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**Incorporating Equity and Social Dimension
into Community Climate Adaptation
Planning and Watershed Management:
A Review of the Literature and Resources**

Incorporating Equity and Social Dimension into Community Climate Adaptation Planning and Watershed Management: *A Review of the Literature and Resources*

Prepared by:

Linnea Warren May, Michelle Miro, Loveline Phillips
RAND Corporation

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For more information, contact:

The Water Research Foundation

1199 North Fairfax Street, Suite 900
Alexandria, VA 22314-1445
P 571-384-2100

6666 West Quincy Avenue
Denver, Colorado 80235-3098
P 303-347-6100

www.waterrf.org
info@waterrf.org

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Research Team

Principal Investigators:

Linnea Warren May, MPH

Michelle Miro, PhD

RAND Corporation

Project Team:

Loveline Phillips, MS, MPhil

Lena Easton-Calabria, MSc

Krista Romita Grocholski, PhD

Alexandra Ntazinda, MPH, MPhil

RAND Corporation

WRF Project Advisory Committee

Alan Cohn, MS

New York City Department of Environmental Protection

Pinar Balci, PhD

New York City Department of Environmental Protection / WSP USA Inc.

Liliana Malesevic, MS

EPCOR

Juli Beth Hinds, AICP

UC-San Diego

Jill Oropeza, MS

City of Fort Collins

Ciara Clark, MA, MPA

City of Houston

Participating Utilities and Organizations

Baltimore City Department of Public Works (Baltimore DPW)

California-Nevada Applications Program (CNAP)

Carolinas Collaborative on Climate, Health, and Equity (C3HE)

Great Lakes Integrated Sciences and Assessments (GLISA)

Houston Water

Louisville Metro Sewer District (MSD)

Massachusetts Water Resources Authority (MWRA)
Metropolitan Water Reclamation District of Greater Chicago (Chicago MWRD)
Milwaukee Metropolitan Sewerage District (MMSD)
Pittsburgh Water and Sewer Authority (PWSA)
Salt Lake City Department of Public Utilities (SLCDPU)
Santa Ana Watershed Project Authority (SAWPA)
South Florida Water Management District (SFWMD)
Western Water Assessment (WWA)

Technical Advisory Committee

Kelly Spencer, MS
Baltimore City Department of Public Works (Baltimore DPW)

Lolita Thompson, PE
Metropolitan Water Reclamation District of Greater Chicago (Chicago MWRD)

Ekaterina Fitos, GISP, MBA, MA
Houston Water

Kellie Watson, JD
Louisville Metropolitan Sewer District (MSD)

Peter Coffaro, MPA, MBA
Milwaukee Metropolitan Sewerage District (MMSD)

Anthony Igwe, MS, MDiv
Pittsburgh Water and Sewer Authority (PWSA)

Holly Lopez, MPP
Salt Lake City Department of Public Utilities (SLCDPU)

Jeff Mosher, MS
Santa Ana Watershed Project Authority (SAWPA)

Nicole Cortez
South Florida Water Management District (SFWMD)

WRF Staff

Harry Zhang, PhD, PE
Research Program Manager – Integrated Water and Stormwater

Pam Prott
Project Coordinator

Megan Karklins
Communications & Marketing Manager

Angelina Dinsmore
Content Lead

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Acronyms and Abbreviations

BET	Branch Equity Team
BRIC	Building Resilient Infrastructure and Communities
BSB	Beckley Sanitary Board
CDC	Centers for Disease Control and Prevention
CEJST	Climate and Economic Justice Screening Tool
CEQ	Council on Environmental Quality
CAP	Customer Assistance Program
CASPER	Community Assessment for Public Health Emergency Response
CEED	Center for Earth Energy & Democracy
CWSRF	Clean Water State Revolving Fund
DCI	Disadvantaged Community Involvement
DEI	Diversity, equity, and inclusion
DWM	Department of Watershed Management
DWR	Department of Water Resources
DWSRF	Drinking Water State Revolving Fund
DWW	Drainage and Wastewater
EFC	Environmental Finance Centers
EIB	Environmental impact bonds
EJ	Environmental justice
EJSE	Environmental Justice and Service Equity
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FPA-East	Flood Protection Authority-East
GSI	Green stormwater infrastructure
IRWM	Integrated Regional Water Management
LIHEAP	Low Income Home Energy Assistance Program
MMSD	Milwaukee Metropolitan Sewerage District
MSD	Metro Sewer District
MMW	Milwaukee Water Works
MWBE	Minority-owned and women-owned business enterprise
NEORS	Northeast Ohio Regional Sewer District
OEHHA	Office of Environmental Health Hazard Assessment
PAB	Project Advisory Board
PAC	Project Advisory Committee
PCWA	Piney Creek Watershed Association
PWD	Philadelphia Water Department
PWSA	Pittsburgh Water and Sewer Authority

RSE	Racial and Social Equity
SAV	Submerged aquatic vegetation
SAWPA	Santa Ana Watershed Project Authority
SFPUC	San Francisco Public Utility Commission
SPU	Seattle Public Utility
SRF	State Revolving Fund
SVI or SoVI	Social Vulnerability Index
TBL	Triple bottom line
WIFIA	Water Infrastructure Finance and Innovation Act
WIOA	Workforce Investments Opportunity Act
WRF	The Water Research Foundation
WSAC	Water Supply Advisory Committee
WUCA	Water Utility Climate Alliance

Executive Summary

ES.1 Key Findings

- Dimensions and definitions of equity and “water equity”: Water sector conceptualizations of water equity have evolved to encompass not only distributional equity but also procedural and contextual elements, including community voice and cultural and historical context. Water utilities are taking steps to address these elements of equity, such as vulnerability assessments to identify areas and populations at higher risk of water-related hazards, community engagement, inclusive workforce development, and comprehensive approaches to measure and address the distribution of costs and benefit of water management.
- Water management: The research team examined equity-related literature around five main functions of water management, derived from the Water Research Foundation (WRF) and Water Utility Climate Alliance (WUCA)-supported work on water utility business functions: i) drinking water; ii) water supply; iii) wastewater; iv) water/environmental monitoring and management; and v) stormwater management. Of these, equity-related work is relatively more developed for drinking water and stormwater management functions, with less literature equity related to wastewater, water supply and water/environmental monitoring and management.
- Water utility needs: There are several funding streams available to support utilities aiming to integrate equity considerations into their operations and planning processes, but very few case studies on how utilities have leveraged funding other than operational funds. The literature is rife with examples of utilities collaborating with partners, ranging from academic organizations, to community-based non-profits, to other public sector entities to contribute resources, in-kind support, and capacity; help secure additional funding; and support relationships and engagement with residents.
- Existing resources: There is a large set of existing national, state, and local-level datasets available to water utilities for equity planning and measurement purposes. There are a handful of existing guidebooks available to utilities, some focused on equity in water management (primarily related to stormwater management), a few focused on other aspects of water management that could have equity applications, and others focused generally on equity (particularly racial equity) in organizational practices and local policies and decisions.

ES.2 Background and Objectives

Legacies of disinvestment and discriminatory policies have led to climate change disproportionately affecting communities of color and low-income communities, with barriers to participation in climate adaptation planning and programs exacerbating the issue. Equity-oriented climate-related water resources management and planning must consider both who is impacted by the problem and the solutions, as well as how well they are included in decision making and implementation processes. However, doing so requires a new paradigm, and many water managers lack tools to incorporate social dimensions and equity into their planning and management decisions. Effective guidance is needed to support utilities in selecting

appropriate goals, activities, and measures related to their efforts to embed equity considerations in holistic watershed management in a way that is *evidence-based, action-oriented, and relevant* to their community context.

This project is aimed at enhancing the capacity of water utilities and water resources practitioners to meaningfully integrate equity into watershed planning and management. To achieve this objective, the research team synthesized findings from a range of inputs: recent peer-reviewed research, report, and case studies (described in this literature review); real-world experience among utilities (gathered through consultations and a national survey); and workshop discussions with water resources practitioners and experts. The outcome of this work is an action-oriented guidebook—featuring case studies, measures, and metrics—for water utilities and watershed management organizations who seek to integrate equity and social dimensions into community climate adaptation planning and holistic water resources management.

The goal of the literature review was to identify what best practices and approaches to integrating equity considerations into water management are widely recommended and/or have shown promise among case studies. The research team also aimed to identify gaps in existing literature that could be filled through the upcoming practitioner interviews and survey.

ES.3 Project Approach

To achieve these objectives, this project will carry out: i) an interdisciplinary literature and case study review (this document); ii) interviews with utility partners, community-based organizations, and other stakeholders; iii) a national survey of utilities; iv) the development of an action-oriented guidebook; v) a virtual workshop; and vi) outreach and dissemination. Together, these will come together to create a guidebook that is the direct product of inputs, experience and guidance from practitioners and thought leaders, as well as create supporting materials and activities to improve its usability.

This document is focused on the interdisciplinary literature and case study review, which involved a comprehensive approach to gather relevant information on the topic of water utility considerations of equity and social dimensions in water management. The review began by searching clearinghouses, such as academic databases and government websites, to identify relevant literature. A snowball approach was also used, where references from identified documents were examined to find additional relevant literature. The research team also collected and reviewed other equity-related guidebooks targeted at the water sector, or more broadly for utilities, municipalities, or infrastructure owner-operators. Finally, documents were gathered from the Project Advisory Committee (PAC) and Project Advisory Board (PAB), focusing on those documents that PAC and PAB members felt had been most useful in their own work. The documents were analyzed using a thematic approach, whereby key themes and issues related to water equity were identified and synthesized. The use of multiple methods to gather documents ensured that a comprehensive and diverse range of literature was included in the review.

ES.4 Benefits

For water leaders to more holistically integrate equity considerations into water resources planning and management, sector-relevant guidance, tools and resources are needed. The findings from this initial phase of our work have focused on synthesizing existing best practices; guidebooks, datasets, and other resources; and case studies that could form a foundation for the guidebook being developed in this work. Nearly all findings are relevant to the operations of water utilities, as our findings point to a large body of existing tools and resources and funding streams and reflects progress made in this sector on defining and refining the concept of water equity. The research team also noted areas where the water sector could additionally benefit from the tools and resources to be developed in this project. Specifically, some functions within the water sector, including water supply, wastewater, and monitoring-related activities have relatively less experience and literature to support water leaders in integrating equity considerations. Existing resources are more geared towards and relevant to higher-capacity institutions and that there is a need for resources and guidance materials that can be used across a broader range of resource levels.

CHAPTER 1

Introduction

Climate change poses disproportionate impacts on communities of color and low-income communities (U.S. Environmental Protection Agency 2021a). While these and other populations facing social vulnerability have been and are more likely to bear the brunt of natural hazards affected by climate change, they are also less able to prepare for such events in the future (U.S. Environmental Protection Agency 2021a). Legacies of disinvestment also exaggerate these effects. High-profile water crises such as those in Flint, MI or Jackson, MS, have cast environmental injustices in stark relief and further degraded public trust in utilities (Bosman 2016). In addition to the unequal distribution of impacts, there are also barriers that limit participation of socially vulnerable community members in climate adaptation planning and programs. For example, green infrastructure programs, residents with lower incomes are generally less reached (Mason, Ellis, and Hathaway 2019).

Water agencies and utilities find themselves at the confluence of these challenges. They face increasing costs due to the impacts of climate change on water systems, coupled with deferred maintenance in many post-industrial communities. This has forced utilities to make tough decisions about how to finance infrastructure investments. But this decision making is not simple, even in contexts where stakeholders have agreed upon climate and resilience goals. For example, investments intended to meet some community resilience goals (e.g., green infrastructure) may have unintended consequences for social equity (e.g., green gentrification and displacement).

Equity-oriented climate-related planning must consider both who is impacted by the problem and the solutions, as well as how well they are included in decision making and implementation processes. However, doing so requires a new paradigm, and many water managers lack tools to incorporate social dimensions and equity into their planning and management decisions. For utilities to balance equity with climate adaptation and watershed management trade-offs, they must move past traditional approaches to watershed management or historical drivers of decision making, such as cost-benefit analyses (Kronenberg et al. 2021).

Although the disproportionate impacts of climate change on communities are a key motivation for this work, the focus is on generalizable aspects of water resources planning and management, rather than specific climate adaptation functions and services. This is because utilities need to take a broader perspective on institutionalizing equity within their organizations, processes, and services to meaningfully integrate equity considerations into climate adaptation planning.

1.1 Emerging Paradigms in Water Resources Management and Planning

Over roughly the past decade, the role of local governments, agencies, utilities, and others in decisions that impact equity has come into focus. Tools and support for local policymakers have

proliferated, such as the use of an “equity lens” when evaluating the potential impacts of new policy. Federal actions such as the Justice40 initiative for environmental justice require different decision-making bodies, including water utilities, to consider the impact of decisions on “disadvantaged communities” and these initiatives influence the distribution of federal funding, including new infrastructure and pandemic recovery funds.

Specific to water equity, national networks have established some principles that elucidate emerging paradigms for the water sector, such as the US Water Alliance’s “Pillars of Water Equity”: “water equity occurs when all communities: 1) Have access to safe, clean, affordable drinking water and wastewater services; 2) Share in the economic, social, and environmental benefits of water systems; and 3) Are resilient in the face of floods, drought, and other climate risks” (U.S. Water Alliance 2022). There is also a developing movement for water utilities to embrace their role as anchor institutions in communities, investing in ways that consider long-term equity and economic and social vitality of the communities where they work (U.S. Environmental Protection Agency 2021b). Given the variety of emerging guidance, utilities have questions about how to identify localized goals that align with principles and measure progress toward them, all while working within local context and capacity.

1.2 Water Sector Needs for Centering Equity

Recent research has highlighted the needs of actors, including climate adaptation planning professionals and utilities, in adapting to these emerging paradigms for decision-making. Stakeholders have expressed uncertainty in how the benefits promised under Justice40 will be measured and who will be responsible for measurement and accountability for meeting the initiative’s goals (Fu, Williams, and Shipp 2022).

For those who are interested in meeting (or required under local ordinances to meet) equity goals, there are a number of questions that they will need to answer, including the parameters of equity: Equity in *what*, for *whom*, and *why* does it matter (McDermott, Mahanty, and Schreckenber 2013)? Determining these parameters is critical for understanding what needs to be measured and how it should be communicated. The content or “what” of equity is broken down into three elements: Contextual equity (the extent to which preexisting political or socioeconomic conditions limit or enable people's capacity to engage in and benefit from resource distributions); Procedural equity (reflects the decision making processes or rules, and the extent to which the process recognizes different groups to ensure their inclusion or representation); and Distributive (refers to how costs, risks, and benefits are allocated or distributed across society; distribution can be based on equality, need, merit, etc.) (McDermott, Mahanty, and Schreckenber 2013).

There are other dimensions of equity covered in the environmental and climate literature, namely *structural*, *epistemic* and *trans/intergenerational* equity. Structural equity refers to the historical, cultural, and institutional dynamics that routinely reinforced patterns of privilege and disadvantage and resulted in cumulative disadvantage for marginalized groups (Foster, Shaver, and Greene 2022). Epistemic equity refers to equity in knowledge generation or the ability to of all populations to both be heard and contribute to policies, processes, and other forms of decision making, as well as the capacity of institutions to incorporate and respond to their

contributions (Fricker 2007). Transgenerational equity refers to the just distribution of resources across generations. These dimensions are important considerations for long-term environmental planning and intersect in some ways with procedural, structural, and distributional equity considerations. In this work, the research team focused on the latter three dimensions given their widespread use in water and environmental contexts.

The “who” of equity is also relevant to determine target populations, as well as social and spatial scales at which equity will be measured. And finally, the “why” of equity – whether it be to do no harm, or to move to a situation where group membership does not determine experiences or outcomes – will have implications for the most appropriate tools and measures to use.

A recent qualitative study of perceptions of community-based stakeholders implementing environmental justice programming found that while tools and data for decision-making were available (e.g., Climate and Economic Justice Screening Tool, EJScreen, CalEnviroScreen), “guidance on how to use these tools to assess risk, allocate benefits, and supplement with hyperlocal knowledge of hazards, priorities, and stakeholder capabilities may be especially useful to municipalities implementing programs” (Siddiqi et al. 2022). Moreover, a RAND review of existing equity indicators uncovered a number of limitations to their use, including challenges with topical specificity (i.e., indicators developed for one sector are difficult to apply to another), mixing and matching of data at different geographic scales and representing different time periods, and measures of social vulnerability standing in for measures of equity, though the concepts are theoretically distinct (Finucane, Warren May, and Chang 2021b).

A growing portfolio of work has illustrated the value of community-engaged planning approaches to address environmental equity and has explored the needs of utilities making decisions that consider equity. For example, in the process of developing an environmental racism tool illustrating how discriminatory practices in past urban planning and housing policies have contributed to environmental inequities in cities today, researchers conducted literature and policy reviews, as well as community consultations with groups who working to advance environmental justice (RAND Social and Economic Well-Being Division 2022). These consultations underscored the importance of genuine community engagement in planning processes, something that practitioners will need to consider as they refine their equity-oriented planning processes. Additionally, recent work funded by Southern California Edison to support the development of equity metrics for the electricity sector highlighted the important role of community context in choosing equity goals, as well as considering goals that touch on contextual, procedural, and distributional equity (Kalra et al. 2022).

1.3 An Action-Oriented Guidebook

Utilities attempting to responsibly manage the effects of climate change on their systems are increasingly recognizing the potential for an uneven distribution of benefits and costs in their jurisdictions. Existing conditions, exacerbated by climate change, put pressure on natural systems, infrastructure and people in ways that are often interdependent and context-specific. Vulnerability assessments and multi-benefits assessments have emerged as important tools for incorporating social considerations in climate adaptation planning and utilities management

alongside cost-benefit analyses. The extent to which these tools are used to guide actions that balance social inequalities and improve community resilience depends on how the assessments are conducted, the use of assessment findings in plans and projects and integration into goal-setting and evaluation, and socialization of these processes and outcomes with stakeholders. Across the United States, there are examples of utilities and local government agencies that have established processes for incorporating equity as they pursue multiple objectives and regulatory compliance. However, this is not yet widespread.

It is also clear that effective guidance is needed to support utilities in selecting appropriate goals, activities, and measures related to their efforts to embed equity considerations in holistic watershed management in a way that is *evidence-based*, *action-oriented*, and *relevant* to their community context. This effort is thus geared towards developing a guidebook to help to fill gaps and supplement utility capacity to integrate equity and social dimensions into planning by walking practitioners through: i) the process of developing a framework, ii) selecting measures and metrics, iii) evaluating local leadership and capacity, iv) linking guidance with available tools and resources, and v) presenting lessons from the field as illustrated in case studies from around the country.

1.3.1 Examining the Current State of the Science and Practice

As a first step in developing this guidebook, the research team examined the current state of science and practice through a comprehensive literature and document review. There has been considerable growth in recent years in efforts to document and disseminate equity-oriented processes and projects by utilities and municipal authorities. For example, in climate action planning, in 2021, two leading clearinghouses launched equity portals that house thousands of reports and exemplary policies that address equity in climate change adaptation and mitigation (Georgetown Climate Center’s Adaptation Clearinghouse State of California Office of Planning and Research’s ResilientCA (Georgetown Climate Center 2022; State of California Office of Planning and Research 2022)). To support the overall review, the research team reviewed articles, reports, and tools from state, regional, and local government entities; consultants, research, and community-based organizations; academic and gray literature; as well as previous WRF publications. In addition, the research team identified and catalogued case studies to illustrate effective strategies, approaches, and success stories in practice.

