25 YEARS PACIFIC INSTITUTE

SUSTAINABLE WATER JOBS

A NATIONAL ASSESSMENT OF WATER-RELATED GREEN JOB OPPORTUNITIES

January 2013

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INTRODUCTION

Many jobs, in different sectors of the economy, are required to manage, deliver, and treat the fresh water required to satisfy our commercial, institutional, industrial, agricultural, and domestic needs.

A range of sustainable water strategies to address 21st century water challenges have emerged that reach far beyond the conventional water sector. Growing attention is being given to measures such as low-impact development, water reuse, watershed restoration, water conservation and efficiency, and many other proven and promising practices. As the country shifts to more sustainable water management, new services, occupations, and markets are emerging. In addition, over the next decade there is a need for major investments in the nation's aging infrastructure for wastewater, stormwater, and drinking water along with ongoing operation and maintenance jobs to sustain that infrastructure. Many of these jobs are eligible for public funding and have been the focus of increased funding through the American Reinvestment and Recovery Act (ARRA) and other federal and state policies. However, information is vitally needed to help local, state, and federal agencies, utilities, companies, unions, and non-profit entities adopt strategies that maximize job creation and other potential benefits of these practices.

The need to take advantage of any opportunities for increased quantity and quality of employment opportunities is acute: twelve million U.S. workers interested and available to work are unemployed (BLS 2012). Millions more are working but remain in financial distress with basic needs, such as healthcare, unmet. Some 10.5 million workers were employed for more than half of the past year, yet still have an income below the official poverty level (DOL 2012). For working parents in poverty, constraints on their ability to provide stable and appropriate childcare can pass their hardship onto their children. The impact reaches far into the physical and emotional health of families, and can suppress economic growth. Research now shows that inequality is harmful to economic growth and that regions and countries with greater equality experienced more vigorous economic growth (Pastor 2011).

The jobs generated by sustainable water strategies have rarely been tracked, yet a growing body of research points to significant numbers of jobs in certain sectors and in certain places. The types of jobs involved in implementing sustainable water strategies cover a broad range of occupations. We identified 136 occupations involved in the work of achieving more sustainable water outcomes in agriculture, urban residential and commercials settings, restoration and remediation, alternative water sources, and stormwater management. The quantity of employment created by sustainable water practices is substantial. The data available points to 10-15 jobs per $1 million invested in alternative water supplies; 5-20 in stormwater management; 12-22 in urban conservation and efficiency; 14.6 in agricultural efficiency and quality; and 10-72 jobs per $1 million invested in restoration and remediation. The view that environmental conservation produces net job losses is not supported by any of the data on sustainable water projects.

This research suggests that water is a worthy arena for exploring green jobs, and if we continue to separate our efforts at water sustainability and economic opportunity, we may miss opportunities to strengthen both through integration. There is now greater awareness of the promise of green jobs – the potential for crafting economic strategies that improve environmental impacts while creating quality work opportunities. But these efforts have largely focused on energy efficiency and renewable energy. This report finds that the growing interest in exploring green jobs in water is well merited.

For meaningful opportunities to be created in sustainable water management, better information is needed for various stakeholders, including workforce development and community-based organizations, labor

Source: Amigos de los Rios

unions, utilities and public agencies, and businesses. This report looks at the full spectrum of sustainable water strategies and provides foundational information on the following questions:

- What are the best practices across sectors for sustainable water management and use?
- What policies and investments are driving sustainable water strategies and what evidence exists of their prevalence and growth?
- What activities and occupations are involved when these practices are adopted?
- What data are available to quantify the jobs generated by these practices?
- What is the quality of these sustainable water occupations, their growth in the overall economy, and what are the demographics of the workforce in these professions?
- How can disadvantaged communities be linked to job opportunities in the water sector?

The research is drawn from a review of academic and professional literature, exploration and analysis of secondary data, interviews with practitioners and researchers, case studies of community-based water jobs programs, and focus group discussions with practitioners. Each section of the report more fully describes our data sources and methods.

