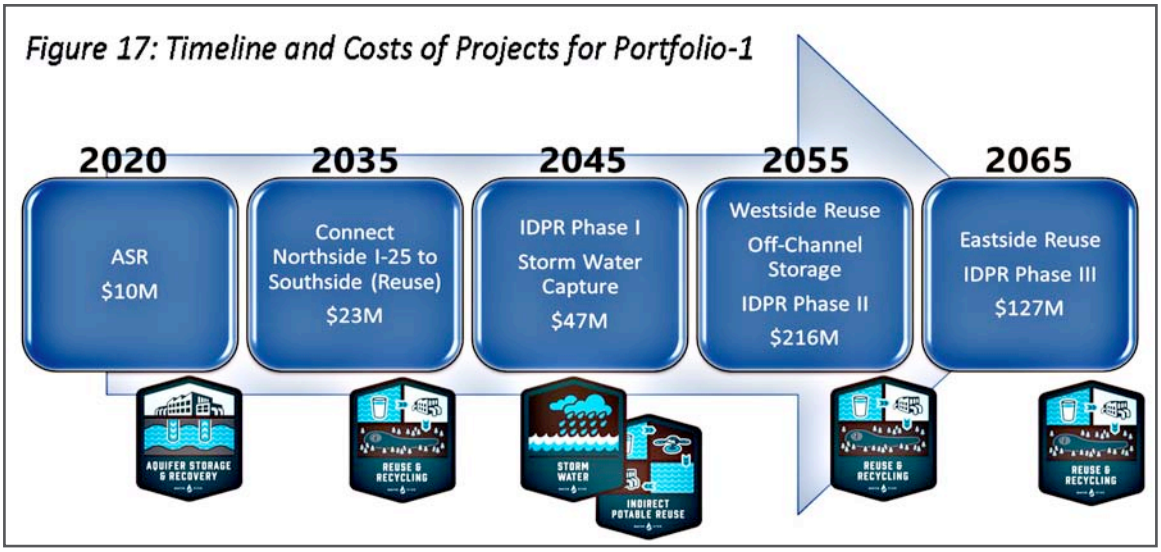
Criteria

The Plan then identified three portfolios with different water management alternatives to fill the water gaps, while maintaining groundwater levels at management levels. The alternatives were ranked based on multiple criteria including: yield; reliability; technical feasibility; permitting; time to implement; socio-economic impact; ecosystem protection; and carbon footprint — among others. **Figure 17** shows one of the three portfolios with timelines and costs for several water management alternatives including: Aquifer Storage and Recovery (ASR); stormwater capture; storage; and indirect potable reuse (IDPR).

"Balanced Approach"

The portfolio selection was based on a "balanced approach" filling gaps for the medium-demand/medium-supply scenario. The worst-case scenario (high-demand/low-supplies) was seen to potentially lead to over-investment in infrastructure, leading to excessive costs to ratepayers and stranded capacity. The best-case scenario (low-demand/high-supplies) was seen to lead to under-investment and lack of preparedness in case future conditions turned worse than projected.

Figure 17: Timeline and Costs of Projects for Portfolio-1



Uncertainty Planning

Planning Benefits

Five-Step Process

Case Study

Incorporating Uncertainties

The Water 2120 Plan was adopted in 2016 and was the result of a two-year effort involving Water Authority staff and multiple consultants, as well as an exhaustive public outreach program that included community conversations, Town Hall meetings, and multiple presentations to federal and state stakeholders such as Reclamation, the US Corps of Engineers, US Fish & Wildlife, the New Mexico Interstate Stream Commission, and many others. The Plan was also endorsed by The Nature Conservancy and local economic development organizations such as the Albuquerque Chamber of Commerce and the New Mexico Homebuilder's Association.

Summary and Conclusions

Planning for future water demands, supplies, and management alternatives is an inherently uncertain process. Accounting for uncertainties in the planning process can lead to lower risks, more reliable outcomes, and higher likelihood of success in the face of changing and uncertain future conditions. This article presents a framework to incorporate uncertainty into the water planning process. The key difference between deterministic and uncertainty-based planning is that the latter acknowledges and accounts for multiple alternative assumptions and future conditions.

The uncertainty-based planning framework follows a five-step process including: 1) identifying key uncertainties; 2) quantifying key uncertainties; 3) relating key uncertainties to planning strategies/ outcomes; 4) assessing the sensitivity to uncertainties; and 5) managing/reducing uncertainty through data collection. Each of these steps is explained using practical water planning examples. Stakeholder communication, especially during the uncertainty identification phase, is crucial.

The article demonstrates these concepts using a 100-year water plan developed by the Albuquerque Bernalillo Water Utility Authority. The Water Authority's 2120 Water Plan was based on: a comprehensive evaluation of demand and supply uncertainties; incorporating uncertainties due to population projections; water usage rates; climate change; and hydrologic variability. The Plan then combines these uncertainties into representative planning scenarios. Future water needs are met while ensuring that existing groundwater supplies are utilized in a sustainable manner. Several water alternatives are explored to develop multiple water portfolios that provide future water managers several options to fill water gaps while maintaining the health and sustainability of the water system. The 2120 Water Plan demonstrates how uncertainties can be incorporated into an adaptive and resilient water plan.

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Dr. Singh is the Vice President of the Western Region with INTERA Incorporated. He has over 16 years of research and consulting experience in the areas of water resources planning and management, surface water and groundwater modeling, risk and uncertainty analyses, climate change impact assessments, optimization techniques, geographic information systems (GIS), and data analytics. Dr. Singh has a MS and PhD in Civil and Environmental Engineering from the University of Illinois, Urbana-Champaign, and is a registered Civil Engineer in the States of California and Texas.

Climate Resilience

Resiliency

Robustness & Flexibility

Water Infrastructure

"Climate" Bonds

Bonds Basics

Market Trends

Seal of Approval

CLIMATE & WATER RESILIENCE

EMERGING WATER RESILIENCE SHIFT: FINANCE, POLICY, ENGINEERING, PLANNING

by John H. Matthews & Alex Mauroner (Alliance for Global Water Adaptation)

Introduction

Stating that the impacts of climate change will predominantly be felt through water is not a new observation. Achieving climate resilience within — and through — water management will require an evolution in how we design, plan, manage, and finance water infrastructure.

The term "resilience" (or, more commonly in the US, "resiliency") has become the new gold standard when it comes to facing the impacts of climate change. Standardization of the concept is necessary if we are to avoid the pitfalls of "greenwashing" and maladaptation.