The objectives of this literature review are to: i) characterize the current state of science and practice; ii) identify areas that are undeveloped in existing literature and documentation that can be the focus of interviews or survey work (upcoming tasks in this project); iii) draw out key principles and practical steps for water sector leaders that can guide them in integrating equity into their work. The literature review findings will serve as the foundation for the guidebook and are described in this document. The remainder of the report is organized as follows:

- Chapter 2: Methods
- Chapter 3. Equity Overview
- Chapter 4: Equity and Water Resources Management
- Chapter 5: Funding, Capacity, and Collaboration Requirements
- Chapter 6: Existing Guidebooks, Measures, Metrics, Data, and Tools

CHAPTER 2

Methods

The literature and case study review involved a comprehensive approach to gather relevant information on the topic of utilities considerations of equity and social dimensions in water management. The review began by searching clearinghouses, such as academic databases and government websites, to identify relevant literature. In addition to specific themes related to water equity and water resources planning and management (e.g., co-benefits, equity and green infrastructure), the literature review also investigated sources that characterize cross-cutting issues, such as the nature and extent of governance challenges in achieving more equitable outcomes in watershed management, new ways that federal programs are being tailored to address local needs, and unexpected externalities that arise. A snowball approach was also used, where references from identified documents were examined to find additional relevant literature. In addition, documents were gathered from experts and stakeholders in the field of water equity, leveraging the project advisory board and committee members. Importantly, while the review was systematic and the product useful for the research community, this task was conducted through the lens of relevance to the main deliverable for this project, which is intended for practitioners. The review continued until saturation was reached, meaning that no new documents or themes were identified.

Overall, the review included a total of 176 documents derived from academic articles, reports, and case studies. The documents were analyzed using a thematic approach, where key themes and issues related to water equity were identified and synthesized. These themes were used as an organizing framework for this document and included: i) dimensions of equity (Chapter 3) – contextual, procedural, distributional; ii) elements of water resources management (Chapter 4) – administration/operations, drinking water, water supply, wastewater, stormwater, water/environmental quality monitoring and management; iii) water sector needs (Chapter 5) – funding, capacity, collaboration; iv) equity resources (Chapter 6) – existing guidebooks, and measures, metrics, data, and tools.

The team will use the literature review and case studies to: i) develop an approach to organizing the interactive guidebook; ii) identify key measures, metrics, data, and tools to feature in the guidebook; iii) select case studies that align with the framework and resources to be featured in the guidebook; and iv) identify key limitations and caveats to available approaches and resources (e.g., what these approaches—and water management, broadly—can and cannot do with respect to impacts on broader population health and equity). This synthesis will be written to be of use to water leaders that are taking stock of how their goals, projects and performance indicators address equity, those that have decided to embark on equity-oriented planning, and those that are already engaged in growing their equity focus and desire to learn from counterparts working to address similar issues.

CHAPTER 3

Equity Overview

This chapter provides an overview of the dimensions of equity, definitions of water equity from the literature, and a description of the ways that water utilities are operationalizing the different dimensions of equity in their water management processes and decisions.

Although it may seem that questions of equity in policy and decision-making are of recent interest, the concept of social equity dates to Aristotle and Plato. The consideration of equity has been a pillar of public administration in the United States since the 1960s and 1970s, particularly as relevant to questions of racial justice and civil rights through the Civil Rights act of 1964, as well as equity in access to education through the creation of the federal Head Start program, for example (Wooldridge and Bilharz 2017).

The national environmental justice (EJ) movement in particular has its origins in the late 1980s when the study *Toxic Waste and Race* exposed the disproportionate environmental and health burdens faced by minority and low-income communities (Chavis 1987). Not long after the release of the study, in 1991 the First National People of Color Environmental Leadership Summit convened in Washington, DC to focus national attention on the problem and advocate for solutions (U.S. Department of Energy). President Clinton’s 1994 Executive Order 12898 – Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations established EJ offices at the U.S. Environmental Protection Agency (EPA), Department of Justice (DOJ), and other federal agencies (U.S. Environmental Protection Agency 2023g), among other changes to identify and address EJ issues at the federal level.

However, over roughly the past decade, the role of *local* governments, agencies, utilities, and others in decisions that impact equity and environmental justice has come into focus. Organizations like the Government Alliance on Race and Equity have been established to provide tools and support for local policymakers, such as the “equity lens” tool by which jurisdictions utilize data to identify inequitable outcomes (e.g., disproportionate housing cost burden among Black residents) and to identify the ways in which specific decisions contribute to those outcomes (e.g., zoning ordinances that encourage or discourage construction of affordable housing). Recent federal actions such as 2021s Justice40 initiative for environmental justice require different decision-making bodies to consider their roles in the promotion of equity. Justice40 guidance provides examples of “covered programs” across sectors with the opportunity to enhance equity through benefits to and costs borne by “disadvantaged communities”:

*A “covered program” is a Federal Government program that falls in the scope of the Justice40 initiative because it includes investments that can benefit disadvantaged communities across one or more of the following seven areas: **climate change**, clean energy and energy efficiency, clean transit, affordable and sustainable housing, training and workforce development, remediation and reduction of legacy pollution, and the*

development of critical clean water and wastewater infrastructure (The White House 2022).

Stakeholders like water utilities and stormwater management organizations are clearly implicated in the new guidance, which is closely tied to local investments funded federally through the Inflation Reduction Act, the Bipartisan Infrastructure Law, and the American Rescue Plan, in addition to other possible future federal legislation (Fu, Williams, and Shipp 2022). Additionally, regulatory guidance like the U.S. Environmental Protection Agency's (EPA) Integrated Planning Framework for Advancing Climate Resilience and Environmental Justice has been increasingly used in negotiations with regulators, and resources to support these negotiations were described as a critical driver for utilities adopting new planning paradigms (Barr 2022).

Since 2020, there has been a growing interest specifically in *racial* equity in public sector agencies across the United States. The national reckoning on racial justice following the murder of George Floyd and other Black Americans by police has spurred many cities to take a closer look at their policies and practices to address systemic racism. Municipal governments have been implementing a range of initiatives to promote racial equity, including creating equity offices, conducting racial equity impact assessments, and adopting policies to address racial disparities in areas such as housing, education, public safety, and infrastructure (including water management). Many cities have also been engaging with community members and organizations to ensure that their efforts are informed by the needs and perspectives of those most affected by racial inequities.

Recent research has highlighted the needs of stakeholders, including climate adaptation planning professionals and utilities, in adapting to these emerging paradigms for decision-making. Stakeholders have expressed uncertainty in how the benefits promised under Justice40 will be measured and who will be responsible for measurement and accountability for meeting the initiative's goals (Fu, Williams, and Shipp 2022). For those who are interested in meeting (or required under local ordinances to meet) equity goals, there are a number of questions that they will need to answer.

3.1 Dimensions of Equity

The first is a set of fundamental, yet often overlooked, questions: What are the parameters of equity? Equity in *what*, for *whom*, and *why* does it matter (McDermott, Mahanty, and Schreckenber 2013)? Determining these parameters is critical for understanding what needs to be measured and how it should be communicated. The content or "what" of equity is broken down into three elements: Contextual equity (the extent to which preexisting political or socioeconomic conditions limit or enable people's capacity to engage in and benefit from resource distributions); Procedural equity (reflects the decision making processes or rules, and the extent to which the process recognizes different groups to ensure their inclusion or representation); and Distributional (refers to how costs, risks, and benefits are allocated or distributed across society; distribution can be based on equality, need, merit, etc.). Specific questions that water sector leaders will need to answer can be mapped to these elements:

- Contextual: What is the utility’s “equity baseline”? What are existing barriers to achieving equity?
- Procedural: How can community members be engaged in the process of holistic water resources management and climate adaptation? How are community needs and preferences assessed and how representative are those assessments?
- Distributional: Who pays and who benefits from investments in water management? How can more equitable outcomes be achieved?

The “who” of equity is relevant to determine target populations, as well as social and spatial scales at which equity will be measured. Terms such as “underserved,” “vulnerable,” “low-income,” “disadvantaged,” “frontline”, and “environmental justice” community are often used interchangeably in discussions about social equity, but their meanings can vary depending on the context. Utilities may be interested in equity across a watershed or service area, within or between particular neighborhoods, or between racial or economic groups within their community. Each of these target populations will require different approaches to implementation, as well as data and methods of assessment to determine how impacts might be more or less equitably distributed between groups. Additionally, there are various regulatory definitions and references for these terms, which further highlights the need to clarify terminology and define terms wherever possible (Mohnot, Bishop, and Sanchez 2019).

And finally, the “why” of equity – whether it be to do no harm, or to move to a situation where group membership does not determine experiences or outcomes – will have implications for the most appropriate tools and measures to use.

3.2 Definitions of “Water Equity”

While the general parameters of equity will inform the strategies utilities use, there are also considerations in the literature specifically related to “water equity”. Specific definitions of water equity vary:

- The most recent definition provided by the U.S. Water Alliance states that “water equity occurs when all communities have access to safe, clean, and affordable drinking water and wastewater services; are resilient in the face of floods, drought, and other climate risks; have a role in decision-making processes for water management in their communities; and share in the economic, social, and environmental benefits of water systems.”(U.S. Water Alliance 2023a) This is an evolution from the group’s 2017 definition which states that “water equity occurs when all communities have access to safe, clean, affordable drinking water and wastewater services, share in the economic, social, and environmental benefits of water systems, and are resilient in the face of floods, drought and other climate risks.” (U.S. Water Alliance 2023b, 2017)
- Another less recent definition comes from the National Environmental Health Association stating that “water equity is defined as the proportional and equitable distribution of water related to environmental benefits and risks among diverse economic and cultural communities.”(Riggs 2016)
- Utilities themselves have also published definitions of water equity, such as one from the Milwaukee Metropolitan Sewerage District (MMSD) derived from the U.S. Water Alliance

definition: “Water equity is about “just and fair inclusion,” when ALL people have a say in decisions that affect their lives. In the context of “water,” it means: 1) Having access to safe, clean, affordable drinking water and wastewater services. 2) Sharing in the economic, social, and environmental benefits of water systems. 3) Are resilient in the face of floods, drought, and other climate risks.”(Milwaukee Metropolitan Sewerage District 2018)

- And definitions of water equity have been directed at specific utility decisions, such as the River Network and WaterNow Alliance’s definition of equitable water infrastructure *investments*, which are “Directed by the community toward public health and clean, safe, affordable, and accessible water; Distributed intentionally to support low-income and communities of color most at-risk from environmental harms and historic lack of investment; Supportive of the quality and ecological integrity of our streams, rivers, lakes, and other waterways; and Enhance the long-term and technical and fiscal health of water systems and utilities.”(Baer, Koch, and Ingle 2021)

Our review of the literature revealed that definitions of water equity have evolved from primarily considering distributional equity (e.g., are water-related benefits and risks equitably distributed?) to encompass procedural and contextual elements of equity, including not only access to water benefits and risks, but also considering inclusion of community voice in decision-making and recognition of cultural and historical context in decisions. Moreover, communities have different ways of conceptualizing and operationalizing water equity, depending on their unique water-related concerns, community dynamics, and context. The following sections delve into each of these elements of equity as they relate to water management and highlight case studies of utilities that have implemented strategies to integrate considerations of each element of equity into their processes while considering their community context.

3.3 Contextual Equity

Contextual equity is concerned with the extent to which preexisting political or socioeconomic conditions limit or enable people’s capacity to engage in and benefit from resource distributions – the barriers to achieving equity.

3.3.1 Conditions Impacting Contextual Equity in Water Management

Social vulnerabilities and processes have generated inequities in communities, particularly those that are low-income and communities of color. These communities are at a higher risk of water-related hazards due to historical development practices, intentional policies, and market economies. For example, redlining policies in domains ranging from housing to transportation and land use have led to these communities living in low-lying, flood-prone areas with deteriorating infrastructure and aging homes that are less able to withstand storms. Additionally, social, and environmental factors such as lack of social support networks, language barriers, limited access to technology, and medical conditions that reduce mobility can affect a person's ability to prepare for, respond to, or recover from a flooding event. Climate change is also exacerbating existing flooding inequities and leading to migration patterns that reinforce structural inequities (U.S. Water Alliance and The Kresge Foundation 2020).

Furthermore, aging, or inadequate water infrastructure is a challenge in some parts of the country, which have led to decisions with inequitable consequences. For instance, in 2014, the city of Flint, Michigan, switched its water source from Lake Huron to the Flint River to cut costs. However, the new water source was highly corrosive, causing lead from aging pipes to leach into the water supply (U.S. Environmental Protection Agency 2018). Most of the affected population in Flint were low-income, predominantly Black communities. The crisis highlighted the intersection of environmental hazards, infrastructure neglect, and social vulnerabilities, which exacerbated the harmful effects on the community's health and well-being.

Modern water systems are also not equitably available, with some areas of the U.S. entirely lacking centralized water and wastewater systems. Black Americans are more than twice as likely as White Americans to live without modern plumbing. Many rural communities, unincorporated areas surrounding cities, and tribal lands lack centralized water and wastewater infrastructure (U.S. Water Alliance 2017). As an example, California has long grappled with water equity issues, particularly in disadvantaged communities. Many of these communities, primarily composed of low-income and minority populations, faced challenges due to inadequate water treatment facilities and pollution from agricultural runoff, industrial activities, or aging infrastructure. In California's Central Valley, intensive agriculture and water-intensive industries have resulted in groundwater depletion, leading to water shortages for local communities. Many of these communities are low-income and rely on groundwater for their drinking water and agricultural needs. The lack of access to water resources and the environmental consequence of over-extraction exacerbates existing social vulnerabilities in these areas. The issue of groundwater contamination in the Central Valley has been the subject of multiple reports and policy efforts, including a 2013 series of recommendations on nitrate (California State Water Resources Control Board 2020, 2013), among others on 1,2,3-Trichloropropane (1,2,3-TCP) and other contaminants, that have been incorporated into the 2021 Safe Drinking Water Plan for California (California State Water Resources Control Board 2021).

Another important element of contextual equity is acknowledging the history of the relationship between water utilities and communities. Community trust in water utilities has eroded in many communities due to incidents of water contamination, inadequate infrastructure, lack of transparency in decision-making processes, or perpetration of tokenism through inauthentic community engagement efforts. These incidents have eroded public confidence in the ability of water utilities to provide safe and reliable water services and truly incorporate community voice. In many cases, communities that are low-income or communities of color have been disproportionately affected by these issues, leading to concerns about environmental justice (Fernandez-Bou et al. 2021; Karasaki et al. 2023; MCRC 2017). For water utilities, lived experiences of people experiencing these injustices provide critical insight into the context of those who will be affected by decisions made (Matsuda 1987). Moreover, current-day power dynamics often favor communities that are more well-connected, well-represented in decision-making bodies, or who have the resources to advocate for their interests. Power imbalances can also lead to tokenism, where community members are included in the decision-making process only as a symbolic gesture, without any real influence or impact on the outcome. Power dynamics can result in a lack of trust between community

members and decision-makers, which can hinder effective collaboration and compromise and serve as additional barriers to equity (Hughes et al. 2021; Ohene-Okae et al. 2022).

3.3.2 Water Utilities' Considerations of Contextual Equity

According to the documents reviewed, vulnerability assessments are the primary way in which water utilities consider contextual equity in their decision making. Several vulnerability indices and environmental justice screening tools exist to facilitate identifying communities that may be at increased risk of experiencing negative impact of water-related hazards like flooding or water contamination or may be less resilient to rate increases, water shortages, or other harms. These tools or datasets typically include data on the physical, social, and economic characteristics of a community, as well as the potential hazards and risks that it faces. These datasets and tools are covered in detail in Chapter 6.

Case study

The Pittsburgh Water and Sewer Authority (PWSA) has released a stormwater strategic plan that prioritizes investment in neighborhoods that are most vulnerable to negative impacts of flooding, not just susceptibility to flooding (Pittsburgh Water and Sewer Authority 2022c). To this end, the plan recognizes that lessening the impacts of flooding on less affluent communities of color is of heightened importance given existing socioeconomic and environmental inequities. To determine areas of greatest need, PWSA used the 2019 Allegheny County Environmental Justice Index and the EPA EJScreen, both of which identified similar factors and areas of need in the city.

Some utilities are using more robust and bespoke processes for identifying community needs, including processes that deemphasize data collection about water management and instead focus more intensively on the community context.

Case study

The SAWPA DCI program utilized an ethnographically-informed process that involved open-ended listening sessions to gain a comprehensive understanding of the communities within the watershed. This unique approach involved creating a listening space to learn about the strengths and needs of the communities before asking questions related to water management. By using an ethnographic approach, SAWPA was able to validate place-based data collection and recognize community members as experts of their environments. The top needs identified by the program included water management, water rates and cost, communication, and water quality. The core conclusions drawn from the program were that language barriers, communication, tap water quality, and connection to technical assistance projects were major issues that needed to be addressed. (Santa Ana Watershed Project Authority 2019)

Our review uncovered several examples of water utilities that have also taken steps to acknowledge past decisions and policies that have contributed to community mistrust and act as barriers to equity. These examples were less common in the literature and documents reviewed.

Case study

Santa Cruz, California, which relies mainly on surface water for its water supply, faced a public controversy in 2012 related to its pursuit of a desalination project (Baer, Koch, and Ingle 2021). The controversy resulted in a significant loss of public trust in the Santa Cruz Water Department. To address this, the City Council acknowledged the degradation of trust in the Water Department and responded by establishing a Water Supply Advisory Committee (WSAC) in 2014. Over 18 months, the WSAC worked with a facilitator and technical team to develop community-supported solutions to address future water supply needs and long-term sustainability. The WSAC reached a consensus agreement that had broad community support and included an adaptive process for evaluating and selecting water supply projects to sustainably improve long-term water supply reliability. The City Council unanimously accepted the WSAC's recommendations, and the Water Department continues to work hard to implement the plan. As a result, trust between the Water Department and the community has been reestablished, and the WSAC process has been used as a template to address other issues of community-wide importance.

3.3.3 Summary

Contextual equity refers to the extent to which preexisting political or socioeconomic conditions limit or enable people's capacity to engage in and benefit from resource distributions. Communities that are low-income and communities of color are at a higher risk of water-related hazards due to historical development practices, intentional policies, and market economies. Aging or inadequate water infrastructure is a challenge in some parts of the country, and some areas entirely lack centralized water and wastewater systems. Community trust in water utilities has eroded in many communities due to incidents of water contamination, inadequate infrastructure, and lack of transparency in decision-making processes. Water utilities consider contextual equity in their decision-making processes by using vulnerability assessments and other information-gathering processes to identify areas and populations that are at higher risk of water-related hazards and their needs. They have also taken steps to acknowledge past decisions and policies that have led to trust issues in the communities they serve.

3.4 Procedural Equity

Procedural equity reflects the decision making processes or rules, and the extent to which the process recognizes different groups to ensure their inclusion or representation.

3.4.1 Conditions Impacting Procedural Equity in Water Management

The ecosystem of water governance is complex and fragmented, with multiple agencies holding responsibilities over different issues, highly technical subject matter, and protracted decision-making and construction processes. In particular, flood management is a complicated and vast ecosystem of city departments, public agencies, and others that hold various authorities to address aspects of urban flooding. Comprehensive planning with climate data is becoming increasingly prioritized, but climate resilience specialists, scientists, and planners using climate data are not always thinking about the specific needs of communities as they put that data to work. This can result in inconsistent approaches, thereby making meaningful public

participation in decision-making and governance difficult, along with other obstacles such as language barriers and limited technical support or training for people interested in running for and serving on water boards or citizens' advisory councils, which tend to be the primary modes of participation in decision-making (U.S. Water Alliance and The Kresge Foundation 2020).

In addition, some populations experiencing vulnerability have been systematically disenfranchised and excluded from policy making throughout American history, which affects how these communities view and interact with government agencies today (U.S. Water Alliance 2017). And as described previously, a lack of participatory processes and transparency in the past have eroded trust in many water utilities, specifically (Baer, Koch, and Ingle 2021). When communities do not trust their water utilities, they may be less likely to participate in decision-making processes or provide feedback on water-related issues. This can lead to a lack of community input in important decisions, which can result in policies and practices that do not reflect the needs and concerns of the community and contribute to a negative feedback loop.

A lack of understanding of what water utilities do, how they operate, and the trade-offs they must consider can also impact community engagement. Many people may not fully understand the role of water utilities in providing safe and reliable water services, which can lead to misconceptions and mistrust. For example, some people may not understand the complex processes involved in treating and delivering water, or the challenges that utilities face in maintaining aging infrastructure. This lack of understanding can lead to frustration and a lack of engagement with water-related issues (Baer, Koch, and Ingle 2021; Green Infrastructure Leadership Exchange 2022a; Yang and Faust 2019).