The promise of green jobs is not only that environmental efforts can generate employment but that these work opportunities can be a force for addressing poverty and economic inequality (Jones 2008). Like others researching green jobs, we are particularly interested in identifying ways to expand opportunities for disadvantaged communities. Numerous studies have identified worker attributes that function as barriers to employment, putting groups of workers with these attributes at a disadvantage. Various definitions of disadvantaged communities and workers are employed. These often include workers who in the period before employment had one or more of the following conditions:

- Long-term unemployment
- Veteran status
- Low-income and under-employed
- Female
- People of color, or non-white
- Undocumented immigration status
- Past conviction of a crime
- Disabilities (mental or physical)
- Homelessness
- Lacking a GED or high school diploma
- Receiving public assistance

Understanding barriers to employment and designing policy and programs to help disadvantaged workers overcome them is supported by research and an expanding set of best practices (OPRE 2012; NTJN 2012; COWS 2007). Targeted strategies to provide training and supportive services, partner with employers, and create policies and community agreements have been developed to develop "pathways out of poverty." These fit within a larger framework of "targeted universalism," which proposes that to achieve universal outcomes for all parts of society there must be specific strategies designed to address the particular situations of groups within the population (Powell 2012). Achieving sustainable water improvements while creating jobs for

disadvantaged workers is not entirely new. At least nine community-based organizations and numerous community colleges, labor unions, business associations, and other entities currently provide training programs that prepare low-income youth, single parents, and others to access employment in sustainable water-related fields. One of the earliest examples of these efforts was a partnership between the Mothers of East Los Angeles (MELASI), a community-based environmental justice organization, and several southern California water agencies in 1992. Through this partnership, MELASI received modest funding to employ community residents to install water-efficient toilets free of charge in residential households in low-income communities, creating 25 full-time and three part-time jobs (Lerner 1997). Yet cases like this are extremely rare, despite the massive need for improving water sustainability and economic opportunity.

Source: US Department of Agriculture

To understand the range of water-related green jobs opportunities, we must first identify the water challenges that workers would be involved in addressing. The U.S. faces a range of water challenges, including impaired aquatic ecosystems, over-pumped aquifers, inefficient urban and agricultural water use, and drinking water treatment and distribution systems desperately in need of repair, upgrading, and improvement. In Section 1 we review these challenges as the basis for identifying the environmental outcomes an activity must contribute to if it is to be considered "green" from a water standpoint. This approach borrows from the framework for the Green Economy developed by ECO Canada (2010) which defines the green economy as that which involves people and resources in activities that directly contribute to improved environmental outcomes such as wise use of resources and reduced discharges of pollutants to waterways.

Water does not fit in a single sector or industry; the strategies for addressing water challenges occur in diverse industries and involve actors at local, regional, and national scales. In Section 2, we describe practices that have been shown to achieve more sustainable water outcomes and group them into five categories:

Urban Water Conservation and Efficiency: This strategy includes a range of technologies and practices that improve the productivity of water use, allowing for the same or increased production of goods and services while maintaining or even reducing overall water needs. These efforts are conservation and efficiency measures, also referred to as demand management, and include: installation of water-efficient appliances and fixtures in residential, commercial, industrial, and institutional settings; landscape efficiency improvements (advanced irrigation technologies and controllers, mulching, and xeriscaping); and replacing and/or repairing pipes to reduce water loss. These practices can also allow for increased instream flows.

Stormwater Management: This strategy includes a series of practices and techniques referred to as low-impact development (LID) or "green infrastructure," defined as systems and techniques intended to infiltrate, retain, and/or reuse stormwater on the site where it is generated. Some green infrastructure

techniques include downspout disconnection, rainwater harvesting, urban tree planting, land conservation, and installing rain gardens, planter boxes, bioswales, permeable pavement, groundwater retention basins, and green roofs.