The Alliance for Global Water Adaptation (AGWA) is a network of technical water professionals, spanning the full range of disciplines engaged on water management issues from economics and engineering to governance and eco-hydrology. For the last ten years, we've worked actively to define and operationalize resilience for the water community and for policy makers and investors in dozens of countries.

Within AGWA, we have defined water resilience has having two key components: 1) robustness (how we prepare for climate impacts we feel confident will occur); and 2) flexibility (how we prepare for alternate futures and scenarios to cope with the high levels of uncertainty that are associated with many future impacts). Robustness is an area that most technical water professionals are already comfortable with, while flexibility is really a return to an older, less-optimized, and more humble approach to making long-term decisions about water resources, institutions, and decisions. In practice, flexibility is much less conceptually familiar to most people in the water community.

In this article, we will describe what we see as some of the emerging trends around water and climate change, with a strong emphasis on resilience.

Water-Resilient Finance: Green and Climate Bonds

Nowhere is the standardization of climate resilience needed more than in the realm of climate finance, where billions of dollars in the US and abroad are invested annually in water infrastructure projects with purported climate adaptation or climate mitigation (i.e., carbon emissions) benefits. A look into the climate bonds market (also called the green bonds market) demonstrates some of the efforts being undertaken to define and expand climate resilient water infrastructure.

New climate finance patterns are beginning to emerge that hold the promise to divert financial flows towards resilience. More robust financial risk assessments can articulate expectations for those seeking finance as well as those looking for "good" investments. For over a decade, financial institutions have begun scaling-up issuances of so called "green" or "climate" bonds — wherein the bond proceeds go towards climate change mitigation or adaptation projects. As the use of climate bonds increases, the need for standardization, transparency, and credibility becomes more vital.

Before taking a look at efforts to standardize resilience within climate bonds, it is important to understand the broader context and scale in which they operate. To begin, a "climate bond" operates in the same manner as a normal bond — with one key exception. Both are fixed-income instruments issued in order to raise finances for a specific project or asset. Issuing entities repay the bond over specified time periods, with interest. The key difference is in the use of proceeds: climate bonds help finance projects or assets with climate mitigation and/or adaptation benefits.

To get an idea of the scale of the climate bonds universe, consider the following. Each year Climate Bonds Initiative (CBI) releases a State of the Market report to present trends and statistics from the broader landscape of the "climate-aligned bonds" universe, reflecting private sector investment. Results from 2018 are a staggering 1.45 trillion US Dollar (USD) equivalency in outstanding bonds globally. The water sector accounted for 101 billion USD in outstanding climate-aligned bonds in 2018. Bonds certified against CBI's Water Infrastructure Criteria (discussed below) represent a small but growing subset of that figure, totaling more than 8 billion USD since 2016.

Standardizing Climate Bonds

Climate Bonds Initiative is a close AGWA partner, working to mobilize the 100 trillion USD bond market for climate change solutions. In addition to performing and sharing market research, CBI's main initiative has been the development of a Climate Bonds Standard and Certification Scheme designed to provide scientifically-defensible credibility to investments in a low-carbon economy. The Climate Bonds Standard is a labeling scheme for bonds, essentially an independently verified seal of approval demonstrating that bond proceeds will go towards projects or assets with mitigation and/or adaptation benefits. The screening tool helps investors assess claims for the climate integrity of bonds.

Climate Resilience

Criteria Development

Consortium

Goal

Robustness & Flexibility

Nature-Based Solutions

Hybrid Solutions

Operational Lifetime

Resilience Rewarded

Mitigation Component

Adaptation Component

The Climate Bonds Standard includes sector-specific criteria to ensure that the wide range of project types are adequately assessed and scrutinized for their climate benefits. Currently, a dozen distinct sector criteria have been developed, including a set for water infrastructure. Each sector is developed by technical and industry experts, in conjunction with public consultation, before review and approval by CBI's Climate Bond Standard Board.

Water Infrastructure Criteria

In mid-2014, a consortium of **n**on-**g**overnmental **o**rganizations (NGOs) coordinated the development of criteria for defining climate-resilient water infrastructure.

Consortium members are:

- AGWA
- CDP: a not-for-profit charity that runs the global disclosure system for investors, companies, cities, states and regions to manage their environmental impacts (www.cdp.net/en)
- Ceres: a sustainability nonprofit organization working with influential investors and companies to build leadership and drive solutions throughout the economy (www.ceres.org)
- Climate Bonds Initiative: an international, investor-focused not-for-profit working solely on mobilizing the $100 trillion bond market for climate change solutions (www.climatebonds.net)
- World Resources Institute (WRI): a global research organization focusing on seven critical issues at the intersection of environment and development (www.wri.org)

The consortium's goal is to make the expectations clear for issuers of bonds as well as the risks transparent to investors. The initial phase of this Water Infrastructure Criteria for certifying climate bonds was limited to traditional gray water infrastructure investments (i.e., traditional "built" infrastructure), with the exclusion of hydropower. We crowd-sourced the criteria with several hundred technical experts globally. Our assumption was that we needed to address both aspects of resilience: robustness and flexibility. As a result, the criteria explore the level of technical analysis as well as the water governance and allocation context. Some of these elements are within the control of the issuer (e.g., the depth of the technical and planning analysis) while others are largely about how stakeholders interact to resolve or avoid conflicts — especially as water conditions shift from climate impacts over time.

In early 2016, with support from the Rockefeller Foundation and the US Department of Agriculture's Natural Resources Conservation Service, the same NGO consortium began developing supplemental criteria to evaluate and qualify nature-based solutions. Investments in nature-based solutions depend explicitly on the use of ecosystems to provide gray infrastructure-like services — such as water treatment and flood protection — through so-called natural or "green" and hybrid (green-gray) infrastructure. The expanded version of the Water Infrastructure Criteria was released in May 2018. Our work in this area has continued forward, particularly with WRI, around nature-based solutions and public utilities.

At the same time, one of the most critical components when planning for resilient water infrastructure (or any type, really) involves a reframing of the timescales used in climate finance. Traditionally, the finance period has been used as the standard for evaluating the sustainability period of an investment. To encourage long-term thinking, Water Infrastructure Criteria requires evaluating the sustainability of gray and hybrid (a combination of gray and nature-based) investments over the operational lifetime of the investment in question rather than over the finance period. For nature-based infrastructure, operational lifetimes should be evaluated over at least a 100-year period.