3.4.2 Water Utilities' Considerations of Procedural Equity

According to the documents reviewed, it has become a standard process for water utilities to use public meetings to obtain resident input (Green Infrastructure Leadership Exchange 2022a). However, communities often need support to participate authentically in decision-making processes and governance structures and ensuring that participants are representative of the communities that utilities serve is particularly critical for procedural equity. Our review indicated that many tools and case studies are available for water utilities to consider equity, particularly racial equity, that focus on procedural equity and approaches for inclusion.

Utilities can support widespread participation by providing a stipend to compensate community members for their time, providing transportation to meetings and events, offering childcare, ensuring translation services are available, and providing healthy meals (U.S. Water Alliance and The Kresge Foundation 2020). There are also utilities exploring multiple platforms for obtaining community input on decisions, including using virtual formats, utilizing third-party facilitators, incorporating new technology for geospatial exploration, attending existing neighborhood meetings and events, and designing and hosting interactive workshops incorporating arts, games, and other creative engagement approaches (U.S. Environmental Protection Agency 2023e; American Water Works Association 2019; Baer, Koch, and Ingle 2021; Langsdale and Cardwell 2022). Community partners and trusted community-based organizations offer advice on how best to engage their communities, and they can also recommend local vendors and services. Utilities or cities have hired community leaders

(“neighborhood champions” (Baer, Koch, and Ingle 2021) or “ambassadors”) as paid consultants to help develop these strategies, vet scenarios, or gather input from their neighbors on potential investments (U.S. Water Alliance and The Kresge Foundation 2020). Some utilities have also convened formal community advisory boards to represent the community perspective and weigh-in on decisions (U.S. Environmental Protection Agency 2011). Importantly, successful strategies are tailored to the local context (Langsdale and Cardwell 2022).

Case study

The Seattle Public Utility (SPU) developed a 40-year sewer pipe rehabilitation plan through a collaborative process that involved a diverse team of SPU employees, including those responsible for assessing sewer conditions, maintaining and rehabilitating sewers, responding to sewer overflows, and planning rehabilitation work. The team also included staff from SPU's Change Team, Environmental Justice and Service Equity (EJSE) team, Drainage and Wastewater (DWW) Branch Equity Team (BET), and the Office of Planning and Community Development. The process involved several workshops that utilized virtual whiteboarding, small break-out groups, and large group discussions to share ideas and make decisions. The virtual and online format helped to promote more even participation and "airtime" among the participants. Additionally, the EJSE team prioritizes collaboration with communities of color, immigrants and refugees, customers with low income, and customers with limited English proficiency (Race & Social Justice Initiative 2021).

Beyond these strategies, focused largely on obtaining input on decision-making, the review found that some utilities are utilizing approaches to build resident capacity and increase community engagement around implementation and maintenance of water management infrastructure. Particularly common in the stormwater management space, utilities have offered programs to encourage residents to manage stormwater on their properties and participate in the upkeep of neighborhood-based green stormwater infrastructure (GSI) sites. These programs help to educate residents on stormwater management, make community benefits tangible, and increase community demand for similar investments around their service areas (American Rivers 2020; Philadelphia Water Department 2021b).

Case study

Philadelphia's Green City, Clean Waters initiative included plans for neighborhood and household-based initiatives. The Water Department worked with partners to integrate green tools into home repairs and recruited communities to adopt GSI sites. The Rain Check program encouraged homeowners to install landscape improvements that manage stormwater. Another program (Soak It Up Adoption) incentivized local organizations to maintain and engage with local GSI. Soak It Up Adoption provided mini-grants to build capacity and allow community members to become ambassadors of Green City, Clean Waters while maintaining the vegetation that manages runoff. Together, these programs have engaged nearly 13,000 individuals from around the city in GSI programming (Philadelphia Water Department 2021a).

Our review indicated that utilities are also recognizing that an inclusive workforce plays a crucial role in achieving water equity, as discussed in more detail in section 4.1.1 Workforce Considerations.

Water utility operations and decision making can often be perceived as a “black box”. To build trust and address lack of trust as a common barrier to engagement, utilities are focusing on improving transparency, accountability, and education. Strategies in practice include offering open houses of facilities (Southeast Louisiana Flood Protection Authority-East 2024; Pittsburgh Water and Sewer Authority 2022a), developing public performance dashboards of utility investments made and outcomes of those investments (Pittsburgh Water and Sewer Authority 2022d), and developing strategic communications (including messages, communication channels, and Frequently Asked Questions documents) about planned projects for communities in affected areas (U.S. Environmental Protection Agency 2011).

Case study

The Southeast Louisiana Flood Protection Authority-East (FPA-East) is providing in-person and virtual reality tours of the \$4 Billion Hurricane Storm Damage Risk Reduction System that spans three parishes. The VR tour video will also be used as part of the FPA-East's educational initiative aimed at middle school science curriculum (Southeast Louisiana Flood Protection Authority-East 2024).

3.4.3 Summary

Many utilities recognize the importance of community engagement in water management and infrastructure decisions, particularly in achieving procedural equity. Water utilities can support community participation by providing compensation, transportation, childcare, translation services, and healthy meals. Successful strategies are tailored to the local context and involve collaboration with community partners and trusted organizations. In addition, utilities are focusing on building resident capacity and increasing community engagement around implementation and maintenance of water management infrastructure. An inclusive workforce is also crucial in achieving water equity. Transparency, accountability, and education are also important strategies to build trust.

3.5 Distributional Equity

Distributional equity refers to how costs, risks, and benefits are allocated or distributed across society. Depending on equity goals, distribution can be based on equality, need, merit, or other principles.

3.5.1 Conditions Impacting Distributional Equity in Water Management

Water management efforts across the United States, and the social, geographic, and environmental factors surrounding them can either lessen or enhance distributional inequities in a utility's jurisdiction. The overall cost of water services to customers can unequally burden some individuals over others, raising affordability concerns. Distributional equity concerns with respect to affordability can be sharper for utilities with a higher debt service and either a large disparity in incomes or proportion of the population with low income (Patterson 2020). Other conditions impacting distributional equity can include the location and externalities of

infrastructure, operations, or construction activities (e.g., communities living near a wastewater treatment plant) (Randell and Curley 2023). In rural or agricultural settings, distributional inequities can result from unequal access to quality water supply and require considerations of who bears the burden of water polluted by run-off from agricultural areas (typically minority communities and communities with low incomes) as well as the distribution of costs of water cleanup across different water users (e.g., large- and small-scale agriculture, indigenous communities, residential communities), as well as (Fernandez-Bou et al. 2023).

Water affordability is becoming a growing challenge for many households, especially those with low incomes. The cost of water and wastewater services is increasing due to factors such as aging infrastructure, rising energy costs, compliance with environmental regulations, and the impact of climate change (Cushing et al. 2023; Dilling et al. 2023). Federal investment through the Drinking Water State Revolving Fund (DWSRF) and the Clean Water State Revolving Fund (CWSRF) programs administered by the EPA had also been diminishing prior to 2021 and were largely inaccessible to under-resourced communities with limited capacity to apply to these grant programs. Taken together, these factors have put financial pressure on local water utilities and have led to rate increases. Rate increases place a significant burden on households, particularly those that have experienced historical discrimination, underinvestment, and a lack of attention from regulators, particularly Black, Hispanic or Latino, Native American, and other communities of color (Cushing et al. 2023). In a recent study examining the stormwater utility fee affordability, including the proportion of fees covered by low-income households, researchers found that stormwater utility fees did place additional burden on low-income households (Kinney et al. 2023). They also emphasized that full cost recovery for stormwater services may be difficult to achieve when also aiming to achieve affordability goals (Kinney et al. 2023).

Attempting to address infrastructure and climate challenges, water utilities are making significant investments in communities. Lead water line replacement, other pipe and treatment plant upgrades, stormwater management and other flood protection infrastructure, and other investments can convey significant water quality and climate resilience benefits (Rainey, McHale, and Arabi 2022; Green Infrastructure Leadership Exchange 2021). Moreover, multi-benefits are increasingly being considered in these decisions, such as those of GSI (which can offer new green space for recreation, offset urban heat island effects, improve air quality, increase property values, and other benefits, in addition to managing stormwater to reduce the burden on traditional stormwater infrastructure) (U.S. Environmental Protection Agency 2023d), and repurposing agricultural land for water management purposes (e.g., aquifer recharge) (Fernandez-Bou et al. 2021; Fernandez-Bou et al. 2023). There is potential to consider equity in the decision making process for prioritizing, siting, and maintaining the built and natural infrastructure that offer these benefits to communities. (Section 3.3 Contextual Equity describes how prioritization considerations are made with regards to the existing context, distribution of risk, and vulnerability.) Additionally, contracting for the construction and maintenance work performed can be a significant benefit of water investments, as it can create jobs and economic opportunities for local businesses and workers. Ensuring that these benefits are equitably distributed, whether it be based on equality, need, or merit (and determining

which principle to use to determine how benefits should be distributed), is a challenge for water utilities.

There is a growing recognition of some of the unintended consequences of water utilities investments in communities. For example, investment in green space to address stormwater challenges, and resulting property value increases (sometimes called “green gentrification”) presents possible displacement risks in lower-income communities (Rigolon and Németh 2020). As another example, in areas where water is increasingly scarce, the cost of acquiring water for growth is often offset by developers in the form of development or new connection fees. There are concerns in some communities that these costs are passed down to renters and reduce overall housing affordability (Been 2005). Water utilities must contend with the distribution of all benefits, costs, and risks in their considerations of equity.

3.5.2 Water Utilities’ Considerations of Distributional Equity

Water utilities may consider distributional equity in their decisions is through the use of vulnerability assessments, to understand how future investments (and/or externalities of infrastructure) may impact different communities in their jurisdictions. This is an area where contextual and distributional equity are often considered in tandem (i.e., utilities seek to understand how future actions may contribute to or alleviate existing vulnerabilities) and is addressed in Section 3.3.2 Water Utilities’ Considerations of Contextual Equity.

According to the review, affordability and customer assistance programs comprise the primary methods by which water utilities attempt to balance the burden of rate increases within their service areas. These programs take different forms: direct bill payment assistance, sliding scales or tiered water rates, home plumbing repair incentives and assistance, water efficiency incentives and rebate programs, debt forgiveness, and more (U.S. Water Alliance 2021b, 2023a). There are legal considerations associated with these programs that drive the customer assistance choices utilities are able to make (U.S. Water Alliance 2017). These factors are discussed in more detail in section 4.2.1 Drinking Water.

Case study

The Department of Watershed Management (DWM) in Atlanta offers three customer assistance programs. The Care and Conserve Program provides financial assistance for water/sewer bill payments and plumbing repairs to low-income single-family residential customers facing financial difficulties. The program also offers rebates for the installation of water-efficient toilets and showerheads to promote water conservation. The Senior Discount Program offers eligible senior citizens a 30% discount, while the Amnesty Program is a seasonal opportunity for customers with outstanding water bills of \$1,000 or more to enroll in a payment plan with DWM, with late fees waived (U.S. Water Alliance 2021b).

The review identified examples of water utilities creating specific requirements for grant programs they operate to encourage equitable distribution of benefits and co-benefits. Mirroring processes for addressing contextual equity, some utilities follow up their prioritization based on vulnerability or need-based assessments with outcome evaluations that measure the actual distribution of benefits compared to intended benefits (Green

Infrastructure Leadership Exchange 2021). The review also identified a small set of examples of utilities carefully defining outcomes based on the community context to ensure that quality of life is maximized for intended beneficiaries based on *their* conceptualization of benefits (Green Infrastructure Leadership Exchange 2021), building on traditional “triple bottom line” evaluations (The Water Research Foundation 2021). Some utilities also recognize the economic benefits that can accrue from the process of implementing new, and maintaining existing, water infrastructure, creating requirements for contractors and suppliers and encouraging the development of new community economic enterprises to ensure that the benefits of these contracts are equitably distributed (Bozuwa 2019). Procurement and contracting are discussed in more detail in section 4.1.2 Procurement and Contracting Considerations, and green infrastructure and equity considerations are included in section 4.2.4 Stormwater Management.

Strategies to prevent negative impacts of investments (including green gentrification and associated displacement) in underserved communities are less well-formed in the literature (Green Infrastructure Leadership Exchange 2021). These strategies by nature require collaboration with organizations and agencies in other sectors, including economic development and affordable housing.

Case study

Atlanta implemented a green infrastructure project in 2011 in the Historic Old 4th Ward Park to address stormwater flooding issues and combined system capacity challenges. By many measures, the project was a success: It saved \$14 million over the grey alternative, addressed community flooding challenges, and created \$475 million in economic development value. However, the project also led to higher taxes, resulting in significant gentrification and displacement of local low- and moderate-income residents. The Atlanta team acknowledged that they had not taken proactive measures to protect the community from displacement. In their next project, they collaborated with Invest Atlanta, the City's economic development authority, to provide tax relief on impacted property values, invest in home repairs, and require strong community partnerships throughout the project (Green Infrastructure Leadership Exchange 2021).

3.5.3 Summary

Our review found that water utilities consider the distribution of both costs and benefits of water management decisions. The primary methods used by water utilities to balance the burden of rate increases within their service areas are affordability and customer assistance programs. These programs take various forms, including direct bill payment assistance, sliding scales for water rates, home plumbing repair incentives and assistance, water efficiency incentives and rebate programs, and debt forgiveness. Some utilities create specific requirements for grant programs they operate to encourage equitable distribution of benefits and co-benefits, and some consider the economic benefits associated with contracting opportunities with the utility. Strategies to prevent negative impacts of investments in underserved communities are less well-formed in the literature.

Conceptualization and operationalization of water equity have evolved to encompass not only distributional equity but also procedural and contextual elements, including community voice and cultural and historical context. Water utilities are taking steps to address these elements of equity, such as vulnerability assessments to identify areas and populations at higher risk of water-related hazards, community engagement, inclusive workforce development, and comprehensive approaches to measure and address the distribution of costs and benefit of water management.

CHAPTER 4

Equity and Water Resources Planning and Management

This chapter describes six main aspects of water resources management, adapted from the WUCA, WRF, and Denver Water funded work entitled *Water Utility Business Risk and Opportunity Framework* (Wasley and Jacobs 2020). This framework provides a comprehensive categorization of the main functions of the water sector, including management focal areas, termed water-specific business functions, (e.g., stormwater and wastewater) and other business functions that are not specific to the water sector (e.g., procurement and planning). For this work, the research team adopted the five water-specific business functions along with a higher-level grouping of the other business functions, which the research team termed water sector administration and operations. Through these six functional areas of water management, the research team examined literature and practice. The functional areas and a summary of the literature are described below.

It is important to note that while the disproportionate impacts of climate change on communities are a key motivation for this work, the research team structured this section around more generalizable aspects of water resources planning and management, rather than on specific climate adaptation functions and services within them. The research team did this because for utilities to meaningfully integrate equity considerations into climate adaptation planning, they need to take a broader perspective on institutionalizing equity within their organizations, processes and services provided to communities.

4.1 Equity in Water Sector Administration and Operations

The internal readiness or culture and practice of an organization are important factors in enhancing equity within an organization, and speak to their capacity to support equitable service provision to their community. However, incorporating equity considerations into water utility administration and operations is a relatively less explored aspect of water equity. Most of the published academic literature in this space is focused on principles and practice of advancing organizational equity more broadly, and not specifically in the water sector (Bailly et al. 2021; Crisp, Kolby, and Potter 2022; Sardana 2019). And while there are a number of thought leaders and organizations tackling these issues, such as the U.S. Water Alliance, there is a general need for enhanced sector-specific operational definitions and specific strategies for achieving water equity within water utility administrations.

4.1.1 Workforce Considerations

The water industry is facing significant challenges in recruiting and retaining a well-prepared and competent workforce to deliver critical services for public health, natural environment, and economic vitality. To address these challenges, water utilities are advancing their workforce programs in four key areas: recruitment, retention, competency, and community partnerships.

One effective strategy has been to collaborate with city and state agencies, schools, and trusted nonprofits to develop career pipelines for recruitment when permanent utility positions

become available. These collaborations can connect students and trainees to jobs in the water sector and create linkages between academic curricula and work-based learning. Partnerships can also be formed with labor unions to create adult workforce development programs that include pre-apprenticeship training for individuals with little experience and employment barriers. Pre-apprenticeship programs teach trainees industry skills through hands-on work experience and help them qualify for registered apprenticeship programs in the skilled trades. Apprenticeships with local labor unions are solid pathways into permanent employment in the trades on which the water industry relies. Educators play a crucial role in connecting students with career paths and can commit to local hiring in vulnerable neighborhoods (U.S. Water Alliance 2017). This generates multiple benefits, from flood resilience to local economic vitality (U.S. Water Alliance and The Kresge Foundation 2020). Moreover, by ensuring that their workforce reflects the diversity of the communities they serve, water utilities can better understand and respond to the needs and concerns of those communities. An inclusive workforce can also help build trust and understanding between water utilities and the public, leading to more effective and equitable water policies and practices (Milwaukee Metropolitan Sewerage District 2018; U.S. Water Alliance 2023a, 2023e).

Case study

MMSD is working with partners to build opportunities for careers in the Milwaukee water sector. MMSD's Fresh Coast Ambassador Program, launched in 2018, provides high school students with work experience in green infrastructure. MMSD also implemented "banning the box" on job applications in 2020, meaning that the applications no longer include questions about applicants' criminal records. In May 2021, MMSD, Milwaukee Water Works, Veolia Water Milwaukee, and the Wisconsin Department of Natural Resources hosted the first One Water, Our Water: Explore Milwaukee Water Jobs Fair to build water workforce equity in Milwaukee. Milwaukee Water Works (MWW) has developed a youth apprenticeship program and partners with Milwaukee Area Technical College to provide internships for students to gain experience working in MWW's treatment plants and water quality laboratories. These efforts aim to foster greater awareness of water sector careers and build a stronger pipeline for potential future employees (Milwaukee Metropolitan Sewerage District 2018).

Case study

DC Water Works has implemented a local hire program to promote job training and apprenticeship programs and increase local employment opportunities. The program focuses on advertising water jobs to residents, encouraging contractors to interview and hire District residents, and promoting job training and apprenticeship programs (U.S. Water Alliance 2023d)..

4.1.2 Procurement and Contracting Considerations

Equity considerations in procurement and contracting by water utilities include policies and practices that aim to provide disadvantaged and underrepresented groups with equal access to contracting opportunities. This includes promoting diversity and inclusion in the procurement process, such as setting goals for minority-owned and women-owned business enterprise (MWBE) participation (U.S. Water Alliance 2023a). Additionally, water utilities have used

procurement and contracting to support local economic development and job creation, particularly in communities that have historically been marginalized or underserved. These policies are backed by disparity studies that document historical disparities in MWBE access to contracting opportunities.

Case study

In 2010, the Louisville Metropolitan Sewer District (MSD) introduced a Local Labor Preference Program, which mandates that contractors commit to a percentage of local hires for any project exceeding \$5 million. More recently, MSD conducted a Disparity Study that led to legislation that allowed them to set mandatory race and gender goals for their Supplier Diversity Program, formalize a Community Benefits Program, and implement a Small Local Business Enterprise Program. In particular, the Community Benefits Program requires that prime contractors on projects above \$2 million commit to providing a related community benefit as part of their services. Examples have included a virtual engineering career panel workshop, school playground and fence upgrades, meals for students, and new homes and community gardens built for residents (Ohene-Okae et al. 2022).

4.2 Water-Specific Business Functions

4.2.1 Equity Considerations Related to Drinking Water

There is a growing body of literature examining how drinking water entities are incorporating equity into planning and operations. Efforts to promote water equity in drinking water utilities encompass considerations of affordability, quality of service, and the recognition of the human right to water (Sala-Garrido et al. 2023). Drinking water affordability programs generally provide financial assistance to low-income households, and aim to address the disproportionate burden of high water costs on already overburdened communities, ensuring that access to safe drinking water is not hindered by financial constraints (Goddard, Ray, and Balazs 2021; Nemati and Schwabe 2023). The human right to water is a principle that affirms that every person has the right to sufficient, safe, acceptable, physically accessible, and affordable water for personal and domestic use (Yu et al. 2019). Ensuring quality of service is an additional focus of literature and practice and involves research that generally examines aspects of distributional equity in relation to unsafe drinking water provision (Caballero, Gunda, and McDonald 2022; Karim, Guha, and Beni 2020), as well as regulatory and policy approaches to improve the performance of drinking water utilities.