Environmental Restoration and Remediation: Environmental restoration is the process of returning the chemical, physical, and/or biological components of a degraded ecosystem to a close approximation of pre-disturbance conditions. Techniques include reconfiguring stream beds, daylighting urban stormwater channels, and restoring riparian areas and wetlands. Environmental remediation – a subset of restoration – refers to the process of targeted removal of specific toxic substances or pollutants from soil or water. Methods for remediation include technologies such as air sparging (injecting air into contaminated soil) to reduce the concentration of volatile compounds from soil and installation of permeable reactive barriers.

Alternative Water Sources: Alternative water sources include a range of unconventional sources, such as rainwater, stormwater, greywater, and reclaimed water. Projects to capture these alternative water sources can be implemented by a water utility or at the facility level by households or businesses. For the purposes of this report, we focus on activities at the utility-scale because many of the actions at the site level, such as rainwater harvesting, are captured in the stormwater strategy, described above. This includes conjunctive use, the coordinated use of ground and surface water to optimize supply and storage.

Agricultural Water Efficiency and Quality: These practices are meant to improve the productivity of water use, reduce runoff, and, in some cases, improve crop yield and quality. Techniques include utilizing improved irrigation scheduling and technology (such as sprinkler and drip irrigation systems); lining canals and other seepage control options; constructing spill reservoirs and district reoperation; recycling tailwater (also called runoff) on-farm; increasing pump efficiency; utilizing conservation tillage/no till techniques; restoring riparian zones or constructing buffer zones; planting cover crops; and constructing livestock fencing around water bodies. These practices can also allow for increased instream flows.

In Section 3, for each of these five sustainable water strategies, we describe the regulations and financing mechanisms that are driving their implementation. This includes the key institutions, policies, standards and codes, and funding sources that influence the prevalence and growth of sustainable water strategies. Understanding these drivers is relevant to gaging the scale of job opportunities that can be expected. Knowing the key institutions and policies is also useful in efforts to craft "high-road" policies and agreements that ensure that water policies are crafted in such a way that the jobs created are high quality and reach in-need populations.

In Section 4, we turn to the occupations involved in each of the five sustainable water strategies. Here, we map these occupations across the phases of activity in implementing each water strategy, and provide the available information on the numbers of jobs created.

Section 5 looks at the occupations involved in sustainable water as they exist in the overall economy, examining aspects of their current job quality and projected growth. We look at the projected number of job openings as an indication of the future demand for workers. This is rooted in some important lessons from past green jobs efforts. Much of the previous green jobs investments went into preparing workers for occupations that were green and entirely new, such as solar installers and energy auditors, yet the demand for graduates of these programs fell short. Because these workers were not prepared with a broader set of skills that qualified them for conventional occupations, they were left with limited options for employment (COWS 2012). For occupations with high projected openings, we analyze the entry-level and median wage, percentage of workers represented by unions, workforce race, and gender demographics of the workforce.

For a subset of nine sustainable water occupations that require unique skills and have substantial projected job openings, we analyze the training and certification needed. The premise of this analysis is that efforts to link disadvantaged workers to expanding opportunities are most successful when participants gain a competitive advantage through unique skills that contribute to sustainable water outcomes.

The sixth and final section is an analysis of programs currently providing training and workforce development for low-income communities with a focus on careers in sustainable water activities. This is based on case studies of nine organizations and focus group discussions held with fifteen practitioners. The analysis focuses on the challenges and opportunities related to funding, outreach, training, placement, and partnership and policy engagement strategies.