A Scorecard for Resilience

The Water Infrastructure Criteria were designed to evaluate and correspondingly reward the resilience of water-related assets and projects. Although the Criteria were designed by technical experts to be scientifically rigorous, they were also designed with the end user in mind. As such, the evaluation process is fairly straightforward. Most, if not all, of the required documentation is already generated as part of a typical project planning and design cycle. Indeed, we've found in talking with issuers that the Criteria describe the emerging state of the art in how we envision risk in a climate-shifting world.

The Criteria is comprised of a mitigation component and an adaptation and resilience component. The mitigation component works to provide transparency into the project's impacts on **g**reen**h**ouse **g**as (GHG) emissions and the degree of mitigation that will be delivered over the project's operational lifetime. Baseline and project emissions must be stated as well as methods for tracking and monitoring actual emissions over the life of the bond. In order to pass the mitigation component, projects must either have no net GHG emissions expected or a negative net GHG emissions impact.

The adaptation and resilience component of the Water Infrastructure Criteria require that a vulnerability assessment be undertaken to diagnose climate impacts and potential climate risks. If the vulnerability assessment finds that climate change will have a significant impact on the project or asset, the bond issuer will also need to provide an adaptation plan laying out the proposed courses of action that would address the identified climate risks.

Climate Resilience

Criteria Categories

In the Adaptation and Resilience Section of the Water Infrastructure Criteria, all projects are evaluated using a basic checklist type scoring system consisting of a series of binary questions, plus supplementary documentation as required by the Criteria Document.

The Criteria scorecard covers five categories:

(1) Allocation
(2) Governance
(3) Technical Diagnostics
(4) Nature-Based Solutions (if applicable)
(5) Adaptation Plans (if applicable)

Each question in the scorecard will result in a "yes" or "no" answer, with "yes" corresponding to 1 point. Projects must score at least 60% for each category to meet the requirements of the Adaptation and Resilience components. Issuers first self-assess using the scorecard. Then, bond issuers hire independent verifiers (certified by Climate Bonds Initiative) to check the information using evidence provided.

Engineered, Nature-Based, or Hybrid

As mentioned earlier, water infrastructure assets evaluated by the Criteria can be engineered, nature-based, or hybrid systems. They cover a wide range of services and categories. Generally speaking, the Criteria are applicable to water infrastructure or water-use systems that monitor, collect, treat, or distribute water, or that protect against (or mitigate the impacts of) floods and droughts. Examples of engineered infrastructure could include wastewater treatment plants or drip irrigation systems. Nature-based infrastructure could include the use of wetlands for water treatment or aquifers for water storage. An example of hybrid infrastructure would be a "room for the river" flood control system that mixes ecosystems with built structures such as levees or dikes. To date, a diverse mix of assets have been financed using certified climate bonds under the Water Infrastructure Criteria.

Financing Climate Resilient Water Management in the United States

Climate Bonds Issued

Since the first phase of the Water Infrastructure Criteria was launched in 2016, several large-scale bonds have been issued by utilities, municipalities, and banks. The San Francisco Public Utilities Commission (SFPUC) was the first to issue a climate bond under the Water Infrastructure Criteria, with subsequent climate bonds going towards financing new infrastructure assets or system improvements and upgrades. To date, SFPUC has issued over USD 1.4 billion in certified Climate Bonds for water infrastructure.

Sewer Improvement

SFPUC's initial climate bond of USD 240 million was issued in May 2016 to finance sustainable stormwater management and wastewater projects as part of the city's Sewer System Improvement Program. The climate bonds were dedicated to increasing seismic and system reliability and reducing neighborhood flooding for existing SFPUC sewer infrastructure.

Water System Program

The second Climate Bonds Certified water issuance in December 2016 helped raise USD 259 million for projects in SFPUC's Water System Improvement Program — one of the largest water infrastructure projects ever undertaken in the US. Altogether, 87 local and regional projects were financed, ranging greatly in size and scope. They included improvements to pipelines, storage reservoirs, and pump stations. Larger scale projects included upgrades to, and addition of, new treatment, storage, and transmission facilities.

Benefits

These facilities are designed to:

- Increase System Reliability
- Reduce Seismic Vulnerability
- Improve Water Quality
- Recover and Store Groundwater
- Protect Crucial Freshwater Resources for San Francisco and seven surrounding counties

Capital Projects

A year later, in December 2017, SFPUC issued a series of bonds totaling over USD 505 million. Projects in this phase were again carried out as part of the broader Water System Improvement Program. Projects were aimed at water recycling, water treatment, and water supply, including pump station upgrades, seismic upgrades, dam improvements, and myriad other programs.

In August 2018, SFPUC issued another USD 408 million worth of bonds certified under the Water Infrastructure Criteria. The bonds were issued to finance and refinance capital projects of the Wastewater Enterprise under the same Sewer System Improvement Program mentioned earlier. Specifically, funds will go towards: upgrades and new assets for stormwater; flood resilience; sewage treatment; wastewater; and associated control system infrastructure. These measures are intended to address aging infrastructure, seismic reliability, combined sewer discharges, rising sea levels, and localized flooding.

Climate Resilience

Increasing Trend

International Bonds

San Francisco has been the largest issuer of certified climate bonds for water infrastructure in the United States, but it is not alone. Local governments and financial institutions across the country have begun to finance their climate-aligned water projects with these bonds. Last year in particular saw a large number of issuances. In April 2019, the Illinois Finance Authority issued USD 450 million in climate bonds to finance wastewater treatment, sanitary sewerage, and drinking water facilities. In November 2019, the Benton Washington Regional Public Water Authority in Arkansas issued USD 59 million in climate bonds for water infrastructure assets. Domestic examples continue to be added (see Table 1).

Financing Climate Resilient Water Management Globally

The increasing use of certified climate bonds for water infrastructure is taking place outside the United States as well. In May 2018, the Water Infrastructure Criteria were expanded to include coverage of resilient nature-based solutions for water. Marking the first issuance against the newly expanded Water Infrastructure Criteria, the Dutch State Treasury Agency issued a nearly USD 6.8 billion bond for low-carbon development and sustainable water management, including financing natural infrastructure solutions for reducing flood risks in the Netherlands in early 2019.

To date, these criteria have been applied and certified for at least USD 8 billion in assets for projects in the USA, Nigeria, South Africa, China, Chile, The Netherlands, Malaysia, and Australia, inclusive of climate-related risks with drought, inland and coastal flooding, snowpack changes, and other potential and realized impacts.