Of these strategies, affordability (often called “customer assistance”) programs are the most widely covered in the literature. Those implemented in practice, however, can have limited success because utilities often do not have direct access to low-income households (e.g., multi-family housing units typically have a single meter), state policies make it difficult to finance, or the system lacks the resources to develop a program. Utilities with customer assistance programs often partner with local organizations that are already working with families struggling with poverty (Patterson 2020).

Case study

DC Water collaborated with the federal Low Income Home Energy Assistance Program (LIHEAP) to automatically enroll LIHEAP-supported households into their Customer Assistance Program (CAP). This was possible because many multi-family buildings are sub-metered for energy, but not for water. DC Water has used other strategies to expand its affordability program, including using various marketing strategies, such as social media and outreach through churches and nonprofits. However, as of 2020, only 575 households of the intended 14,000 households were participating. It is possible that the number of eligible households was overestimated, the message failed to reach the intended audience, or the discount offered was not sufficient to cover the costs of applying. Despite DC Water's efforts to provide financial assistance to low-income customers, they, like many other water utilities, lack the necessary data to offer targeted assistance (Patterson 2020).

4.2.2 Equity Considerations Related to Water Supply

There is relatively less work on the concept of equity related specifically to water supply planning. Outside of the United States, in Australia and New Zealand in particular, there has been more attention given to the role of indigenous communities in water supply management and decision making processes for both groundwater and surface water (Jackson 2018; Quitian and Rodríguez 2016). Within the United States, there is legacy of work focused on the dynamics of reservoir construction, operation and land loss and its implications on indigenous communities (Randell and Curley 2023). In the context of rural populations and those dependent on groundwater, either from municipal or private sources, there is increasing attention to the role of sustainable groundwater management in enhancing distributional equity, as well as policy efforts to include overburdened populations in groundwater management decision making (Dobbin and Lubell 2021; Moench 1992; Hoogesteger and Wester 2015). However, there is a need for greater community-centered work that prioritizes the voices and needs of marginalized communities in current water supply planning and management.

4.2.3 Equity Considerations Related to Wastewater

While there is a large body of work on wastewater system quality and access in the context of international development, in the United States, considerations of water equity in wastewater management specifically are generally focus on epidemiological or public health-related studies (Medina et al. 2022). Testing and monitoring of wastewater systems during the COVID-19 pandemic did bring to light some issues around distributional equity in wastewater systems (Naughton et al. 2023) and there is additional work on distributional equity related to quality and access to centralized wastewater systems and decentralized septic systems (Hernandez and Pierce). Finally, given the role of citizen engagement in areas near large wastewater treatment plants there is also a body of research and practice around both distributional and procedural equity related to wastewater treatment plant operations and community externalities (Gen, Shafer, and Nakagawa 2012). However, there is still a need for comprehensive work on wastewater equity across the United States. This includes addressing disparities in access to wastewater services, ensuring equal treatment and quality standards for all communities, and

incorporating community input and decision-making processes in the planning and implementation of wastewater management strategies.

4.2.4 Equity Considerations Related to Stormwater Management

Given the long-term and growing impacts of urban flooding on populations experiencing vulnerability, equity is an increasing focus of stormwater management efforts across the United States. In this space, there is a body of research and practice examining and measuring aspects of equity in flood-impacted areas (White-Newsome and Slay 2022; Emrich et al. 2020). The vast majority of this work is focused on understanding distributional equity, or which populations are most exposed to and affected by flooding (Maantay and Maroko 2009). This research and practice also highlight the need to address structural inequities (or aspects of contextual equity) that contribute to flood vulnerability, such as housing and planning practices that exacerbate exposure and reduce flood resilience (Hughes et al. 2021; Tate et al. 2021). Increasingly, research and practice are focusing on aspects of procedural equity by characterizing barriers to community engagement, decision-making processes, and access to resources and support during stormwater planning and implementation (Cousins 2018). A subset of stormwater management, green stormwater infrastructure (GSI) solutions that seek to benefit both the environment and urban communities aim to address social inequities by providing multiple co-benefits such as improved water quality, aesthetics, public health outcomes and even housing costs (U.S. Water Alliance 2017). Given these intended benefits, there is growing support for stormwater managers to integrate equity considerations into GSI siting decisions and planning processes (Matsler et al. 2023). Of the areas of water management, this is one of the most well-developed in terms of integrating equity considerations across multiple dimensions (Locke et al. 2021). Still, however, work is pointing to continued inequities in GSI implementation and the need for ongoing evaluation and adaptation of strategies to ensure equitable outcomes (Heynen, Perkins, and Roy 2006; Zuniga-Teran et al. 2021).

Case study

San Francisco Public Utility Commission (SFPUC) outlines a set of equity co-benefits that must be met (at least two) to qualify for their Green Infrastructure Grant Program. These co-benefits include factors such as locating the project in an Environmental Justice Area, providing public access, and offering educational opportunities, with descriptions of how each can be achieved using different best management practices. This approach ensures that equity goals are integrated into the project design process, with equity objectives stated from the outset and maintained throughout the grant process. Additionally, the guidebook provides a step-by-step guide to applying for and navigating the process, making it more accessible and reducing barriers to applications (Green Infrastructure Leadership Exchange 2021).

Case study

The New York City Department of Environmental Protection (DEP) introduced a series of Cloudburst Resiliency Projects in January 2023 intended to improve stormwater management in flood-prone communities across the city. The program is investing \$400 million in green infrastructure projects design to reduce flooding from high-intensity, short precipitation events. The program involves a collaboration between multiple New

York City departments, including DEP, the Department of Transportation, the Department of Design and Construction, and the Department of Parks and Recreation. These departments worked together on a site selection process and vulnerability framework that prioritized locations at risk from historic and future flooding that also had environmental justice and other social factors contributing to flood vulnerability (City of New York 2023).

4.2.5 Equity Considerations Related to Water/Environmental Monitoring and Management

Incorporating equity into water quality and water resources monitoring, as well as watershed management, is not well documented in academic and practitioner literatures. There is a growing body of work harnessing indigenous knowledge for more holistic and equitable watershed management, as well as centering planning and management around the needs of indigenous communities (Sarna-Wojcicki et al. 2019; Cronin and Ostergren 2007). This body of work contains best practices and lessons learned for recentering the water sector approaches addressing the needs of the populations they engage with, and recentering holistic watershed management approaches on indigenous or other community-led approaches. In addition, there is some literature pointing to inequities in data and monitoring for disadvantaged communities, though much of this focuses on drinking water (Reibel, Glickfeld, and Roquemore 2021).

Case study

To enhance flood protection and public safety, MMSD undertook the rehabilitation of the Kinnickinnic River through an \$80 million flood protection initiative that necessitated the inclusion of a substantial land area, particularly along residential corridors. MMSD collaborated with local community health centers, leveraging trusted voices and neighborhood spaces to engage with both Spanish- and English-speaking residents. Due to the tight couplings between environmental health and community well-being, MMSD partnered with the Sixteenth Street Community Health Center to establish a coalition focused on river restoration. This effort not only contributed to the rejuvenation of the river but also played a key role in engaging and promoting economic development within the surrounding community (Milwaukee Metropolitan Sewerage District 2023).

Case study

The Beckley Sanitary Board (BSB), a wastewater and stormwater utility in West Virginia, began to strategize in 2004 on how to comply with regulations requiring a stormwater management program to protect and restore water quality. Recognizing that a utility-only approach would fall short, BSB partnered with the Piney Creek Watershed Association (PCWA), a local non-profit, to consolidate efforts and galvanize volunteers and funding to clean up streams, monitor water quality, and lead environmental education and outreach programs. The partnership resulted in a trail network of over 20 miles of restored and connected recreational trails alongside Piney Creek, and BSB has continued to collaborate with PCWA to identify and address sites affected by septic failures or agricultural pollution. The partnership has provided numerous community benefits, fostering goodwill and improving the value residents place on water, ultimately

contributing to BSB's watershed improvement mission (U.S. Environmental Protection Agency 2021b).

CHAPTER 5

Water Sector Needs: Funding, Capacity, and Collaboration Requirements for Integrating Equity in Water Resources Planning and Management

Taking steps to operationalize equity in water resources planning and management requires resources: human, financial, technological, and institutional. This chapter summarizes examples of funding and collaboration arrangements utilities rely on for incorporating equity considerations into water management. It also explores the role of capacity building in supporting equitable community planning.

5.1 Funding for Utilities to Operationalize Equity

Water utilities face significant challenges related to funding equity considerations in water management, as the primary source of funding for utilities comes from ratepayers. Equity considerations are combined with goals of building climate resilience and repairing and maintaining infrastructure, and financially strained utilities must make trade-offs between ensuring water is affordable for households, ensuring their fiscal health to continue operating reliably, and investing in infrastructure to meet regulatory requirements and provide safe water (U.S. Water Alliance and The Kresge Foundation 2020; Patterson 2020). This is a particular challenge for tribal communities, rural regions, and low-income areas, especially communities of color, who tend to operate with smaller margins and have more difficulty accessing low-interest loans or funding through grant programs, which are the primary supplements for utilities' capital budgets (Patterson 2020).

Utilities face a “chicken and egg” situation when it comes to securing funding to support operationalizing of equity: garnering support to use capital funds or applying for additional outside funding requires some baseline commitment of personnel time and resources, as well as a commitment to do things differently (U.S. Water Alliance 2023a). Water utilities are often large, entrenched institutions in communities. As a result, they may face barriers to organizational change necessary to establish and maintain equity-oriented practices, including staff with the time necessary to lead the charge, as described in other areas of this report (Green Infrastructure Leadership Exchange 2022b).

The review identified a few examples of funding for equity activities. Not only does ensuring equity in water management planning and processes often incur costs, but equitable investment in infrastructure requires careful consideration of funding schemes. Below are examples of utilities dedicating operating budget to these activities, and examples of external funding sources that have been leveraged.

5.1.1 Funding Organizational Change and Utility Operations that Center Equity

While organizational change and integration of equity considerations into municipal operations are highlighted in the literature, there are very few examples of funding opportunities for these

activities outside of utility operating budgets. A set of federal programs, including the EPA’s Brownfields Environmental Workforce Development and Job Training grants and Environmental Health Sciences Environmental Career Worker Training programs and Workforce Investments Opportunity Act (WIOA) investment set-asides focused on water sector employment training and low-income youth could be used to support equity-oriented changes to the water utility workforce (PolicyLink 2022). At the community level, State Revolving Funds (SRFs) administered by the EPA can be dedicated helping to meet the human capital needs of certain water systems, particularly small or low-income systems, though the review did not identify specific examples of utilities using this funding source to meet equity goals (Patterson 2020). The review also didn’t identify any specific funding opportunities specifically for DEI capacity-building and other organizational change efforts other than those funded out of water utility operating budgets.

5.1.2 Funding Community Engagement

As described above, community engagement efforts may include community advisory boards, public meetings, surveys, and other outreach activities designed to gather input from community members and ensure that their perspectives are incorporated into water management decisions. Water utilities fund their community engagement efforts through a variety of means, primarily via their operating budgets but also with grants and partnerships with community organizations (Dragoman 2022; San Francisco Public Utilities Commission 2022; U.S. Water Alliance 2021b). Grants for community engagement are largely “planning grants” and have come from federal, state, and local government sources , as well as from local philanthropy (City of Philadelphia 2023; U.S. Environmental Protection Agency 2023a). (Partnerships with community organizations are discussed more expansively in section 5.3 Collaboration.)

Case study

The California Department of Water Resources (DWR) Integrated Regional Water Management (IRWM) Program promotes collaborative planning and water resources management throughout the state and various bond acts approved by California voters have provided over \$1.5 billion in State funding to advance integrated regional water management projects. SAWPA’s DCI program was funded by an IRWM Proposition 1 grant. IRWM also provided \$2.9 million in funding for technical assistance to develop programs and policies to address the needs identified through the DCI process (Santa Ana Watershed Project Authority 2019).

Case study

The SFPUC is a leading example of a utility that invested in robust community engagement. In 2020, the SFPUC through the Community Benefits Program allocated a portion of the program’s \$4.7 million annual budget for community engagement efforts. They organized public workshops, town hall meetings, and online surveys to gather feedback on projects related to water supply, wastewater management, and stormwater issues (San Francisco Public Utilities Commission 2022).

Case study

In 2020, the City of Atlanta initiated a community-driven water equity planning process to address disparities in access to clean water and water infrastructure. The city allocated approximately \$1.5 million to support this multi-year initiative. The funds were used for conducting community outreach, hiring consultants to work closely with residents, organizing public meetings, and providing resources for community members to actively participate in the planning process (U.S. Water Alliance 2021b).

Case study

With regards to equity strategies, the Philadelphia Water Department (PWD) received about \$550,000 Operations Transformation Fund grant (Islam 2021) to support the designing, building, and piloting of an Equitable Community Engagement Toolkit to create the conditions for equitable engagement between the City and the communities served (Dragoman 2022). Particularly communities including people living with disabilities, no to limited English proficiency, without digital access or have low digital literacy, and those of color who have been impacted by systemic racism.

5.1.3 Funding Equitable Infrastructure

There are a variety of funding sources available to water utilities to maintain and improve infrastructure outside of utility operating funds, including several examples of federal, state, and local funding options that center equity. However, there are some limitations as to which types of entities are eligible to receive grants through some of these mechanisms. Specifically related to stormwater management, there are examples of utilities that have been able to creatively braid funding sources to implement infrastructure that meets the needs of marginalized communities.

Prior to 2021, the DWSRF, CWSRF, and Water Infrastructure Finance and Innovation Act (WIFIA) programs were collectively funded at around \$2.7 billion annually (U.S. Water Alliance 2021a). Since 2021, the launch of the Justice40 initiative and the passage of the Bipartisan Infrastructure Law has expanded the amount of federal funding available for infrastructure, with an increased focus on equity in its disbursement and intended use. For example, announced in 2023, the EPA's *Advancing Water Equity and Access for All Commitment* will invest \$500 million in helping to ensure more communities have access to drinking water, wastewater, and stormwater services (U.S. Environmental Protection Agency 2023c). (As it is a new program, there are no examples available of communities using this mechanism.) The Federal Emergency Management Agency's (FEMA) Building Resilient Infrastructure and Communities (BRIC) provides funding for states, local communities, tribes and territories to implement hazard mitigation projects, many of which relate to flood control, drought resistant infrastructure, and other water management projects (U.S. Environmental Protection Agency 2023a; Green Infrastructure Leadership Exchange 2022b). The USDA Rural Utilities Service Water and Environmental Programs is the primary federal program supporting rural communities (10,000 people or less) to finance water and wastewater projects (Patterson 2020). The BRIC program is particularly competitive, and the review suggested that communities with capacity constraints and challenges meeting the financial match required to

apply are not well-served by the program (Weber 2023) (though FEMA and state agencies are making efforts to support these communities with the process).

As described above, SRFs are also a common source of funding for infrastructure, especially for urban water and wastewater infrastructure. States administer the program under federal parameters, must provide 20% state matching funds to federal dollars, and must provide loans at or below market rate. Funds can also be used to refinance debt, provide loan guarantees, and in some cases give subsidies or grants to projects (U.S. Environmental Protection Agency 2023f). These funds are also typically provided to governmental entities (local, county, special district) and public utilities. Related to equity, the Safe Drinking Water Act requires each state to define “disadvantaged communities” to identify water systems that qualify for additional subsidies through SRF programs.

Utilities have taken advantage of a variety of options at the local level for funding infrastructure with equity goals. Many have implemented stormwater fees to provide an ongoing source of funding for stormwater infrastructure (Pittsburgh Water and Sewer Authority 2022b), and some communities have established mechanisms to distribute the funding collected from stormwater fees throughout their service area, with an eye toward equity. Others have used public funding options like revenue bonds or new taxes (LA River Master Plan 2024; San Francisco Water Power Sewer 2024). Environmental impact bonds (EIB) have also been used, such as one that provided \$14 million of funding for stormwater improvements in Atlanta’s Proctor Creek watershed (U.S. Water Alliance 2021c).

Case study

The Northeast Ohio Regional Sewer District (NEORS) created a Community Cost Share Program, funding through a set aside account for the pooling and dissemination of funds derived from the Stormwater Fee collected in each member community. 25% of the total annual Stormwater Fee collected in each member community is allocated to the Community Cost Share Account for that community. NEORS controls the Community Cost Share Account and uses a grant application process to disperse funds to member communities and uses equity criteria to make those disbursements (Northeast Ohio Regional Sewer District 2023).

Case study

San Francisco launched a multi-billion-dollar Sewer System Improvement Program funded through revenue bonds, user fees, and a dedicated parcel tax, which helps to finance the upgrades and expansions of the city's sewer system (San Francisco Water Power Sewer 2024).

Case study

Atlanta’s DWM partnered with Quantified Ventures to help structure a \$14 million dollar EIB. The bond is financing six green infrastructure projects to manage stormwater in economically and environmentally distressed neighborhoods in the Proctor Creek watershed that previously lacked access to funding. Outside investors contributed to the EIB with a promise that they would receive a return on investment if they projects

achieved their intended outcomes (performance greater than 6.52 million gallons of stormwater capture), which it did (Quantified Ventures 2023).

Green infrastructure presents an opportunity for water utilities to secure local funding due to its co-benefits. Co-benefits like stormwater management, improved water quality, job opportunities in ongoing maintenance, and enhanced community aesthetics make green infrastructure projects more attractive to local governments, local philanthropy, and other stakeholders, and also pull in partners from diverse sectors with their own funding landscapes, increasing the likelihood of securing funding for these projects (U.S. Water Alliance and The Kresge Foundation 2020) and allow utilities to braid together multiple federal, state, local, and private funding streams (Green Infrastructure Leadership Exchange 2022b).

Case study

PWD's Green City, Clean Waters Program used a combination of grants, loans, and public-private partnerships to finance the installation of green roofs, rain gardens, and permeable pavements, among other initiatives (Philadelphia Water Department 2022a).

5.1.4 Funding for Affordability Programs

Utilities largely fund affordability programs, intended to offset the costs of water and sewer services to ratepayers, through their operating funds. Pandemic recovery legislation like the American Rescue Plan Act and the Low Income Household Water Assistance Program offered some temporary relief to households (and to utilities that offered expanded assistance during the pandemic) (Orbach et al. 2022). Some states offer support to utilities through grant programs to offset the costs of affordability programs, such as Michigan's Affordability and Planning Grant (Department of Environment 2023). In general, the review indicated that options to help utilities to ensure water affordability remain constrained (Patterson 2020).

5.1.5 Summary of Funding Considerations for Operationalizing Equity

Water utilities are challenged to fund efforts to embed equity considerations in water management, especially in low-income areas and communities of color. However, there are some examples of funding for equity activities, such as federal programs and grants for community engagement efforts. Water utilities can also access funding sources for infrastructure maintenance and improvement with a focus on equity, including federal, state, and local funding options that center equity. Water utilities can take advantage of co-benefits afforded by GSI to secure local funding and braid funding sources together. Affordability programs are largely funded through operating budgets, but some states offer support to utilities through grant programs.

5.2 Capacity to Operationalize Equity

The review of the literature suggested that capacity constraints contribute to water inequity between communities and challenge utilities attempting to secure the resources needed to integrate equity into their planning activities. Most communities and utilities identified as case studies in the review would be considered "high capacity", with larger service areas, dedicated staff responsible for community engagement or equity, and/or with significant state or local government support for their efforts (Ohene-Okae et al. 2022). The workforce needed to

operationalize equity in utility operations and across business functions is different from the “traditional” water sector workforce, both demographically (e.g., to more accurately represent the demographics of the community) and in terms of skills needed for the job. When the water workforce has the necessary capacity and skills to integrate equity into their operations, there may not be a need for additional funding to support equity efforts. This is because equity becomes part of the daily business of running a water utility.