Source: Bob Nichols

CURRENT WATER CHALLENGES

As we enter the second decade of the 21st century, the United States faces a complex and evolving set of freshwater challenges. Despite the fact that the nation is, on average, a comparatively water-rich country, we are reaching absolute limits on our ability to take more water from many river systems like the Colorado, Sacramento-San Joaquin, and Chattahoochee River systems. We are also over-pumping groundwater aquifers in areas such as the Great Plains and California's Central Valley. At the same time, continued population and economic growth are adding new demands for water, in competition with other uses. Furthermore, many of the nation's water bodies remain contaminated. Wetlands, aquatic ecosystems, and fisheries are in decline. Much of our water infrastructure has not been adequately maintained and confidence in our tap water system is falling. Significant public health threats from contaminated drinking water exist in a growing number of communities, and the affordability of water for low-income users is a growing concern. Climate changes compound many of these challenges by altering water availability and quality and increasing the risk of both floods and droughts.

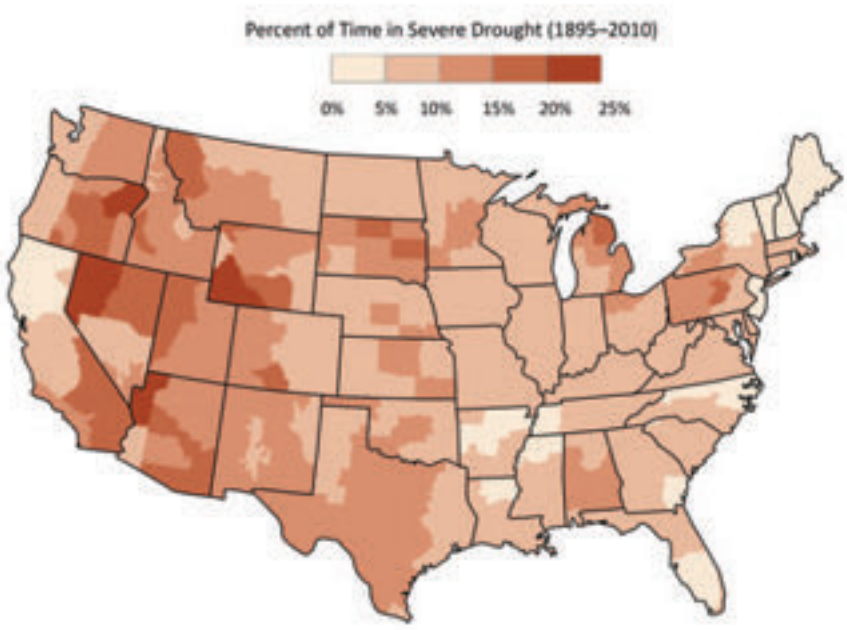
Despite major improvements in water quality in the United States over the last century, we still have a long way to go in order to ensure access to clean, affordable water to all and healthy aquatic ecosystems. Industrial waste on rivers is no longer catching fire, as it did in the 1960s. Thousands of people no longer die every year from water-related diseases such as cholera, dysentery, and typhoid.

Most Americans have access to highly reliable, safe, and remarkably inexpensive water from their taps to drink, and to flush toilets, providing safe and reliable sanitation. Yet, not all Americans have access to safe drinking water.

While the U.S. commonly reports 100% access to safe water and sanitation in international water surveys, there is a small, but not insignificant, number of people who lack such services (Allen 2012). For example, 1.7 million people lack indoor plumbing (RCAP 2004). Others lack access to safe drinking water because it is not affordable – 8,000 households on average have their water temporarily shut off in Denver each year due to nonpayment of bills, for example (Wescoat et al. 2007).

Additionally, water quality varies among communities. While the Safe Drinking Water Act sets specific maximum contaminant levels (MCLs) to protect human health, some economically disadvantaged communities receive tap water that is less

FIG. 1: PERCENTAGE OF TIME IN SEVERE AND EXTREME DROUGHT NATIONWIDE BY HYDROLOGIC REGION, 1895-1995



Source: GAO 2003

safe than the water that other communities receive—typically small drinking water systems, rural communities dependent on unprotected wells, and communities on tribal lands (Allen 2012). For example, the smallest class of water systems (i.e., those serving 25-500 people), have 28 times more water quality violations, per person, than the average for systems of all sizes, and more than 500 times more than the large systems serving more than 10,000 people (EPA 1999, EPA-OIG 2004).