California's Resilience Shift

Broader Trends: Seeing New Risks, Institutionalizing Resilience

Outside of climate finance, many other concurrent trends demonstrate a broader shift towards institutionalizing resilience within (and outside) the United States. California is again at the forefront of this movement. In April 2019, Governor Gavin Newsom made clear his state's commitment to water resilience. An executive order directed his administration to change the way they develop, manage, and think about water systems — including ecosystems. The order requires more strategic assessment and a deeper understanding of California's water challenges, ensuring that all state actions ensure safe and resilient water supplies for communities, the economy, and the environment. Agencies such as the California Natural Resources Agency, California Environmental Protection Agency, and the California Department of Food and Agriculture will work with scientists, engineers, environmental representatives, and local stakeholders to develop the state's water resilience portfolio. Private finance markets are doing their part to more adequately acknowledge climate risks. The CEO of BlackRock, a leading global investment management corporation with over USD 7 trillion in assets under management, recently declared that climate change must be a defining factor in how companies conduct their business. Signaling the potential beginnings of a sea change in private finance, BlackRock has laid out a set of climate-related initiatives including making sustainability integral to investment portfolios and divesting in fossil fuels.

Table1: Bonds for Water Infrastructure in the United States Certified According CBI Standard

This list is not exhaustive and some numbers have been rounded.

Issuer	Date Issued	Total Issuance (Million USD)
SFPUC	May 2016	240
SFPUC	December 2016	259
Capital Region Water (PA)	May 2017	44
SFPUC	December 2017	121
SFPUC	December 2017	384
SFPUC	August 2018	408
City of Santa Fe, NM	March 2019	14
Illinois Finance Authority	April 2019	450
Mississippi Development Bank	May 2019	13
City of Starkville, MS	May 2019	10
South Central Connecticut Regional Water Authority	July 2019	13
City of Portland, ME	August 2019	7
Town of York, NY	August 2019	4
San Lorenzo Valley California Special Water District	August 2019	14
Porter Special Utility District (TX)	October 2019	13
Benton Washington Regional Public Water Authority (AR)	November 2019	59
Southside Public Water Authority (AR)	February 2020	17

2020: A Year for Water and Climate

The United Nations has declared 2020 to be the year of "Water and Climate Change." As part of the campaign, the UN's annual World Water Development Report (WWDR) for 2020 covers a range of topics associated with aspects of climate resilient water management (e.g., governance, finance, etc.). The report covers challenges, opportunities, and potential responses for adaptation, mitigation, and resilience that can be achieved through improved water management. The report was launched on World Water Day (March 23). *See:* www.unwater.org/publications/world-water-development-report-2020/. Under the coordination of the UN, World Water Day marked the official start of the "Water and Climate Change" campaign. The UN shared key messages on the links between water and climate change, as well as policy recommendations for achieving climate resilience through improved water management. The day served as a communication and awareness-building campaign, including a series of events (both virtual and in-person) highlighting the theme.

Climate Resilience

Mainstreaming Water Resilience

Climate Adaptation

Best Practices Leadership Trainings

Knowledge Platform

Member-Based Network

New Efforts from the Alliance for Global Water Adaptation

The Alliance for Global Water Adaptation (AGWA) is an international NGO working across technical and policy programs to mainstream resilient water resources management, focusing on the connections between water resources and climate adaptation and mitigation.

AGWA has wide-ranging initiatives that include:

- New Methodologies to mainstream technical risk assessment and reduction in water management planning, design, and operations
- Nature-Based Solutions: enabling and scaling up nature-based solutions for adaptation
- Policy Role of Water: promoting the bridging role of water in global climate policy dialogues and negotiations, primarily through the UN Framework Convention on Climate Change (UNFCCC)

AGWA also works to mobilize funds for adaptation and mitigation through climate finance and climate bonds standards. Development of the Water Infrastructure Criteria for climate bonds (mentioned earlier) was led by AGWA.

Several new initiatives from AGWA are being developed in order to further mainstream climate resilience through water. First, AGWA recently convened a small group of business resilience and sustainability leaders at Microsoft's headquarters near Seattle, Washington. For two days, participants discussed what climate adaptation means for businesses, as well as the level of progress and state of needs now and in the near term. This effort is in its early days, though it is clear that businesses are willing and eager to receive help translating insights from the public sector and civil society into workable outcomes for corporations to address climate resilience.

AGWA is also working to mainstream new best practices for adaptation with leaders of national governments' climate adaptation programs. AGWA and the UNFCCC have begun working with three globally oriented and interconnected universities to deliver a month-long coordinated course for national adaptation focal points and their teams. Divided loosely into Asia-Pacific, Africa-Europe, and the Americas, the courses are intended to rapidly build advanced delivery capacity over a one-month timespan for national climate planning and adaptation teams. Courses with coordinated curricula and learning objectives should begin in 2021, under a five-year commitment. Major Course Topics are anticipated to include: Planning; Policy Frameworks; Governmental Coordination (across ministries and governance levels); Private Sector Engagement; Finance and Cost-Benefit Analyses; Ecosystems; Infrastructure; Transboundary Considerations; and Equity Issues (social, gender, and cultural).

In working at a high level with government representatives, the project aims to greatly influence climate and water activities in the long-term and at a globally relevant scale.

Crowdsourcing a New Wave of Climate-Water Efforts

For others looking to learn more about new best practices for climate-resilient water management, a number of resources are available. AGWA created a Knowledge Platform for capacity building around the latest climate adaptation methodologies (*see* https://AGWAguide.org/). Publications, training materials, case studies, and a climate-water podcast are all hosted on the web-based platform. New resources are added often.

Conclusion

Finally, AGWA is a members-based network. Anyone working around or interested in climate and water is encouraged to join and sign onto its mailing list (*see* https://alliance4water.org/get-involved/). Topical newsletters are available on policy and governance, technical approaches and risk assessment methodologies, and general climate-water news. Each also includes noteworthy resources, opportunities, and news.

The secretariat works with members across the network through crowdsourcing knowledge products and publications, joint project development, and other collaborative efforts. You're encouraged to join a network of professionals already nearly 2,000-strong as we work to achieve climate resilience through water.

For Additional Information:

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John Matthews is the co-founder and Executive Director of the Alliance for Global Water Adaptation. His work blends technical and policy knowledge for climate adaptation and water management for practical implementation, primarily targeting decision-making frameworks for adapting water infrastructure and ecosystems to climate impacts. He holds a PhD from the University of Texas at Austin.