The review identified a small set of programs available to support capacity building, including new guidance for FEMA’s BRIC program, which has guiding principles that include “supporting communities through capability- and capacity-building” (U.S. Environmental Protection Agency 2023a). Additionally, as part of the Bipartisan Infrastructure Law, the EPA will support standing up 29 Environmental Finance Centers (EFCs) to help communities access funding for infrastructure improvements and greenhouse gas reduction projects, with a particular focus on communities that have historically struggled to access federal funding (U.S. Environmental Protection Agency 2022).

5.3 Collaboration to Support Operationalizing Equity

The literature is rife with examples of utilities collaborating with partners, ranging from academic organizations, to community-based non-profits, to other public sector entities to contribute resources, in-kind support, and capacity; help secure additional funding; and support relationships and engagement with residents (Green Infrastructure Leadership Exchange 2022b). Collaboration is described as a critical element of promoting water equity as a means of establishing trust and relationships in the community, allowing for co-developed solutions to water management problems, sharing resources (Pittsburgh Water and Sewer Authority 2022b), and building capacity to enable participation in decision-making and policy development (U.S. Water Alliance 2023b). In recognition of these factors, new water equity funding from the federal government involves significant collaboration with academic, non-profit, philanthropic and private sector partners (U.S. Environmental Protection Agency 2023c).

Water utilities benefit from collaboration, with partners providing capacity and in-kind support for a variety of activities: research and data collection activities to inform planning and technical problem-solving (The Water Research Foundation 2017), including research into equity implications (U.S. Water Alliance and The Kresge Foundation 2020); human capital needed to conduct community engagement (Pittsburgh Water and Sewer Authority 2022b); resources for implementation of new infrastructure; and education about water issues for local youth and community members that contribute to residents understanding their water system and the function of utilities.

Case study

Before the launch of Green City, Clean Waters, PWD found that many commercial and industrial sites in the city had impervious surfaces, which contributed to significant stormwater runoff. To address this issue, the department created a multifaceted program to work with businesses to enhance their properties with green tools and reduce stormwater bill charges, while also protecting local waterways. The success of the program relied on collaborations with various industries, businesses, faith-based

institutions, hospitals, and nonprofits, and involved granting private funds to manage stormwater. PWD partners with businesses and communities during every phase of infrastructure development and implementation, from site plans to construction and inspection.

The department also partnered with the School District of Philadelphia to promote watershed-based education through the Green City, Clean Waters program. School District of Philadelphia teachers and administrators, in collaboration with the Fairmount Water Works Interpretive Center to create an “Understanding the Urban Watershed” curriculum, which educates middle school students on drinking water, wastewater, and stormwater. Additionally, educators from Philadelphia Parks & Recreation provided GSI lessons at recreation centers and parks across the city (Philadelphia Water Department 2022b).

Case study

PWSA collaborates with non-profit partners like Grounded Strategies and Pittsburgh Parks Conservancy to support local watershed task forces. These organizations bring together experts and concerned citizens at the watershed level to disseminate information about the watershed, discuss watershed planning, and create implementation strategies for small-scale infrastructure projects. They also offer PWSA a conduit by which to conduct community engagement and support capacity building (Pittsburgh Water and Sewer Authority 2022b).

As described above, collaboration can also open doors to new funding opportunities or help utilities more efficiently use available resources. Community-based organizations may be eligible for funding that water utilities are not (Green Infrastructure Leadership Exchange 2022b). Many utilities have already partnered with community groups and local artists to incorporate local artwork into projects and create green space, recreational facilities, and educational training centers, often funded by local philanthropies and other diverse funding sources (U.S. Water Alliance and The Kresge Foundation 2020). Collaborating with a nonprofit organization that has expertise in the water sector or a successful neighboring utility has enabled utilities to reduce costs on supply purchases, hiring qualified system operators, building a sustainable customer base, and other related expenses (U.S. Water Alliance 2021a).

With regards to building relationships with community members, utilities have benefited from partnering with community-based organizations, which often have the trust of residents and can help increase the representativeness of public engagement efforts. Utilities have invited leaders from these organizations to serve on advisory committees to help define the issues and co-develop goals, visions, and principles to guide planning processes (U.S. Water Alliance and The Kresge Foundation 2020). Utilities have also collaborated with other agencies in various sectors that are planning projects in the same neighborhoods. For instance, when municipalities are improving roads or public transportation, utilities can partner with other city departments to make below- and above-ground infrastructure repairs and reduce neighborhood disruptions (U.S. Water Alliance 2017; U.S. Water Alliance and The Kresge Foundation 2020; Philadelphia Water Department 2022b).

Case study

In Atlanta, water utilities, community-based organizations, and nonprofit partners collaborate to achieve equitable, resilient, and integrated water management. The Intrenchment Creek One Water Management Taskforce was formed to restore the healthy hydrological function of the watershed through cross-sector collaboration. The Taskforce developed a plan for equitable, integrated, and complementary water management strategies to address flooding and combined sewer overflows for current and future residents. The Taskforce has now evolved into the Intrenchment Creek Community Stewardship Council, a community-led effort to address flooding and combined sewer overflows while advancing community benefits. The Council will partner with the DWM to advance equitable and resilient water infrastructure and decision-making in Atlanta communities (U.S. Water Alliance 2021b).

Case study

PWD collaborates with the Streets Department to achieve secondary benefits from GSI solutions, such as traffic calming and bike/pedestrian safety, while maximizing taxpayer dollars. (Examples include the American Street Improvement Project and the Cottman Avenue Streetscape project.) The Office of Transportation, Infrastructure, and Sustainability, which aims to incorporate sustainability into projects to meet the city's environmental goals, PennDOT, SEPTA, and PIDC all play significant roles in creating "Complete and Green Streets in Philadelphia" while minimizing the amount of construction taking place in neighborhoods (Philadelphia Water Department 2022b).

Collaboration is a critical element in promoting water equity, as it establishes trust and relationships in the community, allows for co-developed solutions to water management problems, shares resources, and builds capacity to enable participation in decision-making and policy development. Water utilities benefit from partnering with academic organizations, community-based non-profits, and other public sector entities to contribute resources, in-kind support, and capacity. Collaboration can also open doors to new funding opportunities or help utilities more efficiently use available resources. Community-based organizations can help increase the representativeness of public engagement efforts and build relationships with community members. Additionally, utilities have collaborated with other agencies in various sectors to reduce neighborhood disruptions and make infrastructure repairs.

CHAPTER 6

Resources for Utilities: Guidebooks, Measures, Metrics, Data, and Tools

There is a plethora of resources available to water utilities to help them integrate equity into their approaches to water management. This chapter provides an overview of the guidebooks, measures, metrics, data, and tools that can be used to support equitable decision-making processes.

6.1 Existing Guidebooks and Case Studies

The research team reviewed existing guidebooks available to water sector professionals (and professionals from select relevant sectors, including energy) in order to i) determine what guidance was currently publicly available for integrating equity and social dimensions into water management and ii) explore options for designing and formatting the guidebook that will be the end product of this project.

A summary of existing guidebooks (not exhaustive, but representative of guidebooks listed in equity and water management clearinghouses, recommended by project partners, and readily accessible via web search), is shown in Table 6-1 below. Across guidebooks, the aspects of equity that water utilities should consider (contextual, procedural, distributional) are well-covered with the strongest emphasis on procedural equity, both in guidance and case studies (e.g., tips for and examples of community engagement in water planning). There are also guidebooks available to support considerations of *racial* equity, most outside of the context of water equity (e.g., related to municipal policy and decision-making or organizational change more broadly).

Guidebooks touch on some of the aspects of holistic water management, with stormwater management covered most comprehensively within available guidebooks, particularly related to equity considerations. Guidebooks cover equity considerations in water quality/environmental monitoring, to a small degree, and provide guidance that applies to equity considerations in water sector administration and operations or generic guidance that could apply across aspects of water management. Stormwater management also dominated the case studies featured in available guidebooks and reports reviewed, with few real-world examples of equity considerations within other aspects of water management. Relatedly, urban water management considerations were covered more comprehensively than rural considerations, with case studies from larger, high-capacity utilities like Atlanta, GA; Louisville, KY; Milwaukee, WI; Philadelphia, PA; San Francisco, CA; and Seattle, WA featured most often across guidebooks and reports. Finally, implementation factors were largely not discussed in guidebooks, with very limited guidance available on funding approaches to integrate equity and little practical guidance on measuring progress toward equity goals (e.g., data sources were listed, but example measures or metrics were often not provided, much less advice on how to build and execute a measurement or evaluation strategy).

Table 6-1. Existing Guidebooks Related to Equity in Water Management.

Commonly used guidebooks on equity in water management and other relevant guidance documents
Source: Authors' summary of available guidebooks identified via literature review. Sources for each guidebook presented in the table.

Title (Reference)	Author	Aspects of Water Management	Aspects of Equity ¹	Case study communities
Lead Service Line Replacement: Guide to Equity Analysis (LSLR Collaborative)	LSLR Collaborative	Drinking Water	Procedural, Distributional	New York
Equity Guide for Green Stormwater Infrastructure Practitioners (Ohene-Okae et al. 2022)	Green Infrastructure Leadership Exchange, Greenprint Partners	Stormwater management	Contextual, Procedural, Distributional	Seattle, WA; Milwaukee, WI; King County, WA; Atlanta, GA; Pittsburgh, PA; San Francisco, CA; Louisville, KY; Philadelphia, PA; Washington, DC; Oakland, CA
Greening in Place: Protecting Communities from Displacement (Green In Place 2023)	National Audubon Society, Public Counsel, Southeast Asian Community Alliance	Stormwater management	Distributional (primarily)	Atlanta, GA; Chicago, IL; Los Angeles, CA; Greenville, SC
Green Infrastructure in Parks: A Guide to Collaboration, Funding, and Community Engagement (U.S. Environmental Protection Agency 2017)	U.S. EPA	Stormwater management; Water/ Environmental Monitoring and Management	Contextual, Procedural, Distributional	Indianapolis, IN; Philadelphia, PA; Shoreline, WA; Long Island City, NY; Atlanta, GA; Los Angeles, CA; Omaha, NE; Houston, TX; Franklin, MA; Lawrence, MA
Centering Racial Justice in Urban Flood Adaptation: Planning and Evaluation Tools for Decision Makers and Stakeholders (Hughes et al. 2021)	University of Michigan Graham Sustainability Institute.	Stormwater management; Water/ Environmental Monitoring and Management	Contextual, Procedural, Distributional	Great Lakes cities (Buffalo, NY; Detroit, MI; Chicago, IL; Flint, MI; Cleveland, OH; Milwaukee, WI)
Advancing Racial Equity Across the Water Sector: A Toolkit for Utilities (U.S. Water Alliance 2023a)	U.S. Water Alliance	All functions	Procedural, Distributional	None
Water Utility Business Risk and Opportunity Framework: A Guidebook for Water	Cadmus Group, University of Arizona	All functions	None	Fort Collins, CO; San Diego, CA; Tampa, FL; Southern Nevada

¹ Authors' categorization of aspects of equity to align with the equity framework presented in this document. Guidebooks may have used different categories (e.g., including structural or intergenerational equity), which were recoded for this summary table.

Title (Reference)	Author	Aspects of Water Management	Aspects of Equity ¹	Case study communities
Utility Business Function Leaders in a Changing Climate (The Water Research Foundation 2020)				
One Water Implementation Rubric for Utilities (U.S. Water Alliance 2023c)	U.S. Water Alliance	All functions	Procedural, Distributional	None
Making Equity Real in Climate Adaptation and Community Resilience Policies and Programs: A Guidebook (Mohnot, Bishop, and Sanchez 2019)	The Greenlining Institute	N/A	Contextual, Procedural, Distributional	
Tool for Organizational Self Assessment Related to Racial Equity 2014 (Coalition of Communities of Color 2014)	Coalition of Communities of Color	N/A	Contextual, Procedural, Distributional	None
Racial Equity Toolkit: An Opportunity to Operationalize Equity (Nelson and Brooks 2015)	Government Alliance on Race & Equity	N/A	Contextual, Procedural, Distributional	Seattle, WA; Portland, OR; Multnomah County, OR; Madison, WI
City of Seattle Racial Equity Toolkit (City of Seattle 2012)	City of Seattle Race and Social Justice Initiative (RSJI)	N/A	Contextual, Procedural, Distributional	Seattle, WA
The Energy Justice Workbook (Baker, DeVar, and Prakash 2019)	Initiative for Energy Justice	N/A (energy)	Contextual, Procedural, Distributional	California; New York
Integrating Equity into City Clean Energy Initiatives: Considerations and Resources for U.S. Local Governments (Foster, Shaver, and Greene 2022)	Fosterra Inc. and World Resources Institute (WRI), American Cities Climate Challenge Renewables Accelerator	N/A (energy)	Contextual, Procedural, Distributional	Washington, DC; Ann Arbor, MI; Austin, TX; Portland, OR; Cincinnati, OH; Chicago, IL; Buffalo, NY; Oakland, CA; New York City, NY; Connecticut; New York
A Guidebook on Equitable Clean Energy Program Design for Local Governments and Partners (Curti, Andersen, and Wright 2018)	Urban Sustainability Directors Network, Cadmus Group	N/A (energy)	Contextual, Procedural, Distributional	Portland, OR; Minnesota; Colorado; Somerville, MA; Sacramento, CA; Brooklyn, NY

There were some common design elements and features in the guidebooks reviewed. Most were relatively concise and graphics- rather than text-heavy. They featured tables and checklists to organize information and provide tips and were often organized around a guiding framework with graphical signposts to indicate elements of the framework that were being addressed. Many guidebooks included worksheets and blank space, indicating they were intended to be interactive documents and to be filled in by end users.

Regarding common content elements, guidebooks often referenced existing tools and resources but did not offer much detail on those sources beyond brief summaries and embedded links to access them. Guidebooks usually contained a glossary of terms being used and an acronym list. They also leaned heavily on case studies to illustrate how utilities have applied the concepts discussed.

6.2 Existing Quantitative Measures, Metrics, Data, and Data-based Tools

The review identified existing measures, metrics, data, and data-based tool available to water utilities for planning and evaluation purposes which exist at the national, state, and local level at various levels of geographic aggregation, with many aggregating data down to the census tract level. Table 6-2 lists commonly used national-level data and tools and select state and city-level data and tools identified in the review.

Water utilities often use environmental data to identify risks, assets, and community vulnerabilities, but climate and water data often lack information on socio-economic disparities within a service area. Therefore, water professionals need information to determine which populations are most vulnerable to risk and why, in addition to helping them understand other equity implications of their planning decisions. By collecting and integrating social data with climate data, they can work with high-risk communities to better inform stormwater management, groundwater concerns, emergency response, and flood mitigation. Integrated and layered data are increasingly available to utilities at the national and state levels, with some local communities building their own data and tools (U.S. Water Alliance and The Kresge Foundation 2020). Federal and state entities also use existing tools and data to determine target communities for investment. For example, the Climate and Economic Justice Screening Tool (CEJST) will help Federal agencies to identify disadvantaged communities intended to benefit from Justice40 Initiative programs (Council on Environmental Quality 2023). Utilities can use these tools to inform applications for funding through these mechanisms.

Case study

Seattle Public Utilities (SPU) used multiple local tools to identify community vulnerability and resiliency and to facilitate planning: The Drainage and Wastewater (DWW) Social and Environmental Systems Analysis helped to identify residents who may be disproportionately affected by structural sewer system failures. The analysis incorporated citywide data on racial equity, language access, environmental burdens, and health disadvantage. SPU also measured resiliency using the City of Seattle's Racial and Social Equity (RSE) composite index, which linked resiliency to factors such as

limited financial resources, limited English language proficiency, lower educational attainment, and race and ethnicity (Race & Social Justice Initiative 2021).

Case study

Richmond, CA has launched a Climate Action Plan Open Data Dashboard, which serves as a transparent and accessible online portal to collect various social and demographic data. The portal is available for all communities to use in their resilience planning and has been used in water management planning. New map tools display data geographically for flood risk, infrastructure assets, and social vulnerabilities together (U.S. Water Alliance 2023d).

The review included a targeted search for examples of utilities using enhanced triple bottom line (TBL) analyses that include equity components. The review discovered a lack of guidance and case studies on how utilities can integrate cost-benefit indicators that explicitly consider the impact on communities experiencing vulnerability (or other communities of interest) into their analyses. Nevertheless, it is recommended that utilities plan such analyses to showcase how investments can promote equitable water management and have a transformative impact on communities {U.S. Water Alliance, 2017 #26}. Equity-based cost-benefit analysis requires different data and analytic capabilities, as described in the Limitations of Existing Resources section of this chapter.

Case study

Philadelphia's Green City, Clean Waters' Rain Check and Soak It Up Adoption programs aim to achieve environmental, economic, and social benefits. These programs manage stormwater through landscape improvements and provide workshops to educate participants on stormwater management. Rain Check has also created economic gains by generating green jobs for 15 local companies, which has provided part-time stormwater management work for over 40 individuals (Philadelphia Water Department 2021b).

Table 6-2. Existing Data and Data-based Tools for Integrating Equity into Decision-making and Evaluation for Water Management.

Commonly used national-level data and tools and select state and city-level data and tools

Source: Authors' summary of available tools and datasets identified via literature review. Sources for each dataset and data-based tool presented in the table.

Scale	Data tools	Agency	Description	Example communities used
National	Climate and Economic Justice Screening Tool (CEJST) (Council on Environmental Quality 2023)	Council on Environmental Quality (CEQ)	A geospatial mapping tool that identifies areas across the nation where communities are faced with significant burdens. These burdens are organized into eight categories: climate change, energy, health, housing, legacy pollution, transportation, water and wastewater, and workforce development.	General
National	Community Assessment for Public Health Emergency Response (CASPER) (Centers for Disease Control and Prevention 2020)	Centers for Disease Control and Prevention (CDC)	An epidemiologic technique designed to provide household-based information about a community's needs in a timely, inexpensive, and representative manner. This information can be used to initiate public health action, facilitate disaster planning, and assess new or changing needs during the recovery period following a disaster.	Flint, Michigan
National	Equity Tools and Data Sources (LSLR Collaborative 2020)	LSLR Collaborative	Clearinghouse of data sources of interest to water utilities exploring lead service line replacement, including data on National Public Health Resources; Resources for Identifying Locations of Schools and Child Cares; Existing Indices; Community Demographics; Economic and Employment Status; Community Development Patterns; and Other Indicators	
National	EJ SCREEN 2.0 (U.S. Environmental Protection Agency 2023b)	U.S. EPA	An environmental justice (EJ) mapping and screening tool that provides EPA with a nationally consistent dataset and approach for combining environmental and demographic socioeconomic indicators to determine environmental justice. EJScreen includes: 13 environmental indicators, 7 socioeconomic indicators, 13 EJ indexes, 13 supplemental indexes	Pittsburgh (PWSA Stormwater Strategic Plan)
National	EnviroMapper for Envirofacts (U.S. Environmental Protection Agency 2023b)	U.S. EPA	Used to map various types of environmental information, including air releases, drinking water, toxic releases, hazardous wastes, water discharge permits, and Superfund sites. EnviroMapper can be used to create maps at the national, state, and county levels, and link them to environmental text reports.	
National	EJ Clearinghouse	U.S. EPA	A compilation of resources to assist EJ partners, including a variety of screening and mapping tools in addition to resources on subject matter expertise, applying for assistance, available funding,	

			developing organizational capacity, Justice40, public participation, publications, and “What is EJ?”	
National	Environmental Justice Dashboard (Centers for Disease Control and Prevention 2023a)	CDC	Brings together data on environmental exposures, community characteristics, and health burden. Users can enter a county or zip code to view maps, infographics, and other data related to environmental justice at the local level.	
National	Environmental Justice Index (EJI) (Centers for Disease Control and Prevention 2023b)	CDC/Agency for Toxic Substances and Disease Registry (ATSDR)	Scores census tracts using a percentile ranking which represents the proportion of tracts that experience cumulative impacts of environmental burden and injustice equal to or lower than a tract of interest. For example, an EJI ranking of 0.85 signifies that 85% of tracts in the nation likely experience <i>less severe</i> cumulative impacts on health and well-being than the tract of interest. The EJI is constructed by combining three modules of indicators: Environmental burden, Social vulnerability, and Health vulnerability.	
National	How's My Waterway? (U.S. Environmental Protection Agency 2023h)	U.S. EPA	Provides a comprehensive overview of water quality data and information in the United States on three different scales: community, state, and national. Collecting data from eight databases across EPA, HMW answers questions about aquatic life, eating fish, swimming, drinking water, restoration, and protection.	Michigan Department of Environment, Great Lakes, and Energy; Conserve North Texas
National	National Equity Atlas (National Equity Atlas 2024)	PolicyLink and USC Equity Research Institute	A data and policy tool for the community leaders and policymakers who are working to build a new economy that is equitable, resilient, and prosperous. The Atlas contains data on demographic change, racial and economic inclusion, and the potential economic gains from racial equity for the largest 100 cities, 430 large counties, the largest 150 regions, all 50 states, and the United States as a whole.	Honolulu, Hawaii Case Study Atlanta, Georgia Case Study Philadelphia, Pennsylvania/New York, New York Case Study Los Angeles-Long Beach-Santa Ana, California
State	CalEnviroScreen 4.0 (California Office of Environmental Health Hazard Assessment 2023)	California Office of Environmental Health Hazard Assessment (OEHHA) and the	Many states offer web-based applications to assist in evaluating community vulnerability throughout the State. Vulnerability may be based on exposure to environmental hazards (e.g., pollution),	California

		California Environmental Protection Agency (EPA)	health indicators, socioeconomic indicators (e.g., income, poverty, race/ethnicity), or a combination. Many states offer web-based applications to assist in evaluating community vulnerability throughout the State. Vulnerability may be based on exposure to environmental hazards (e.g., pollution), health indicators, socioeconomic indicators (e.g., income, poverty, race/ethnicity), or a combination.	
State	California Disadvantaged Communities Mapping Tool (California Department of Water Resources 2023)	CA DWR		California
State	Mapping for Environmental Justice (The Green Initiative Fund 2020)	Mapping for Environmental Justice		Colorado
State	Connecticut Distressed Municipalities (Connecticut Department of Economic and Community Development 2023)	Connecticut Department of Economic & Community Development		Connecticut
State	Environmental Justice Communities (Illinois Power Agency 2023)	Illinois Solar For All		Illinois
State	Illinois EJStart (Illinois Environmental Protection Agency 2023)	Illinois EPA		Illinois
State	Hoosier Resilience Index (Indiana University 2024)	Indiana University		Indiana
State	Maryland EJScreen Mapper (Maryland Department of Natural Resources 2023)	Maryland Department of Natural Resources		Maryland
State	Environmental Justice Viewer (Massachusetts Department of Environmental Protection 2022)	Massachusetts Department of Environmental Protection		Massachusetts
State	Assessing the State of Environmental Justice in	University of Michigan		Michigan

	Michigan (Grier, Mayor, and Zeuner 2019)		<p>Many states offer web-based applications to assist in evaluating community vulnerability throughout the State. Vulnerability may be based on exposure to environmental hazards (e.g., pollution), health indicators, socioeconomic indicators (e.g., income, poverty, race/ethnicity), or a combination.</p>	
State	Understanding Environmental Justice in Minnesota (Minnesota Pollution Control Agency 2023)	Minnesota Pollution Control Agency		Minnesota
State	Environmental Justice Areas* (East-West Gateway of Governments-Missouri 2021)	East-West Gateway of Governments		Missouri
State	Environmental Justice Mapping, Assessment and Protection Tool (EJMAP) (New Jersey Department of Environmental Protection 2022)	New Jersey Department of Environmental Protection		New Jersey
State	EJ Mapper (New Mexico Environment Department 2024)	New Mexico Environment Department		New Mexico
State	Potential Environmental Justice Areas* (New York Department of Environmental Conservation 2022)	New York Department of Environmental Conservation		New York
State	North Carolina Community Mapping System (North Carolina Department of Environmental Quality 2022)	North Carolina Department of Environmental Quality		North Carolina
State	PennEnviroScreen (Pennsylvania Department of Environmental Protection 2023)	Pennsylvania Department of Environmental Protection		Pennsylvania
State	Virginia Block Group Level Demographic Maps	Virginia Department of Transportation		Virginia

	(Virginia Department of Transportation 2023)		Many states offer web-based applications to assist in evaluating community vulnerability throughout the State. Vulnerability may be based on exposure to environmental hazards (e.g., pollution), health indicators, socioeconomic indicators (e.g., income, poverty, race/ethnicity), or a combination.	
State	Washington Tracking Network (Washington Department of Health 2022)	Washington Department of Health		Washington
City	Twin Cities Environmental Justice Mapping Tool (Center for Earth 2015)	Center for Earth Energy & Democracy (CEED)	Some cities offer web-based tools (interactive) or static reports that layer data on environmental risks (e.g., pollution) with social and economic data to enable integrating equity into decision-making.	Minneapolis - St. Paul
City	Drainage and Wastewater (DWW) Social and Environmental Systems Analysis (Seattle Public Utilities 2020)	City of Seattle, SPU		Seattle
City	Racial and Social Equity Index (RSE) (City of Seattle 2023)	City of Seattle, SPU		Seattle

6.2.1 Lessons in Applying and Modifying Measures, Metrics, Data, and Tools

While the review identified an abundance of data and tools available to utilities and hosted on some utility websites, there is a dearth of information available in the literature on how measures, metrics, data, and tools have been used in practice in the context of integrating equity into water management, including a lack of case studies illustrating these experiences.

Given the nature of available data, existing tools have primarily been used by utilities to identify communities of need, disadvantaged, frontline, and EJ communities. By analyzing data on risk, vulnerability, and equity, water utilities have determined which communities are most at risk of experiencing water-related issues, such as flooding, water contamination, or drought impacts. This information has been used to prioritize investments in infrastructure and services to address these issues and ensure equitable access to safe and sustainable water services (See section 3.3 on Contextual Equity for more information and case studies) (Pittsburgh Water and Sewer Authority 2022c). Additionally, data have been used to understand the multiple benefits of investments in water infrastructure, such as improved public health, economic development, and environmental sustainability (Ohene-Okae et al. 2022). By considering these benefits, water utilities have been able to make more informed decisions about where to invest resources and how to maximize the impact of their investments. In cases of EIBs, these analyses have been measures of the success of the project and determine the amount of financial return for investors (Quantified Ventures 2023). In addition, data have been used to support disaster response efforts. By collecting and analyzing data on the health and well-being of affected communities, water utilities have been able to better understand the impact of disasters and develop more effective response strategies to support the needs of affected communities.

Case study

During the Flint water crisis, when lead-contaminated water was supplied to residents, a Community Assessment for Public Health Emergency Response (CASPER) tool was used to initiate public health action, facilitate disaster planning, and assess new or changing needs during the recovery period (Centers for Disease Control and Prevention 2016). The index helped in determining which neighborhoods were most at risk due to factors such as poverty, race, and education level. This information was critical in prioritizing assistance and interventions for the affected communities.

Case study

In New Orleans Louisiana, after Hurricane Katrina struck in 2005, the CDC's Social Vulnerability Index (SVI) was used to assess the social vulnerability of communities affected by the disaster (Flanagan et al. 2011). It helped identify areas with high concentrations of people who were at a greater risk due to factors like poverty, disability, and lack of access to transportation and healthcare. This information aided in targeting relief efforts and resources to the most vulnerable areas.

The review suggested that available data are rarely ready to use “off the shelf” to directly inform water utilities’ equity-based decision-making, nor should they be used without consideration of the community context. Often available data had to be supplemented with local information in coordination with other water professionals (e.g., modeling or water

quality experts), as well as housing departments, planning agencies, community development corporations, and community-based organizations in order to provide information needed to understand equity implications, multiple benefits, or unintended consequences (U.S. Water Alliance 2017).

Most publicly available data for water management planning is quantitative in nature. Some utilities have utilized qualitative methods to offer context and explanation of quantitative data, including meeting with community members where they live and working directly with them to collect and use information, which helps build trust and ensure that investments are cost-effective, meet multiple objectives, and contribute to community resilience. For example, people living in high-risk areas have extensive knowledge of the realities of chronic flooding and understand their neighborhood's specific challenges with floodwaters, as well as external factors such as affordability concerns that affect their ability to prepare, cope with, and recover from disasters. This lived experience can help evaluate appropriate flood mitigation strategies (U.S. Water Alliance and The Kresge Foundation 2020).

Case study

The importance of citizen engagement in developing measures was demonstrated in Pittsburgh, where climate experts from the RAND Corporation are collaborating with PWSA to integrate technical and social data for innovative green infrastructure system design and policy evaluation. By using advanced modeling of wet weather events in the Negley Run Watershed, hilly areas that experience regular flooding were identified. When paired with information gleaned from stakeholder engagement, a more comprehensive approach to mapping risks has emerged (U.S. Water Alliance and The Kresge Foundation 2020).

Beyond collecting qualitative data from residents, some utilities have engaged in community science approaches, as both a means of collecting information to inform their planning, but also as a community engagement strategy. Community science techniques involve training the public to engage in scientific data collection and analysis, and they can be useful for filling data gaps, particularly in measuring flooding or water quality issues. For example, the use of cell phone cameras and apps can help document flooding impacts and provide localized information in a visual format (U.S. Water Alliance and The Kresge Foundation 2020). Training community members to monitor their water, collect samples, perform tests, and provide materials and support can also help fill research gaps where government-sponsored water monitoring is not available or accessible (U.S. Water Alliance 2017).

Case study

The Chesapeake Bay SAV (submerged aquatic vegetation) Watchers program is a volunteer-based effort coordinated by the Bay Program's SAV Workgroup that provides community members with an educational experience while also generating valuable data for Bay scientists and resource managers. Volunteers collect information on SAV diversity and habitat characteristics at various sites throughout the Bay and its tributaries and submit photos of their observations. These data have been useful for assessing the overall condition of the Bay and identifying the relationship between drivers and responses, such

as the impact of improved water quality conditions on SAV growth (Chesapeake Bay Program 2023).

6.2.2 Limitations of Existing Measures, Metrics, Data, and Tools

While there are a lot of tools, guidebooks, and data available for utilities considering equity approaches, there are limitations to the applicability and comprehensiveness of many existing resources.

Data availability and standardization

In general, data available to water utilities is not sufficient or standardized to the extent necessary for equity measurement. Data available to water utilities is often in unique formats specific to the entity collecting it. This data is typically stored in legacy IT systems developed in the early 2000s or even the 1990s, often in closed, hard-to-access proprietary formats (U.S. Water Alliance 2021a). This makes accessing and using historical data within entities and collaboration across entities challenging. There are also very few online clearinghouses of standardized water-related data (Hughes et al. 2023), inhibiting innovation and research into water management issues. Finally, for utilities interested in measuring the equity outcomes and impact associated with their investments, it is often challenging to find the data and design analyses necessary to make attributions. This is particularly true for those interested in TBL analyses: Assumptions are liberally applied to enable utilities to assign broad social and economic benefits (e.g., health or employment impacts) specifically to their water investments. Additional specific data limitations are described in the sections below.

Measures of equity

There are several limitations to existing measures of equity for water sector professionals. One limitation is that traditional measures of equity, such as those based on income or race, may not fully capture the complexity and heterogeneity of social and economic disparities that exist within geographic communities. For example, a community may have a high median income but still have pockets of poverty and inequality. Moreover, when they account for more complex aspects of social and economic characteristics, many existing “equity” measures do so by relying on measures of vulnerability, including vulnerability indices. Existing vulnerability indices, such as the CDC’s SVI or the Social Vulnerability Index (SoVi), developed at the Hazards Vulnerability & Resilience Institute at the University of South Carolina, have limitations including tending to focusing on vulnerability due to *characteristics of populations* rather than *processes* (e.g., policies and practices) that have generated vulnerability; lack of transparency in construction and the data that make up the indices; and a lack of established validity and reliability (Finucane, Warren May, and Chang 2021a).

Existing measures do not often fully cover the dimensions of equity (contextual, procedural, and distributional). Measures may not fully capture the historical and cultural context of communities, which can influence their access to and use of water resources, as well as trust in water utilities and ways in which water utilities ought to plan for community engagement. Additionally, existing measures may not fully capture the procedural equity of decision-making processes, such as the extent to which community members are involved in water management decisions and the role of community power and privilege dynamics in those decisions. Finally,

many existing tools are intended to be used as “screening tools” (e.g., the EPA’s EJScreen) or “pre-decisional tools” rather than tools to be used to determine outcomes or impacts of decisions, investments, or policies. As a result, the actual equity impacts of investments are not easily assessed with existing tools.

Moreover, data are often not disaggregated sufficiently for utilities to use for measuring their chosen parameters of equity. For example, if utilities are interested in geographic equity, they require data to be available at small geographic units of analysis. If they are interested in racial equity, data must be disaggregated by race. (In instances where disaggregation by race/ethnicity is not possible, many utilities have relied on geographic equity to stand-in for racial equity, given residential segregation patterns in many U.S. cities.)

Existing resources do also not currently provide guidance on developing appropriate equity outcomes for programs and policies in different community contexts, using available data from national sources or from utilities themselves. Moreover, guidance is needed to support utilities to understand and balance trade-offs between community preferences, utility goals, and existing regulations in the development of equity outcomes.

Capacity limitations

Using existing data sources, much less modifying and supplementing them to the extent necessary to overcome the limitations described above, requires significant technical and human resources capacity on the part of water utilities. Most examples of utilities that have been able to do this well have been large, urban utilities in collaboration with a diverse set of external partners, including academic and other research partners. A lack of capacity results in many utilities not using the available resources to their full potential or using them incorrectly to make decisions based on information that is not rigorous or reliable.

Summary

Despite the availability of tools, guidebooks, and data for utilities considering equity approaches, there are limitations to the applicability and comprehensiveness of many existing resources. Data availability and standardization are major challenges, with data often not being sufficient or standardized enough for equity measurement. Existing measures of equity also have limitations, including not fully covering the dimensions of equity and not being disaggregated sufficiently for utilities to use for measuring their chosen parameters of equity. Using existing data sources requires significant technical and human resources capacity on the part of water utilities, resulting in under-utilization or mis-utilization of available resources.

References

American Rivers. 2020. "Building a Community of Practice at the Intersection of Water, Climate Resilience, and Equity: Insights and Opportunities from an Assessment of The Kresge Foundation's Climate Resilient and Equitable Water Systems (CREWS) Initiative." American Rivers,. Accessed November 16. https://kresge.org/wp-content/uploads/2020/06/crews_program_assement_public_report_hi_res.pdf.

American Water Works Association. 2019. "A Water Utility Manager's Guide to Community Stewardship." American Water Works Association. Accessed November 16. <https://www.awwa.org/Portals/0/AWWA/Communications/AWaterUtilityManagersGuidetoCommunityStewardship.pdf>.

Baer, Katherine, Caroline Koch, and April Ingle. 2021. "Building Blocks of Trust: Creating Authentic Equitable Relationships Between Community Organizations and Water Utilities." River Network: A Waternow Alliance. Last Modified November. Accessed November 16. <https://www.rivernetwork.org/wp-content/uploads/2021/11/buildingblocksoftrust-r3.pdf>.

Bailly, Anaïs, Benjamin P Brumley, Megan A Mraz, Benjamin S Morgan, Gwenelle Styles O'Neal, Brie Radis, Susan R Wysor Nguema, Colleen Keeler, Mia Ocean, and Erin N Spencer. 2021. "Anti-Racism Working Group: Exploring the Results of an Interdisciplinary Partnership at a Large Public University." *Advances in Social Work* 21 (2/3): 857-875.

Baker, Shalanda, Subin DeVar, and Shiva Prakash. 2019. *The Energy Justice Workbook*. (Initiative for Energy Justice). <https://iejusa.org/wp-content/uploads/2019/12/The-Energy-Justice-Workbook-2019-web.pdf>.

Barr, Omid. 2022. "Leveraging the Integrated Planning Framework for Advancing Climate Resilience and Environmental Justice." UNC School of Government Environmental Finance Center. Accessed November 11. https://efc.sog.unc.edu/wp-content/uploads/sites/1172/2022/07/2022_Integrated_Planning_Final.pdf.

Been, Vicki. 2005. "Impact fees and housing affordability." *Cityscape*: 139-185.

Bosman, Juliet. 2016. After Water Fiasco, Trust of Officials Is in Short Supply in Flint. *New York Times*.

Bozuwa, Johanna. 2019. "Building Resiliency through Green Infrastructure: A Community Wealth Building Approach." The Democracy Collaborative Foundation, Inc. Last Modified February 28. Accessed November 16. <https://democracycollaborative.org/publications/building-resiliency-through-green-infrastructure-a-community-wealth-building-approach>.

Caballero, Mariah D, Thushara Gunda, and Yolanda J McDonald. 2022. "Pollution in the press: Employing text analytics to understand regional water quality narratives." *Frontiers in Environmental Science* 10: 770812.

California Department of Water Resources. 2023. "The Disadvantaged Community Mapping Tool." California Department of Water Resources,. Accessed November 7.
<https://gis.water.ca.gov/app/dacs/>.

California Office of Environmental Health Hazard Assessment. 2023. "CalEnviroScreen 4.0." California Office of Environmental Health Hazard Assessment and the California Environmental Protection Agency. Last Modified May. Accessed November 16.
<https://oehha.ca.gov/calenviroscreen/report/calenviroscreen-40>.

California State Water Resources Control Board. 2013. "Recommendations Addressing Nitrate in Groundwater." California State Water Resources Control Board,. Accessed May 22.
https://www.waterboards.ca.gov/water_issues/programs/nitrate_project/docs/nitrate_rpt.pdf

---. 2020. "Nitrate Project." California State Water Resources Control Board,. Accessed May 22.
https://www.waterboards.ca.gov/water_issues/programs/nitrate_project/index.html.

---. 2021. "Safe Drinking Water Plan for California." California State Water Resources Control Board,. Accessed May 22.
https://www.waterboards.ca.gov/drinking_water/safedrinkingwaterplan/docs/ExecSumPlan_Report.pdf.

Center for Earth, Energy & Democracy. 2015. "Twin Cities Environmental Justice Mapping Tool." Last Modified September 1. Accessed November 8, 2023. <https://ceed.org/the-latest/twin-cities-environmental-justice-mapping-tool-released/>.

Centers for Disease Control and Prevention. 2016. "Community Assessment for Public Health Emergency Response (CASPER) After the Flint Water Crisis: May 17–19, 2016." Centers for Disease Control and Prevention. Accessed November 16. https://www.michigan.gov/-/media/Project/Websites/flintwater/documents/2016/CASPER_Report.pdf?rev=d49ce88517a34da9b3b8887076e07e10.

---. 2020. "Community Assessment for Public Health Emergency Response (CASPER): Interactive Map of CASPERs." Centers for Disease Control and Prevention. Last Modified February 28. Accessed November 8. https://www.cdc.gov/nceh/casper/casper_map.htm.

---. 2023a. "Environmental Justice Dashboard." Centers for Disease Control and Prevention. Accessed November 8. <https://ephtracking.cdc.gov/Applications/ejdashboard/>.

---. 2023b. "Environmental Justice Index (EJI) Explorer." Centers for Disease Control and Prevention. Accessed November 7. <https://onemap.cdc.gov/portal/apps/sites/#/eji-explorer>.

Chavis, Benjamin. 1987. *Toxic Waste and Race in the United States: A National Report on the Racial and Socio-Economic Characteristics of Communities within Hazardous Waste Sites*. United Church of Christ Commission for Racial Justice (New York, NY: United Church of Christ Commission for Racial Justice).

https://d3n8a8pro7vhmx.cloudfront.net/unitedchurchofchrist/legacy_url/13567/toxwrace87.pdf?1418439935.

Chesapeake Bay Program. 2023. "Tier II: Chesapeake Bay SAV Watchers Program." Chesapeake Bay Program. Accessed November 15.