Alex Mauroner is the Network Director at the Alliance for Global Water Adaptation, where he supports capacity building initiatives for new approaches to addressing risks in addition to network-wide collaboration with AGWA's 1800+ members. He holds a Professional Science Master's in Environmental Science and also hosts the "ClimateReady" podcast.

WATER BRIEFS

COVID-19 OPERATIONS **US**

EPA RESOURCES

On March 27, EPA) Administrator Wheeler sent a letter to Governors in all 50 states, territories and Washington, D.C. urging them to ensure that drinking water and wastewater employees are considered essential workers by state authorities when enacting restrictions such as shelter in place orders to curb the spread of COVID-19. Supporting water utilities as they work to provide clean water for drinking and handwashing is essential during the COVID-19 pandemic.

EPA has also posted new information and resources that water stakeholders-including states, municipalities, utilities and their work force can use to support operations during the pandemic. [*See* www.epa.gov/coronavirus/water-utility-resources-covid-19-pandemic]. For example, on the website, the agency is summarizing resources that can support utilities, including by helping maintain adequate staffing and laboratory capacity. Included in the materials is an incident action checklist to support water utilities as they prepare for, respond to, and recover from a pandemic. While most water systems already have continuity plans in place as part of best-management practices, EPA recommends that states work with their utilities to review these plans and to keep up with the latest announcements on COVID-19.

EPA supports states and cities that are taking proactive measures to ensure continued access to clean water during the COVID-19 pandemic. Many drinking water systems are discontinuing service cut-offs, restoring service to customers whose service was previously cut-off, and refraining from imposing penalties for nonpayment. EPA recommends widespread adoption of these practices, which provide critical support for public health.

For info: EPA website at: www.epa.gov/coronavirus

EPA ENFORCEMENT **US**

CORONAVIRUS SUSPENSION

In a Memorandum dated March 26 from Susan Parker Bodine, EPA's top compliance official, EPA announced its decision to suspend enforcement of certain environmental laws and regulations during the coronavirus outbreak. Bodine referred to the need for EPA to "…adjust to the evolving COVID-19 pandemic" and then announcing the "temporary policy regarding EPA enforcement of environmental legal obligations during this time." Meanwhile, a coalition of environmental groups sent a letter to the agency objecting.

The Memorandum changes normal procedures that apply to pollution noncompliance. "The EPA will exercise the enforcement discretion specified below for noncompliance covered by this temporary policy and resulting from the COVID-19 pandemic, if regulated entities take the steps applicable to their situations, as set forth in this policy. For noncompliance that occurs during the period of time that this temporary policy is in effect, and that results from the COVID-19 pandemic, this policy will apply to such noncompliance in lieu of an otherwise applicable EPA enforcement response policy."

The new policy will apply retroactively beginning on March 13, 2020. Bodine's Memorandum also notes that, "Authorized states or tribes may take a different approach under their own authorities."

The seven-page Memorandum ends with the EPA general viewpoint of this temporary policy. "This temporary policy makes EPA offices and the EPA's governmental and private sector partners, as well as the general public, aware of how the EPA intends to exercise its enforcement discretion with respect to certain compliance situations during the exigencies of the COVID-19 pandemic. This memorandum does not alter any provision of any statute or regulation that contains legally binding requirements, and it is not itself a regulation."

Readers should refer to the Memorandum for a more specific idea of how it applies to the particular situation or regulated industry.

For info: Memorandum available at: https://www.epa.gov/sites/production/files/2020-03/documents/oecamemooncovid19implications.pdf

WOTUS RULE **US**

SCIENCE BOARD CRITIQUE

EPA's own Science Advisory Board (SAB) heavily criticized the proposed "Waters of the United States" (WOTUS) rule in a comment letter submitted February 27th. For additional information, *see* TWR's previous Water Brief on the draft SAB comments at Water Briefs, *TWR* #191.

Rebuking the EPA for its proposed rule, SAB's letter began with a succinct statement of what is at stake: "Establishing a sound, consistent, scientifically supported and clear definition of 'waters of the United States' (WOTUS) is a critical component of implementing the [law]… commonly known as the Clean Water Act (CWA). The Act itself does not provide such a definition. Achievement of the Act's overall objective 'to restore and maintain the chemical, physical and biological integrity of the Nation's waters requires a clear definition of the geographic and hydrologic scope of these waters. …The Board concluded that the proposed WOTUS rule does not incorporate best available science and as such we find that a scientific basis for the proposed Rule, and its consistency with the objectives of the Clean Water Act, is lacking."

SAB's eight-page letter is recommended reading for its detailed review of the proposed rule's shortcomings and the basis for SAB's conclusion. The letter ends with a summary of the Board's position: "In summary, current scientific understanding of the connectivity of surface and ground water, which has been reviewed by the SAB previously, is not reflected in the proposed Rule. Specifically, the proposed definition of WOTUS excludes ground water, ephemeral streams, and wetlands which connect to navigable waters below the surface. The proposed Rule does not present new science to support this definition, thus the SAB finds that the proposed Rule lacks a scientific justification, while potentially introducing new risks to human and environmental health."

The final rule has been labeled by the agencies as the "Navigable Waters Protection Rule."

For info: SAB Letter available from: https://yosemite.epa.gov/sab/sabproduct.nsf/WebBOARD/ (*Search*: "epa-sab-20-202")

INSTREAM FLOWS **CO**

NEW LEGISLATION

On March 30, the Colorado Water Trust (CWT) issued a press release heralding two new bipartisan bills that will help restore river water. HB 20-1037, the instream flow augmentation bill, will facilitate court-approved plans under which water users can add water back into heavily used rivers

under the auspices of the Colorado Water Conservation Board (CWCB). Water added back to the river will be protected as "instream flow," or water that is designated for environmental purposes, but other water users can continue to divert water from the river for consumptive uses like agriculture and municipal delivery just as they always have. It's a new concept using augmentation plans for instream flow and required clarification of old law.

HB 20-1157, the instream flow loan bill, will add tools to a loan program that the CWCB has managed for some time. Previously, a water user could only loan their water right to CWCB to be used for instream flow use in 3 out of 10 years. This legislation increases that to 5 out of 10 years. Additionally, in the past, only one ten-year loan period was allowed, but now that loan period can be extended for two additional ten-year periods. In sum, a water user can now loan their water to the CWCB for up to fifteen out of thirty years. According to CWT, what the legislation boils down to is a big benefit to aquatic environments and flexibility for water users who want to engage in this program, often for compensation.

For info: Kate Ryan, CWT, 720/ 570-2897, kryan@coloradowatertrust.org or http://coloradowatertrust.org/

REUSE ACTION PLAN US

EPA RELEASE

On February 27, EPA and other federal, state, and local water leaders announced the release of the *National Water Reuse Action Plan: Collaborative Implementation (Version 1)*. The National Water Reuse Action Plan (WRAP) is a coordinated and collaborative effort across the water user community to advance consideration of water reuse to ensure the security, sustainability, and resilience of our nation's water resources. Safe and reliable water supplies for human consumption, agriculture, business, industry, recreation, and healthy ecosystems are critical to our nation's communities and economy. Water reuse can improve the security, sustainability, and resilience of our nation's water resources, especially when considered at the watershed or basin scale.

The Action Plan builds on more than four decades of water reuse experience and practice in the United States. It frames the business case that water reuse is a viable and growing means of supporting our economy and improving the freshwater portfolio of farmers, industry, communities, and ecosystems. The WRAP identifies action leaders, partners, and target completion dates for 37 actions across 11 strategic themes, while generating action through more than 200 initial implementation milestones. These actions represent initial momentum and serve as a catalyst for additional partnerships and subsequent actions to strengthen and diversify the Nation's water resources.

Information for the actions included in the WRAP is available in two forms: Printed Publication: A print version that profiles actions with committed leaders and summary-level information about each action implementation plan; and WRAP Online Platform: A web-based repository that includes all actions (developed and undeveloped) and full action implementation plan text, where applicable. The WRAP Online Platform will undergo routine updates on each action's progress and serve a variety of functions, including communicating ongoing activity and creating accountability for action progress.

For info: EPA website at: www.epa.gov/waterreuse/water-reuse-action-plan

SUCTION DREDGE MINING WA

PROHIBITING LAW SIGNED

On March 18, Governor Jay Inslee signed into law a bill (HB 1261) prohibiting suction dredge mining in rivers and streams that provide important habitat for endangered salmon, steelhead, and bull trout. The bipartisan law allows Washington to join other West Coast states in restricting the harmful recreational mining practice. It also requires all suction dredge miners to obtain a water quality permit.

HB 1261, in Section 1, states that the legislature "…finds that Washington state, unlike other states and the environmental protection agency, has taken no action to regulate or limit water quality impacts from motorized or gravity siphon aquatic mining. The legislature also finds that federal courts have determined that discharges from this activity require regulation under the clean water act and…that harmful water quality impacts are occurring in areas designated as critical habitat for threatened or endangered steelhead, salmon, and bull trout, including spawning areas for chinook salmon relied on by southern resident orcas."

Suction dredge mining is a recreational mining practice that vacuums up stream bottoms and riverbeds in search of gold, destroying vital wildlife habitat, increasing sedimentation, and suspending toxic mercury in waterways, according to the Center for Biological Diversity (CBD).

Washington's new law follows in the footsteps of California, Idaho, and Oregon, as well as other western states, in putting reasonable measures in place to protect fish and water quality from the damaging form of mining. Washington has spent nearly $1 billion to restore salmon habitat in the state, but previously the state did not have measures in place to track and prevent suction dredge mining's impact to salmonids and their habitat.

For info: HB 1261 available from: https://apps.leg.wa.gov/billinfo/; Sophia Ressler, CBD, 206/ 399-4004, sressler@biologicaldiversity.org or https://biologicaldiversity.org

WATER USE MITIGATION WA

WATER RIGHT PURCHASE

The Washington Department of Ecology (Ecology) announced that as part of Ecology's commitment to find water solutions for Skagit Basin landowners, water is now available for some landowners in Skagit and Snohomish counties affected by a 2013 state Supreme Court ruling. On October 3, 2013, the Washington State Supreme Court ruled in *Swinomish Indian Tribal Community v. Department of Ecology* that Ecology exceeded its authority in establishing water reservations. [*See* https://ecology.wa.gov/Water-Shorelines/Water-supply/Protecting-stream-flows/Instream-flow-implementation/Skagit-River-basin-projects]. A new continuous release of water into the Skagit River also provides additional water for fish in the river. For additional information about the *Swinomish* case and mitigation programs, see Water Briefs, *TWR* #117 and Sessions & Christensen, *TWR* #175.

The Skagit River Basin Mitigation program, established by Ecology, provides a legal right to water for approximately 340 affected landowners who did not have a legal water source for nearly seven years. It also provides water for limited new domestic uses in Skagit County. To establish this mitigation program, in 2019 Ecology agreed to purchase water from Seattle City Light near Newhalem, in the upper

WATER BRIEFS

Skagit River watershed. The purchased water is tied to a senior water right owned by Seattle City Light and used at their Skagit River Hydroelectric Project.

Ecology will work directly with affected landowners to provide documentation that records their legal water source and partner with Skagit County to provide documentation needed for county building permits. The program is part of Ecology's ongoing water supply work in the Skagit basin. Ecology continues to look for opportunities to implement long-term water solutions in the Skagit River Basin through collaboration with watershed partners.

For info: Keeley Belva, Ecology, 360/ 480-5722, keeley.belva@ecy.wa.gov or https://ecology.wa.gov/

TRANSFER OF FACILITIES US RECLAMATION TITLE

On March 23, the US Bureau of Reclamation (Reclamation) released its final guidelines to streamline the transfer of eligible Reclamation facilities to local ownership. Title transfer is a voluntary conveyance of federal ownership of water projects or facilities, such as small dams, canals and associated lands, to local water users. Local ownership can leverage more capital funding and reduce federal paperwork requirements and costs while reducing federal liability. "This Administration's title transfer process embodies the President's goals of streamlining bureaucratic processes and making our government more efficient and accountable," said Secretary of the Interior David Bernhardt. "Title transfers are a win for local communities and a win for the American taxpayer. The Department looks forward to continuing our work with local water users to reduce title transfer costs, stimulate infrastructure investment through local ownership with the bottom-line goal of making this streamlined approach a major success."

The title transfer streamlining guidelines will complement this Administration's Categorical Exclusion (CE) process under the National Environmental Policy Act (NEPA). The title transfer CE lists criteria that will determine if simple or uncomplicated facility transfer can be expedited under NEPA. Reclamation, water users and other stakeholders are already working together on pending title transfers across the western states. The John D. Dingell, Jr. Conservation, Management and Recreation Act (P.L. 116-9) gives Reclamation the programmatic authority to transfer title of certain Reclamation facilities without additional authorizing legislation. Each title transfer is voluntary and done on a case-by-case basis.