<https://www.chesapeakebay.net/what/programs/monitoring/sav-monitoring-program/tier-ii-chesapeake-bay-sav-watchers-program#:~:text=The%20second%20tier%20of%20the%20Chesapeake%20Bay%20SAV,useful%20data%20for%20Bay%20scientists%20and%20resource%20managers.>

City of New York. 2023. "Mayor Adams Announces Construction of new Cloudburst Resiliency Projects to Better Manage Intense Rainfall Events in Flood-Prone Neighborhoods." City of New York. Accessed May 22. <https://www.nyc.gov/office-of-the-mayor/news/023-23/mayor-adams-construction-new-cloudburst-resiliency-projects-better-manage-intense>.

City of Philadelphia. 2023. "Operations Transformation Fund." City of Philadelphia. Accessed November 7, 2023. <https://www.phila.gov/programs/operations-transformation-fund/>.

City of Seattle. 2012. "Racial Equity Toolkit: To Assess Policies, Initiatives, Programs, and Budget Issues." 1-page instructions. City of Seattle,. Accessed November 16.

https://www.seattle.gov/documents/Departments/RSJI/RacialEquityToolkit_Introduction.pdf.

---. 2023. "City of Seattle Racial and Social Equity Index Users' Guide." City of Seattle,. Accessed November 16.

<https://www.seattle.gov/Documents/Departments/OPCD/Demographics/RacialSocialEquityIndexUsersGuide2023.pdf>.

Coalition of Communities of Color. 2014. "Tool for Organizational Self Assessment Related to Racial Equity 2014." Coalition of Communities of Color. Accessed November 16.

<https://www.coalitioncommunitiescolor.org/research-and-publications/ccorgassessment>.

Connecticut Department of Economic and Community Development. 2023. "Distressed Municipalities." Connecticut Department of Economic and Community Development. Accessed November 7, 2023. https://portal.ct.gov/DECD/Content/About_DECD/Research-and-Publications/02_Review_Publications/Distressed-Municipalities.

Council on Environmental Quality. 2023. "Climate and Economic Justice Screening Tool: Explore the Map." Accessed November 16. <https://screeningtool.geoplatform.gov/en/#3/33.47/-97.5>.

Cousins, Joshua J. 2018. "Remaking stormwater as a resource: Technology, law, and citizenship." *Wiley Interdisciplinary Reviews: Water* 5 (5): e1300.

Crisp, Gloria, Emily Kolby, and Charlie Potter. 2022. "Centering Equity in Transfer Partnerships." *Journal of College Orientation, Transition, and Retention* 29 (2).

Cronin, Amanda, and David M Ostergren. 2007. "Tribal Watershed Management: Culture, Science, Capavity, and Collaboration." *American Indian Quarterly*: 87-109.

- Curti, Julie, Farah Andersen, and Kathryn Wright. 2018. *A Guidebook on Equitable Clean Energy Program Design for Local Governments and Partners*. (Urban Sustainability Directors Network). https://drive.google.com/file/d/1P5JqV9Bf8T2JZI4ruXSzuOHn7lytzl6_/view.
- Cushing, Lara J., Kristin B. Dobbin, Na'Taki Osborne Jelks, Xinyue Liu, and Rachel Morello-Frosch. 2023. "Water Insecurity And Population Health: Implications For Health Equity And Policy." *Health Affairs, Health Policy Brief*. <https://www.healthaffairs.org/doi/10.1377/hpb20230921.68748/full/>.
- Department of Environment, Great Lakes, and Energy. 2023. "Affordability and Planning Grant." State of Michigan Government. Accessed November 7, 2023. <https://www.michigan.gov/egle/regulatory-assistance/grants-and-financing/affordability-planning-grant>.
- Dilling, Lisa, Meaghan E. Daly, William R. Travis, Andrea J. Ray, and Olga V. Wilhelmi. 2023. "The role of adaptive capacity in incremental and transformative adaptation in three large U.S. Urban water systems." *Global Environmental Change* 79: 102649. <https://www.sciencedirect.com/science/article/pii/S0959378023000158>.
- Dobbin, Kristin B, and Mark Lubell. 2021. "Collaborative governance and environmental justice: Disadvantaged community representation in California sustainable groundwater management." *Policy Studies Journal* 49 (2): 562-590.
- Dragoman, Liana. 2022. "Case Study: Building an equitable community engagement practice." City of Philadelphia. Last Modified April 25. Accessed November 7, 2023. <https://www.phila.gov/2022-04-25-case-study-building-an-equitable-community-engagement-practice/>.
- East-West Gateway of Governments-Missouri. 2021. "2021 Title VI Program Maps – by Jurisdiction." East-West Gateway of Governments-Missouri. Accessed November 7, 2023. <https://www.ewgateway.org/library-post/2021-title-vi-program-maps-by-jurisdiction/>.
- Emrich, Christopher T, Eric Tate, Sarah E Larson, and Yao Zhou. 2020. "Measuring social equity in flood recovery funding." *Environmental Hazards* 19 (3): 228-250.
- Fernandez-Bou, Angel Santiago, J. Pablo Ortiz-Partida, Leticia M. Classen-Rodriguez, Chantelise Pells, Kristin B. Dobbin, Vicky Espinoza, José Manuel Rodríguez-Flores, Chia Thao, Courtney R. Hammond Wagner, Amanda Fencl, Humberto Flores-Landeros, Mahesh L. Maskey, Spencer A. Cole, Shayda Azamian, Eliseo Gamiño, Alexander Guzman, Ana Grace F. Alvarado, Miriam S. Campos-Martínez, Coreen Weintraub, Espi Sandoval, Ruth M. Dahlquist-Willard, Leigh A. Bernacchi, Colleen C. Naughton, Robin M. DeLugan, and Josué Medellín-Azuara. 2021. "3 Challenges, 3 Errors, and 3 Solutions to Integrate Frontline Communities in Climate Change Policy and Research: Lessons From California." *Frontiers in Climate* 3. <https://www.frontiersin.org/articles/10.3389/fclim.2021.717554>.
- Fernandez-Bou, Angel Santiago, José M. Rodríguez-Flores, Alexander Guzman, J. Pablo Ortiz-Partida, Leticia M. Classen-Rodriguez, Pedro A. Sánchez-Pérez, Jorge Valero-Fandiño, Chantelise

Pells, Humberto Flores-Landeros, Samuel Sandoval-Solís, Gregory W. Characklis, Thomas C. Harmon, Michael McCullough, and Josué Medellín-Azuara. 2023. "Water, environment, and socioeconomic justice in California: A multi-benefit cropland repurposing framework." *Science of The Total Environment* 858: 159963.

<https://www.sciencedirect.com/science/article/pii/S0048969722070632>.

Finucane, Melissa L., Linnea Warren May, and Joan Chang. 2021a. *Assessing Social Equity in Disaster Preparation, Response, and Recovery*. Santa Monica, CA: RAND Corporation.

---. 2021b. *A Scoping Literature Review on Indicators and Metrics for Assessing Racial Equity in Disaster Preparation, Response, and Recovery*. Santa Monica, CA: RAND Corporation.

Flanagan, Barry E., Edward W. Gregory, Elaine J. Hallisey, Janet L. Heitgerd, and Brian Lewis. 2011. "A Social Vulnerability Index for Disaster Management." *Journal of Homeland Security and Emergency Management* 8 (1).

https://www.atsdr.cdc.gov/placeandhealth/svi/img/pdf/flanagan_2011_svifordisastermanagement-508.pdf.

Foster, Ben, Lacey Shaver, and Zach Greene. 2022. *Integrating Equity into City Clean Energy Initiatives: Considerations and Resources for U.S. Local Governments* (American Cities Climate Challenge). <https://cityrenewables.org/wp-content/uploads/2022/01/Integrating-Equity-into-City-Clean-Energy-Initiatives.pdf>.

Fricker, Miranda. 2007. *Epistemic injustice: Power and the ethics of knowing*. Oxford University Press.

Fu, Samantha, James Ladi Williams, and Anna Shipp. 2022. "Advancing Equity, Climate Action, and Economic Health in Communities: Challenges and Opportunities for the Justice40 Initiative." Urban Institute. Accessed October 28.

<https://www.urban.org/sites/default/files/2022-10/Advancing%20Equity%20Climate%20Action%20and%20Economic%20Health%20in%20Communities.pdf>.

Gen, Sheldon, Holley Shafer, and Monique Nakagawa. 2012. "Perceptions of environmental justice: The case of a US urban wastewater system." *Sustainable Development* 20 (4): 239-250.

Georgetown Climate Center. 2022. "Adaptation Clearinghouse." Accessed November 7. <https://www.adaptationclearinghouse.org/>.

Goddard, Jessica J, Isha Ray, and Carolina Balazs. 2021. "Water affordability and human right to water implications in California." *PloS one* 16 (1): e0245237.

Green In Place. 2023. "Protecting Communities from Displacement." Toolkit. Accessed November 16. <https://greeninginplace.squarespace.com/toolkit>.

Green Infrastructure Leadership Exchange. 2021. "State of Equity Practice in Public Sector: Green Stormwater Infrastructure 2021 Baseline Report." Accessed November 16.

<https://giexchange.org/wp-content/uploads/2022/01/State-of-Equity-in-Public-Sector-GSI-Baseline-Report-FINAL.pdf>.

---. 2022a. "Community Voices on Equity & Green Stormwater Infrastructure." Accessed November 16. <https://giexchange.org/wp-content/uploads/CommunityVoices.2022.pdf>.

---. 2022b. "The State of Public Sector Green Stormwater Infrastructure 2022." Accessed November 16. <https://giexchange.org/wp-content/uploads/TheStateOfPublicSectorGSI.pdf>.

Grier, Laura, Delia Mayor, and Brett Zeuner. 2019. "Assessing the State of Environmental Justice in Michigan." University of Michigan. Accessed November 16. <https://deepblue.lib.umich.edu/handle/2027.42/149105>.

Hernandez, Ariana, and Gregory Pierce. "The geography and socioeconomic characteristics of US households reliant on private wells and septic systems." *JAWRA Journal of the American Water Resources Association*.

Heynen, Nik, Harold A Perkins, and Parama Roy. 2006. "The political ecology of uneven urban green space: The impact of political economy on race and ethnicity in producing environmental inequality in Milwaukee." *Urban Affairs Review* 42 (1): 3-25.

Hoogesteger, Jaime, and Philippus Wester. 2015. "Intensive groundwater use and (in) equity: Processes and governance challenges." *Environmental science & policy* 51: 117-124.

Hughes, Sara, Christine J. Kirchhoff, Katelynn Conedera, and Mirit Friedman. 2023. "The Municipal Drinking Water Database." *PLOS Water* 2 (4): e0000081. <https://doi.org/10.1371/journal.pwat.0000081>. <https://doi.org/10.1371/journal.pwat.0000081>.

Hughes, Sara, Kirsten Schwarz, Joyce Coffee, Genevieve LaMarr LeMee, Sarah Dobie, Madeleine Lane, and Andres Gonzalez. 2021. *Centering Racial Justice in Urban Flood Adaptation: Planning and Evaluation Tools for Great Lakes Cities*. University of Michigan Graham Sustainability Institute (Ann Arbor, MI). <https://graham.umich.edu/media/pubs/Catalyst-Report-Centering-Racial-Justice-in-Urban-Flood-Adaptation-48491.pdf>.

Illinois Environmental Protection Agency. 2023. "Environmental Justice Communities Map." Illinois Environmental Protection Agency. Accessed May 22. <https://elevate.maps.arcgis.com/apps/webappviewer/index.html?id=d87a45c18a5c4e0fa96c1f03b6187267>.

Illinois Power Agency. 2023. "Illinois Solar for All: Environmental Justice Communities." Illinois Power Agency. Accessed November 7, 2023. <https://www.illinoissfa.com/environmental-justice-communities/>.

Indiana University. 2024. "Hoosier Resilience Index." Indiana University. Accessed May 22. <https://hri.eri.iu.edu/index.html>.

Islam, Labonno. 2021. "The Operations Transformation Fund and Innovating Internally." City of Philadelphia. Last Modified August 16. Accessed November 7, 2023.

<https://www.phila.gov/2021-08-16-the-operations-transformation-fund-and-innovating-internally/>.

Jackson, Sue. 2018. "Indigenous peoples and water justice in a globalizing world." *The Oxford handbook of water politics and policy*: 120.

Kalra, Nidhi, Swaptik Chowdhury, Kelly Klima, and Liam Regan. 2022. *Equity Metrics for Climate Adaptation in the Electricity Sector*. Santa Monica, CA: RAND Corporation.

Karasaki, Seigi, Jessica J. Goddard, Alasdair Cohen, and Isha Ray. 2023. "Environmental justice and drinking water: A critical review of primary data studies." *WIREs Water* 10 (5): e1653. <https://wires.onlinelibrary.wiley.com/doi/abs/10.1002/wat2.1653>.

Karim, Kaleh, Sujata Guha, and Ryan Beni. 2020. "Comparative Analysis of Water Quality Disparities in the United States in Relation to Heavy Metals and Biological Contaminants." *Water* 12 (4): 967.

Kinney, Aimee, Raye Evrard, Kevin Bogue, and Christopher Andrew James. 2023. "Filling the gap: A comparative analysis of stormwater utility fees and stormwater program budgets in the Puget Sound watershed." *JAWRA Journal of the American Water Resources Association* 59 (5): 1128-1145.

Kronenberg, Jakub, Erik Andersson, David N. Barton, Sara T. Borgström, Johannes Langemeyer, Tove Björklund, Dagmar Haase, Christopher Kennedy, Karolina Koprowska, Edyta aszkiewicz, Timon McPhearson, Erik E. Stange, and Manuel Wolff. 2021. "The thorny path toward greening: unintended consequences, trade-offs, and constraints in green and blue infrastructure planning, implementation, and management." *Ecology and Society* 26 (2). <https://doi.org/10.5751/ES-12445-260236>. <https://www.ecologyandsociety.org/vol26/iss2/art36/>.

LA River Master Plan. 2024. "Back to: About: Funding Sources." County of Los Angeles. Accessed May 22. <https://larivermasterplan.org/about/funding-sources/existing-funding-sources/>.

Langsdale, Stacy M., and Hal E. Cardwell. 2022. "Stakeholder engagement for sustainable water supply management: what does the future hold?" *AQUA - Water Infrastructure, Ecosystems and Society* 71 (10): 1095-1104. <https://iwaponline.com/aqua/article/71/10/1095/91431/Stakeholder-engagement-for-sustainable-water>.

Locke, Dexter H, Amanda K Phillips de Lucas, Colleen Murphy-Dunning, Dawn Henning, and Giovanni Zinn. 2021. "Contextual considerations of green stormwater infrastructure siting." *Cities and the Environment (CATE)* 14 (2): 2.

LSLR Collaborative. "Lead Service Line Replacement: Guide to Equity Analysis." Accessed May 15. <https://www.lslr-collaborative.org/step-1-equity-analysis.html>.

---. 2020. "Equity Tools and Data Sources." LSLR Collaborative. Accessed May 15. <https://www.lslr-collaborative.org/equity-tools-and-data-sources.html>.

- Maantay, Juliana, and Andrew Maroko. 2009. "Mapping urban risk: Flood hazards, race, & environmental justice in New York." *Applied geography* 29 (1): 111-124.
- Maryland Department of Natural Resources. 2023. "MDE EJ Screening Tool Version 2.0 Beta." Maryland Department of Natural Resources. Accessed November 7, 2023. <https://mdewin64.mde.state.md.us/EJ/>.
- Mason, Lisa Reyes, Kelsey N. Ellis, and Jon M. Hathaway. 2019. "Urban flooding, social equity, and "backyard" green infrastructure: An area for multidisciplinary practice." *Journal of Community Practice* 27 (3-4): 334-350. <https://doi.org/10.1080/10705422.2019.1655125>.
<https://doi.org/10.1080/10705422.2019.1655125>.
- Massachusetts Department of Environmental Protection. 2022. "Environmental Justice Populations in Massachusetts." Massachusetts Department of Environmental Protection. Accessed November 7, 2023. <https://www.mass.gov/info-details/environmental-justice-populations-in-massachusetts>.
- Matsler, Marissa, Michael Finewood, Ruthann Richards, Olivia Pierce, and Zenya Ledermann. 2023. "Institutionalizing barriers to access? An equity scan of green stormwater infrastructure (GSI) incentive programs in the United States." *Journal of Environmental Policy & Planning*: 1-16.
- Matsuda, Mari J. 1987. *Minority Critique of CLS: Looking to the Bottom: Critical Legal Studies and Reparations*. Vol. 22. Harvard Civil Rights-Civil Liberties Law Review.
- McDermott, Melanie, Sango Mahanty, and Kate Schreckenber. 2013. "Examining equity: A multidimensional framework for assessing equity in payments for ecosystem services." *Environmental Science & Policy* 33: 416-427.
<https://doi.org/https://doi.org/10.1016/j.envsci.2012.10.006>.
<https://www.sciencedirect.com/science/article/pii/S1462901112001773>.
- MCRC. 2017. "The Flint Water Crisis: Systemic Racism Through the Lens of Flint." Michigan Civil Rights Commission. Last Modified February 17. Accessed November 16.
<https://www.michigan.gov/-/media/Project/Websites/mdcr/mcrc/reports/2017/flint-crisis-report-edited.pdf?rev=4601519b3af345cfb9d468ae6ece9141#:~:text=The%20people%20of%20Flint%20have,your%20water%20pipes%2C%20for%20generations>.
- Medina, Clara Y, Krystin F Kadonsky, Fernando A Roman Jr, Arianna Q Tariqi, Ryan G Sinclair, Patrick M D'Aoust, Robert Delatolla, Heather N Bischel, and Colleen C Naughton. 2022. "The need of an environmental justice approach for wastewater based epidemiology for rural and disadvantaged communities: a review in California." *Current Opinion in Environmental Science & Health* 27: 100348.
- Milwaukee Metropolitan Sewerage District. 2018. "Water Equity Task Force: How Milwaukee is Building Water Equity." Milwaukee Metropolitan Sewerage District. Accessed November 6, 2023. <https://www.mmsd.com/careers/workforce-development/water-equity-task-force>.

---. 2023. "Kinnickinnic River Flood Management." Milwaukee Metropolitan Sewerage District. Accessed November 15. <https://www.mmsd.com/what-we-do/flood-management/kinnickinnic-river#>.

Minnesota Pollution Control Agency. 2023. "Understanding environmental justice in Minnesota." Minnesota Pollution Control Agency. Accessed November 7, 2023. <https://mpca.maps.arcgis.com/apps/MapSeries/index.html?appid=f5bf57c8dac24404b7f8ef1717f57d00>.

Moench, Marcus H. 1992. "Chasing the watertable: Equity and sustainability in groundwater management." *Economic and Political Weekly*: A171-A177.

Mohnot, Sona, Jordyn Bishop, and Alvaro Sanchez. 2019. "Making Equity Real in Climate Adaptation and Community Resilience Policies and Programs: A Guidedbook." Accessed November 16. <https://greenlining.org/wp-content/uploads/2019/08/Making-Equity-Real-in-Climate-Adaption-and-Community-Resilience-Policies-and-Programs-A-Guidebook-1.pdf>.

National Equity Atlas. 2024. "Indicators." National Equity Atlas. Accessed May 22. <https://nationalequityatlas.org/indicators>.

Naughton, Colleen C, Fernando A Roman Jr, Ana Grace F Alvarado, Arianna Q Tariqi, Matthew A Deeming, Krystin F Kadonsky, Kyle Bibby, Aaron Bivins, Gertjan Medema, and Warish Ahmed. 2023. "Show us the data: global COVID-19 wastewater monitoring efforts, equity, and gaps." *FEMS microbes* 4: xtad003.

Nelson, Julie, and Lisa Brooks. 2015. "Racial Equity Toolkit: An Opportunity to Operationalize Equity." Racial Equity Alliance. Last Modified October. Accessed November 16. https://www.racialequityalliance.org/wp-content/uploads/2015/10/GARE-Racial_Equity_Toolkit.pdf.

Nemati, Mehdi, and Kurt Schwabe. 2023. "Re-examining the water affordability: A comparison of alternative measures." *JAWRA Journal of the American Water Resources Association* 59 (2): 356-375.

New Jersey Department of Environmental Protection. 2022. "Environmental Justice Mapping, Assessment and Protection Tool." Accessed November 7, 2023. <https://experience.arcgis.com/experience/548632a2351b41b8a0443cfc3a9f4ef6>.