These guidelines, called directives and standards, can be found on the Reclamation Manual site at www.usbr.gov/recman. To learn more about the title transfer process, contact your regional title transfer coordinator by visiting www.usbr.gov/title.

For info: Linda Friar, Reclamation, 202/ 513-0544 or lfriar@usbr.gov

PFAS PROGRESS REPORT US SITES ASSESSMENTS INCREASE

In March, the US Department of Defense (DoD) released its "Per- and Polyfluoroalkyl Substances (PFAS) Task Force Progress Report (March 2020)" regarding DoD's response to PFAS contamination at various military sites. "PFAS is a national issue that requires national solutions. PFAS is found in everyday consumer items – from nonstick cookware to water-resistant clothing. DoD's use of PFAS started in the 1970s, with the introduction of aqueous film forming foam (AFFF) for fuel firefighting purposes." Report at 2.

Notable in the Progress Report is the increase in the total number of sites now being investigated by the military for potential releases of PFAS chemicals to 651 sites. "As DoD continues to progress through the cleanup process, the consolidated inventory of DoD and National Guard installations where the Department is performing an assessment of PFAS use or potential release has increased from 401 to 651 as of the end of FY 2019. These installations represent locations where PFAS may have been used or released and further investigations are being conducted. While our initial focus was on installations with potentially significant historic AFFF use, this is a more comprehensive estimate of installations where PFAS may have been used or released. The preponderance of this increase represents smaller installations across the Army and Army National Guard."

For info: Report available from: www.defense.gov/explore/spotlight/pfas/

DAKOTA ACCESS PIPELINE US ORDER TO PREP EIS

On March 25, the United States District Court, District of Columbia (Court), remanded a pipeline access case to the US Army Corps of Engineers and ordered the agency to prepare an Environmental Impact Statement. *Standing Rock Sioux Tribe, et al., v. U.S. Army Corps of Engineers, et al*., Civil Action No. 16-1534 (JEB), 2020 WL 1441923 (3/25/2020). The case involves a segment of the Dakota Access Pipeline running under the Missouri River and to its effects on the Indian Tribes living nearby.

The Court previously held that the agency's decision "not to issue an EIS largely complied with NEPA." *Standing Rock Sioux Tribe v. U.S. Army Corps of Eng'rs* (*Standing Rock III*), 255 F. Supp. 3d 101, 147 (D.D.C. 2017). "Yet there [we]re substantial exceptions" to such compliance, one of which being the agency's failure to address expert comments noting that the pipeline suffered from serious flaws that could result in extensive environmental harm in the event of a spill. *Id*. The Court accordingly ordered the Corps to consider those issues on remand. *Id*. at 160. That remand was completed and the Tribes strongly disagreedwith the Corps' most recent conclusions.

The Court succinctly summarized its decision on the first page: "In analyzing those conclusions, this Court has received significant guidance from a recent case decided by the D.C. Circuit, *National Parks Conservation Association v. Semonite*, 916 F.3d 1075, 1082 (D.C. Cir. 2019). The appeals court there clarified the inquiry to be conducted by a district court when determining whether an agency has adequately dealt with expert criticisms such as these. Applying *Semonite*, this Court ultimately concludes that too many questions remain unanswered. Unrebutted expert critiques regarding leak-detection systems, operator safety records, adverse conditions, and worst-case discharge mean that the easement approval remains 'highly controversial' under NEPA. As the Court thus cannot find that the Corps has adequately discharged its duties under that statute, it will remand the matter to the agency to prepare an Environmental Impact Statement."

For info: Decision at: www.narf.org/nill/bulletins/federal/documents/standingrock_v_usengineers.html

CALENDAR

April 15 WEB
Environmental Compliance and Enforcement During the COVID-19 Pandemic: Live Webinar, WEB. Presented by the Enviromental Law Education Center; 11 am - Noon PST. For info: Holly Duncan, 5023/ 282-5220 or www.elecenter.com

April 16 CA
CLEE Environmental Awards Banquet, Berkeley. Bancroft Hotel. Presented by the Center for Law, Energy + the Environment. For info: www.law.berkeley.edu/research/clee/

April 17-18 OR
Oregon Environmental Justice Pathways Summit, Eugene. University of Oregon: Gerlinger & Straub Halls. Presented by Beyond Toxics & NAACP Eugene-Springfield. For info: https://ejpsummit.org/

April 20 NV
Nevada Water Law Conference, Reno. Peppermill Resort. For info: CLE Int'l, 800/ 873-7130, live@cle.com or www.cle.com

April 21 WEB
Mvoing Towards a Global Awakening? - The Climate & Biodiversity Crisis Event, WEB. Zoom Web Conferencing. Presented by Boulder Faculty Climate Science and Education Committee. For info: https://cuboulder.zoom.us/j/695215622

April 21 TX
9th Annual Gulf Coast Water Conservation Symposium: Integrating Water Management on the Texas Gulf Coast - Moving Forward with a One Water Approach, Houston. United Way of Greater Houston, 50 Waugh Drive, 8 am - 3:30 pm. For info: www.harcresearch.org/sites/default/files/documents/2020_GCWCS_Program.pdf

April 22 WEB
Stormwater Permmitting at Schools and Community Colleges, WEB. Presented by Best Best & Krieger. For info: www.bbklaw.com/news-events/webinars#sortBy=upcoming

April 22-23 CA
WSWC - NASA Western Water Applications Office (WWAO) Research to Operations (R2O) Workshop, Irvine. National Academy of Sciences Beckman Center. Presented by the Western States Water Council. For info: www.westernstateswater.org/upcoming-meetings/

April 22-25 IL
49th Spring Conference - Section of Environment, Energy & Resources, Chicago. Swissotel. Presented by the American BAR Association. For info: www.americanbar.org/groups/environment_energy_resources/events_cle/

April 27-28 MI
Project Management for Water and Wastewater Utilities Workshops, Detroit. DoubleTree by Hilton Detroit Downtown. For info: www.euci.com/events/

April 28 OR
Water Café - Calculating the BPI for the Columbia River Basin (Part II), Corvallis. Oregon State University, 10 am - 12 pm. For info: Lynn Porta, portae@oregonstate.edu

May 5-8 CA
Association of California Water Agencies Spring Conference & Exhibition, Monterry. Monterey Conference Center. For info: www.acwa.com/events/