New Mexico Environment Department. 2024. "OpenEnviroMap." Accessed May 24. <https://gis.web.env.nm.gov/oem/?map=egis>.

New York Department of Environmental Conservation. 2022. "Webmap: Potential Environmental Justice Areas." Accessed November 7, 2023. https://www.arcgis.com/home/webmap/viewer.html?url=https://services6.arcgis.com/DZHaqZm9cxOD4CWM/ArcGIS/rest/services/Potential_Environmental_Justice_Area_PEJA_Communities/FeatureServer&source=sd.

North Carolina Department of Environmental Quality. 2022. "NCDEQ Community Mapping System." Accessed November 7, 2023. <https://ncdenr.maps.arcgis.com/apps/webappviewer/index.html?id=1eb0f8e2bcfb4cccb3cc212af8a0b8c8>.

Northeast Ohio Regional Sewer District. 2023. "Community Cost-Share Program." Northeast Ohio Regional Sewer District. Accessed November 7, 2023. <https://www.neorsd.org/community/community-cost-share-program/>.

Ohene-Okae, Beatrice, Stephanie Chiorean, Wendy de Hoog, Meghan Hazer, Sarah Kristi Lone, Irene Ogata, Julie Owens, Liz Svekla, Paula Conolly, and Kasey Armstrong. 2022. "Equity Guide: For Green Stormwater Infrastructure Practitioners." The Green Infrastructure Leadership Exchange. Accessed November 16. https://giexchange.org/wp-content/uploads/2022/05/Equity-Guide-for-GSI-Practitioners_March-2022.pdf.

Orbach, Rebecca, Owen Minott, Lily Reckford, James Torrez, and Erin Barry. 2022. "Status of Federal Low Income Household Water Assistance Program." Bipartisan Policy Center. Last Modified December 22. Accessed November 7, 2023. <https://bipartisanpolicy.org/blog/low-income-water-assistance-program/>.

Patterson, Lauren. 2020. "Water Affordability & Equity: Re-Imagining Water Services: A Report from the 2020 Aspen-Nicholas Water Forum." Aspen Institute and the Nicholas Institute for Environmental Policy Solutions. Accessed November 16. <https://www.aspeninstitute.org/wp-content/uploads/2020/12/Water-Forum-Consolidated-Report-2020.pdf>.

Pennsylvania Department of Environmental Protection. 2023. "PennEnviroScreen DEP." Pennsylvania Department of Environmental Protection. Accessed November 7, 2023. <https://gis.dep.pa.gov/PennEnviroScreen/>.

Philadelphia Water Department. 2021a. "Green City, Clean Waters: A Decade in the Community." Philly H2O Blog. Philadelphia Water Department. Accessed November 16. <https://water.phila.gov/blog/gccw10-outreach/>.

---. 2021b. "Green City, Clean Waters: Supporting You & Your Neighbors." Philly H2O Blog. Philadelphia Water Department. Accessed November 16. <https://water.phila.gov/blog/gccw10-neighbors/>.

---. 2022a. "Green City Clean Waters." Philadelphia Water Department. Accessed November 7, 2023. <https://water.phila.gov/green-city/>.

---. 2022b. "Green City, Clean Waters: Progress with Partners." Philly H2O Blog. Philadelphia Water Department. Accessed November 16. <https://water.phila.gov/blog/gccw10-partners/>.

Pittsburgh Water and Sewer Authority. 2022a. "Allegheny County Sanitary Authority (ALCOSAN) Open House 2022." Pittsburgh Water and Sewer Authority. Accessed November 6, 2023. <https://www.pgh2o.com/news-events/events-meetings/2022-09-10-alcosan-open-house-2022>.

---. 2022b. "Project Name: Developing PWSA's Strategic Plan for Stormwater, Project No.: 2020-025-OPS, Action 5: Communications Framework Recommendations." Memo from. Pittsburgh Water and Sewer Authority. Last Modified June 10. Accessed November 16. <https://www.pgh2o.com/sites/default/files/2023-01/Appendix%20A%20SWSP%20Communications%20Memo%20DRAFT.pdf>.

---. 2022c. "Strategic Plan for Stormwater: Final Plan Draft." Pittsburgh Water and Sewer Authority. Last Modified December. Accessed November 16. https://www.pgh2o.com/sites/default/files/2022-12/PWSA_SWSP_2022.12.09_Print%20Version_Letter%20Size_0.pdf.

---. 2022d. "Welcome to Headwaters, Pittsburgh Water and Sewer Authority's organizational performance improvement dashboard." Pittsburgh Water and Sewer Authority. Accessed November 6, 2023. <https://headwaters.pgh2o.com/>.

PolicyLink. 2022. "Advancing Water Equity to Create Communities of Opportunity." PolicyLink. Accessed November 7, 2023. <https://www.policylink.org/federal-policy/advancing-water-equity>.

Quantified Ventures. 2023. "Case Study: Atlanta's Department of Watershed Management." Quantified Ventures. Accessed November 16. https://static1.squarespace.com/static/5d5b210885b4ce0001663c25/t/5e136bad70b78f691391cf07/1578331071956/Atlanta+Case+Study_Quantified+Ventures.

Quitian, Alejandra Saenz, and Gloria Amparo Rodríguez. 2016. "Guidelines for inclusion: Ensuring Indigenous peoples' involvement in water planning processes across South Eastern Australia." *Journal of Hydrology* 542: 828-835.

Race & Social Justice Initiative. 2021. "City of Seattle Racial Equity Toolkit (RET) Summary Sheet: Cover Sheet and Questions." Race & Social Justice Initiative. Accessed November 16. http://clerk.seattle.gov/~cfpics/cf_322096d.pdf.

Rainey, William, Melissa McHale, and Mazdak Arabi. 2022. "Characterization of co-benefits of green stormwater infrastructure across ecohydrologic regions in the United States." *Urban Forestry & Urban Greening* 70: 127514. <https://www.sciencedirect.com/science/article/pii/S1618866722000577>.

RAND Social and Economic Well-Being Division. 2022. "Environmental Racism: Mapping the Legacy of Historic Redlining on Urban Environments." RAND. Accessed November 16. <https://www.rand.org/well-being/community-health-and-environmental-policy/projects/environmental-racism.html>.

Randell, Heather, and Andrew Curley. 2023. "Dams and tribal land loss in the United States." *Environmental Research Letters* 18 (9): 094001.

Reibel, Michael, Madelyn Glickfeld, and Peter Roquemore. 2021. "Disadvantaged communities and drinking water: a case study of Los Angeles County." *GeoJournal* 86: 1337-1354.

- Riggs, David E. 2016. "President's Message: Water and Environmental Equity." *Journal of Environmental Health* 79 (4). <https://neha.org/sites/default/files/publications/jeh/JEH11.16-Pres-Water-and-Environmental-Equity.pdf>.
- Rigolon, Alessandro, and Jeremy Németh. 2020. "Green gentrification or 'just green enough': Do park location, size and function affect whether a place gentrifies or not?" *Urban Studies* 57 (2): 402-420. <https://journals.sagepub.com/doi/abs/10.1177/0042098019849380>.
- Sala-Garrido, Ramon, Manuel Mocholi-Arce, Maria Molinos-Senante, and Alexandros Maziotis. 2023. "Eco-efficiency assessment under natural and managerial disposability: an empirical application for Chilean water companies." *Environmental Science and Pollution Research* 30 (2): 3222-3234.
- San Francisco Public Utilities Commission. 2022. "FY 2020-21 & FY 2021-22 SFPUC Adopted Budget." San Francisco Public Utilities Commission. Accessed November 16. https://sfpuc.org/sites/default/files/about-us/policies-reports/SFPUC_Adopted_Budget_FY2020-21_2021-22.pdf.
- San Francisco Water Power Sewer. 2024. "Sewer System Improvement Program." San Francisco Water Power Sewer. Accessed May 23, 2024. <https://sfpuc.org/construction-contracts/sewer-system-improvement-program#:~:text=The%20Sewer%20System%20Improvement%20Program%20is%20a%20citywide,sewer%20system%20now%20and%20for%20generations%20to%20come>.
- Santa Ana Watershed Project Authority. 2019. *Disadvantaged Community Involvement*. Santa Ana Watershed Project Authority. www.sawpa.org/owow/dciprogram/.
- Sardana, Surbhi. 2019. "Creating a Culture of Equity: Building Awareness Within the Montgomery County Department of Health and Human Services." *The International Journal of Information, Diversity, & Inclusion (IJIDI)* 3 (3).
- Sarna-Wojcicki, Daniel, Jennifer Sowerwine, Lisa Hillman, Leaf Hillman, and Bill Tripp. 2019. "Decentring watersheds and decolonising watershed governance: Towards an ecocultural politics of scale in the Klamath Basin." *Water Alternatives* 12 (1): 241-266.
- Seattle Public Utilities. 2020. "Social and Environmental Systems Analysis: Narrative Atlas." Seattle Public Utilities. Accessed November 16. <https://www.seattle.gov/documents/Departments/SPU/Documents/Reports/DrainageWasteWater/ShapeOurWater-SocialandEnvironmentalSystemsAnalysis.pdf>.
- Siddiqi, Sameer M, Cate Mingoya-LaFortune, Ramya Chari, Benjamin L Preston, Grace Gahlon, Carlos Calvo Hernandez, Alexandra Huttinger, Scott R Stephenson, and Jaime Madrigano. 2022. "The Road to Justice40: Organizer and Policymaker Perspectives on the Historical Roots of and Solutions for Environmental Justice Inequities in US Cities." *Environmental Justice*.

Southeast Louisiana Flood Protection Authority-East. 2024. "Tours." Southeast Louisiana Flood Protection Authority-East (FPA-East). Accessed May 23, 2024. <https://www.floodauthority.org/tours/>.

State of California Office of Planning and Research. 2022. "ResilientCA." State of California Office of Planning and Research. Accessed November 7. <https://resilientca.org/>.

Tate, Eric, Md Asif Rahman, Christopher T Emrich, and Christopher C Sampson. 2021. "Flood exposure and social vulnerability in the United States." *Natural Hazards* 106 (1): 435-457.

The Green Initiative Fund. 2020. "Mapping for Environmental Justice: Colorado." Accessed November 7, 2023. <https://mappingforej.berkeley.edu/colorado/>.

The Water Research Foundation. 2017. "Water Environment Federation: University-Utility Collaborative Partnerships." Accessed November 16. <https://www.wef.org/globalassets/assets-wef/direct-download-library/public/03---resources/wsec-2017-tr-005-university-utility-collaborative-partnerships.pdf>.

---. 2020. "Water Utility Business Risk and Opportunity Framework: A Guidebook for Water Utility Business Function Leaders in a Changing Climate." The Water Research Foundation. Last Modified April 1. Accessed November 16. <https://www.waterrf.org/resource/water-utility-business-risk-and-opportunity-framework-guidebook-water-utility-business>.

---. November 8 2021. *Economic Framework and Tools for Quantifying and Monetizing the Triple Bottom Line Benefits of Green Stormwater Infrastructure*. (The Water Research Foundation). <https://www.waterrf.org/resource/economic-framework-and-tools-quantifying-and-monetizing-triple-bottom-line-benefits-green>.

The White House. 2022. "Justice40: A whole-of-government initiative." The White House. Accessed October 31. <https://www.whitehouse.gov/environmentaljustice/justice40/>.

U.S. Department of Energy, Office of Legacy Management. "Environmental Justice History." Accessed November 28. <https://www.energy.gov/lm/environmental-justice-history>.

U.S. Environmental Protection Agency. 2011. "Lick Run Watershed Strategic Integration Plan: Cincinnati, Ohio, Partnership for Sustainable Communities, Final Report." U.S. Environmental Protection Agency. Last Modified July 18. Accessed November 16. <https://archive.epa.gov/region5/sustainable/web/pdf/lickrun-siplan-201107-report.pdf>.

---. 2017. "Green Infrastructure in Parks: A Guide to Collaboration, Funding, and Community Engagement." U.S. Environmental Protection Agency. Last Modified June. Accessed November 16. https://www.epa.gov/sites/default/files/2017-05/documents/gi_parksplaybook_2017-05-01_508.pdf.

---. 2018. "EPA's Role in Addressing the Urgent Water Infrastructure Needs of Environmental Justice Communities." U.S. Environmental Protection Agency, National Environmental Justice Advisory Council (NEJAC). Last Modified August. Accessed November 16.

https://www.epa.gov/sites/default/files/2019-05/documents/nejac_white_paper_water-final-3-1-19.pdf.

---. 2021a. "Climate Change and Social Vulnerability in the United States: A Focus on Six Impacts." U.S. Environmental Protection Agency. Accessed November 16. www.epa.gov/cira/social-vulnerability-report.

---. 2021b. "Water Utilities as Anchor Institutions: Impacting the equity, social, and economic fabric of communities and regions." U.S. Environmental Protection Agency. https://www.epa.gov/system/files/documents/2021-09/anchor-institutions_report.pdf.

---. 2022. "Biden-Harris Administration Announces Selection of 29 EPA Environmental Finance Centers to Help Communities Access Funds for Infrastructure Projects." *News Releases, U.S. Environmental Protection Agency*. <https://www.epa.gov/newsreleases/biden-harris-administration-announces-selection-29-epa-environmental-finance-centers>.

---. 2023a. "Building Resilient Infrastructure and Communities (BRIC)." U.S. Environmental Protection Agency. Last Modified May 3. Accessed November 7, 2023. <https://www.epa.gov/fedfunds/building-resilient-infrastructure-and-communities-bric>.

---. 2023b. "EJScreen: Environmental Justice Screening and Mapping Tool." U.S. Environmental Protection Agency. Last Modified September 6. Accessed November 7, 2023. <https://www.epa.gov/ejscreen>.

---. 2023c. "EPA Community Grants." U.S. Environmental Protection Agency. Last Modified October 25. Accessed November 8, 2023. <https://www.epa.gov/sustainable-water-infrastructure/epa-community-grants>.

---. 2023d. "Going Wild: The Conservation Co-benefits of Green Infrastructure." U.S. Environmental Protection Agency. Last Modified May 8. Accessed November 6, 2023. <https://www.epa.gov/green-infrastructure/going-wild-conservation-co-benefits-green-infrastructure#:~:text=Green%20infrastructure%20offers%20tools%20that,to%20the%20places%20we%20live>.

---. 2023e. "Public Participation Guide." U.S. Environmental Protection Agency. Last Modified July 5. Accessed November 16. <https://www.epa.gov/international-cooperation/public-participation-guide>.

---. 2023f. "Revolving Loan Funds." U.S. Environmental Protection Agency. Last Modified April 26. Accessed November 7, 2023. <https://www.epa.gov/statelocalenergy/revolving-loan-funds>.

---. 2023g. "Summary of Executive Order 12898 - Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations." U.S. Environmental Protection Agency. Accessed November 28. <https://www.epa.gov/laws-regulations/summary-executive-order-12898-federal-actions-address-environmental-justice>.

- . 2023h. "Water Data and Tools: How's My Waterway." U.S. Environmental Protection Agency. Last Modified April 28. Accessed November 7, 2023. <https://www.epa.gov/waterdata/hows-my-waterway>.
- . 2024. "EJ Clearinghouse." U.S. Environmental Protection Agency. Accessed May 16. <https://www.epa.gov/environmentaljustice/forms/ej-clearinghouse#form>.
- U.S. Water Alliance. 2017. "Seattle: Equity & Environment Agenda." U.S. Water Alliance. Accessed November 16. <https://www.seattle.gov/Documents/Departments/Environment/EnvironmentalEquity/SeattleEquityAgenda.pdf>.
- . 2021a. "An Equitable Water Future: Atlanta." U.S. Water Alliance. <https://uswateralliance.org/wp-content/uploads/2023/09/US-Water-Alliance-An-Equitable-Water-Future-Atlanta.pdf>.
- . 2021b. *An Equitable Water Future: Atlanta*. <https://uswateralliance.org/wp-content/uploads/2023/09/US-Water-Alliance-An-Equitable-Water-Future-Atlanta.pdf>.
- . June 2021c. *Water Equity Taskforce: Insights for the Water Sector*. <https://waterfdn.org/wp-content/uploads/2021/08/USWA-Water-Equity-Taskforce-Insights-for-the-Water-Sector-June-2021.pdf>.
- . 2022. "The Pillars of Water Equity." U.S. Water Alliance. Accessed October 31. <http://uswateralliance.org/wec/framework>.
- . October 2023a. *Advancing Racial Equity Across the Water Sector: A Toolkit for Utilities*. <https://uswateralliance.org/wp-content/uploads/2023/10/Racial-Equity-Toolkit.pdf>.
- . September 2023b. *An Equitable Water Future: A National Briefing Paper*. https://uswateralliance.org/wp-content/uploads/2023/09/uswa_waterequity_FINAL.pdf.
- . 2023c. "Fact Sheets: One Water Implementation Rubric for Utilities." U.S. Water Alliance. Last Modified October. Accessed November 16. <https://uswateralliance.org/wp-content/uploads/2023/10/One-Water-Implementation-Rubric.pdf>.
- . 2023d. "Resources." U.S. Water Alliance. Accessed November 7, 2023. <https://www.uswateralliance.org/sites/uswateralliance.org/files/publications/Water%20Rising%20paper.pdf>.
- . 2023e. "Workforce Diversity Toolkit: Welcome to the Value of Water Campaign's Toolkit for Recruiting a Diverse Water Workforce!". U.S. Water Alliance. Accessed November 6, 2023. <https://uswateralliance.org/resources/workforce-diversity-toolkit/>.
- U.S. Water Alliance, and The Kresge Foundation. 2020. "Water Rising: Equitable Approaches to Urban Flooding." U.S. Water Alliance. Accessed May 22. <https://www.adaptationclearinghouse.org/resources/water-rising-equitable-approaches-to-urban-flooding.html>.

Virginia Department of Transportation. 2023. "Virginia Block Group Level Demographic Maps." Virginia Department of Transportation. Last Modified March 27. Accessed November 7, 2023. <https://www.virginiadot.org/business/bu-civil-rights-maps.asp>.

Washington Department of Health. 2022. "Washington Tracking Network: A Source for Environmental Public Health Data." Washington Department of Health. Accessed November 7, 2023. <https://fortress.wa.gov/doh/wtnibl/WTNIBL/>.

Wasley, E, and K Jacobs. 2020. "Water Utility Business Risk and Opportunity Framework: A Guidebook for Water Utility Business Function Leaders in a Changing Climate." *Water Research Foundation 4729b*.

Weber, Anna. 2023. "The BRIC Wall: Capacity Gaps Put FEMA Grants out of Reach." Expert Blog, NRDC. Natural Resources Defense Council. Accessed November 16. <https://www.nrdc.org/bio/anna-weber/bric-wall-capacity-gaps-put-fema-grants-out-reach>.

White-Newsome, Jalonnie L, and Julie A Slay. 2022. "Learning to lead with equity: Advancing climate resilience planning to address urban flooding across multiple sectors and scales." *Justice in Climate Action Planning*: 97-116.

Wooldridge, Blue, and Betsy Bilharz. 2017. "Social equity: The fourth pillar of public administration." *Global encyclopedia of public administration, public policy, and governance 4* (4): 1-10.

Yang, Euijin, and Kasey M. Faust. 2019. "Dynamic Public Perceptions of Water Infrastructure in US Shrinking Cities: End-User Trust in Providers and Views toward Participatory Processes." *Journal of Water Resources Planning and Management* 145 (9): 04019040. <https://ascelibrary.org/doi/abs/10.1061/%28ASCE%29WR.1943-5452.0001093>.

Yu, Weiyu, Nicola A Wardrop, Robert ES Bain, Victor Alegana, Laura J Graham, and Jim A Wright. 2019. "Mapping access to domestic water supplies from incomplete data in developing countries: An illustrative assessment for Kenya." *PloS one* 14 (5): e0216923.

Zuniga-Teran, Adriana A, Andrea K Gerlak, Alison D Elder, and Alexander Tam. 2021. "The unjust distribution of urban green infrastructure is just the tip of the iceberg: A systematic review of place-based studies." *Environmental Science & Policy* 126: 234-245.



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