May 6 TX
Texas Rainmaker Award Dinner - Postponed Until Sept. 16th, Austin. The Bullock Texas State History Museum, 1800 Congress Avenue; 6:30 - 9:30 pm. Presented by the Texas Water Foundation. For info: texaswater.org

May 7-8 NM
Public Land Law, Regulation and Management Conference, Santa Fe. The Eldorado Hotel, 309 W. San Francisco Street. Presented by Rocky Mountain Mineral Law Foundation. For info: www.rmmlf.org/conferences

May 8 CO
POSTPONED -- Native American Rights Fund 50th Anniversary Gala: Celebrating Fifty Years of Fighting for Native Rights, Aurora. Gaylord Rockies Resort & Convention Center. For info: www.narf.org/50thgala/

May 12 WEB
Groundwater Sustainability Plans: What We Now Know and What is Yet to be Learned, WEB. 10-11 am PDT. Presented by Best Best & Krieger. For info: www.bbklaw.com/news-events/webinars#sortBy=upcoming

May 12 WY
Land-to-Sea Stewardship Through Education, Advocacy & Leading by Example - Water Forum, Cheyenne. Water Development Office, 6920 Yellowtail Road, 10 am - Noon. Presented by Wyoming State Engineer's Office. For info: Jeff Cowley, WSEO, 307/ 777-7641, jeff.cowley@wyo.gov or https://sites.google.com/a/wyo.gov/seo/interstate-streams/water-forum Contact RE: Remote Access

May 12-13 NC
Eastern US Annual Power Plant Water Treatment Conference, Charlotte. Crowne Plaza Charlotte Executive Park. For info: https://lmnpower.com/

May 14-15 CA
Western Water Law Conference: Emerging Issues & Concerns, San Diego. US Grant Hotel. For info: CLE Int'l, 800/ 873-7130, live@cle.com or www.cle.com

May 14-15 CA
Clean Water & Wetlands in California Seminar, Los Angeles. DoubleTree by Hilton Los Angeles Downtown. For info: Law Seminars International, 206/ 567-4490, registrar@lawseminars.com or www.lawseminars.com

May 18-20 CA
WSWC-CDWR 2020 Sub-Seasonal to Seasonal Precipitation Forecasting Workshop, San Diego. DoubleTree by Hilton San Diego Downtown, 1646 Front Street. Presented by the Western States Water Council. For info: www.westernstateswater.org/upcoming-meetings/

May 20 WEB
Applying for a WIFIA Loan Webinar, 2:00 - 3:30 pm ET. Presented by EPA. For info: www.epa.gov/wifia

May 21 MT
Conservation Easements Seminar, Bozeman. Best Western Grantree Inn, 1325 N. 7th Avenue. For info: The Seminar Group, 800/ 574-4852, info@theseminargroup.net or www.theseminargroup.net

May 27-28 NM
The Second Colorado River Basin Data and Modeling Roundtable Meeting, Albuquerque. Sheraton Albuquerque Airport Hotel. Hosted by the Western States Water Council. For info: www.westernstateswater.org/upcoming-meetings/

May 28-29 ID
NGWA Workshop on Groundwater in the Northwest, Boise. Boise Watershed Center, 11818 West Joplin Road. Presented by National Groundwater Assoc. For info: www.ngwa.org/detail/event/2020/05/28/default-calendar/20may5043

Note: *Events are being rescheduled, canceled, or adapted online due to coronavirus. Check with event organizers.*

The Water Report
Water Rights, Water Quality & Water Solutions in the West
260 N. Polk Street • Eugene, OR 97402

CALENDAR

(continued from previous page)

May 29 CA
CEQA and the NEPA Re-Write Seminar, San Diego. Latham & Watkins Conference Center. For info: Law Seminars International, 206/ 567-4490, registrar@lawseminars.com or www.lawseminars.com

June 3-5 China
Aquatech China - 13th Edition Trade Show, Shanghai. National Exhibition & Convention Center. For info: Annelie Koomen, 31 (0)20-549 3019 or a.koomen@rai.nl

June 4-5 AZ
Seventh Annual Tribal Water in the Southwest Conference, Scottsdale. We-Ko-Pa Resort & Conference Center. For info: www.lawseminars.com/seminars/2020/20TRIBWAZ.php

June 4-6 India
World Environment Expo 2020 - International Exhibition, Conference & Awards, New Delhi. Pragati Maidan. Concurrent with World Environment Conference (WEC 20). For info: http://worldenvironment.in/

June 9 CO
RESCHEDULED TO SEPT. 15TH -- Riverbank 2020, Denver. Denver Botanic Gardens. Fundraiser for Colorado Water Trust. For info: http://coloradowatertrust.org/riverbank-2020?mc_cid=edac123877&mc_eid=54a069fd94

June 11-12 OR
The Mighty Columbia Conference, Portland. World Trade Center, 121 SW Salmon Street. For info: The Seminar Group, 800/ 574-4852, info@theseminargroup.net or www.theseminargroup.net

June 14-17 CA
ACE20 Conference: Global Water Experts in Every Segment of the Water Industry, Orlando. Orange County Convention Center. Presented by American Water Works Assoc. For info: www.awwa.org/Events-Education/Events-Calendar

June 15-16 CO
Green Infrastructure Course, Denver. EUCI Conference Center. Concepts, Planning & Implementation. For info: www.euci.com/events/

June 18 WA
Celebrate Waters Event, Seattle. Ivars Salmon House. Presented by the Center for Environmental Law & Policy. For info: www.celp.org

June 18-19 MI
PFAS Litigation in the Midwest Seminar, Detroit. Southfield Town Center. For info: Law Seminars International, 206/ 567-4490, registrar@lawseminars.com or www.lawseminars.com

June 22-23 WA
Tribal Consultations Seminar, Seattle. 901 Fifth Avenue Building. RE: Conducting Projects Effecting Tribal Lands. For info: www.LawSeminars.com

June 22-23 ND
Bakken Oil & Gas Shale Water Management 2020: Cost-Effective Water Strategies for North Dakota Exhibition & Conference, Williston. TBD. For info: www.bakken.shale-water-management.com/?join=VR

June 25-26 WA
Water Law in Washington Seminar, Seattle. Westin Seattle Hotel. For info: Law Seminars International, 206/ 567-4490, registrar@lawseminars.com or www.lawseminars.com

June 28-July 2 ND
Western Governors' Association 2020 Annual Meeting, Medora. TBA. For info: https://westgov.org/