Since the passage of the federal Clean Water Act in 1972, there has been significant progress in reducing point source pollution from factory pipes or sewage treatment plants. However, progress in reducing non-point source pollution, or more dispersed runoff from farms and streets, has been far more limited. Nearly two decades ago, the Environmental Protection Agency declared non-point source pollution the main reason that almost half of surveyed rivers, lakes, and estuaries were not clean enough to meet basic uses such as fishing or swimming (EPA 1996). Today, non-point source pollution continues to be a leading contributor to water contamination nationwide, affecting drinking water quality and aquatic ecosystems.

Under Section 303(d) of the Clean Water Act, states, territories, and authorized tribes are required to develop lists of impaired waters that are too polluted or degraded to meet water quality standards for their given purpose such as fishing or swimming, even after point sources of pollution have installed the minimum required levels of pollution control technology. Table 1 presents an overview of the state of assessed water.

The law requires that states develop a list of impaired water ways and develop total maximum daily loads (TMDLs) for contaminants entering these waters. As of 2010, there were 41,153 impaired water ways in the United States, though it is important to note that a water body can be listed more than once for different contaminants (EPA 2012e). The top ten causes of impairment were pathogens; metals (other than mercury); nutrients; organic enrichment and oxygen depletion (related to nutrients); sedimentation; polychlorinated biphenyls (PCBs); mercury; acidity; impaired biota (or a decline in the health of aquatic life); and turbidity (EPA 2012e).

Recent assessments also offer a grim appraisal of the health of the nation's aquatic systems (Christian-Smith and Allen 2012). The Environmental Protection Agency's Wadeable Streams Assessment (WSA), which collects water quality data at nearly 1,400 random sites across the nation using uniform protocols and a statistical sampling method, indicates that 42% of the nation's total stream length is considered to be in poor condition (EPA 2006). Major stressors included high nitrogen levels (32%); riparian disturbance (26%); and streambed instability (25%) (EPA 2006). At the same time, more and more watersheds are being physically modified with large dams or reservoirs, channelization, flood control levees, and significant water withdrawals (Christian-Smith and Allen 2012).

Concerns about water scarcity are growing across the United States, even in areas that are not traditionally associated with water-supply constraints, such as the southeastern United States (Cooley 2012). In 2003,

FIG. 2: SAFE DRINKING WATER ACT VIOLATIONS BY WATER SYSTEM SIZE

Source: Allen 2012

TABLE 1: STATUS OF ASSESSED WATERBODIES IN THE U.S.

	TOTAL WATERS	TOTAL ASSESSED WATERS	PERCENT OF TOTAL WATERS ASSESSED	GOOD WATERS	THREATENED WATERS	IMPAIRED WATERS	PERCENT OF WATERS ASSESSED AS THREATENED OR IMPAIRED
RIVERS AND STREAMS (MILES)	3,533,205	971,156	27.5%	449,972	6,369	514,816	53.7%
LAKES, RESERVOIRS, AND PONDS (ACRES)	41,666,049	18,944,731	45.5%	5,868,017	38,681	13,038,033	69.0%
BAYS AND ESTUARIES (SQ MILES)	87,791	32,668	37.2%	11,076	17	21,575	66.1%
COASTAL SHORELINE (MILES)	58,618	9,010	15.4%	1,746		7,263	80.6%
OCEAN AND NEAR COASTAL (SQ MILES)	54,120	1,984	3.7%	968		1,016	51.2%
WETLANDS (ACRES)	107,700,000	1,317,011	1.2%	208,944	805	1,107,261	84.1%
GREAT LAKES SHORELINE (MILES)	5,202	4,431	85.2%	78		4,353	98.2%
GREAT LAKES OPEN WATER (SQ MILES)	60,546	53,332	88.1%	62		53,270	99.9%

Source: EPA Watershed Assessment

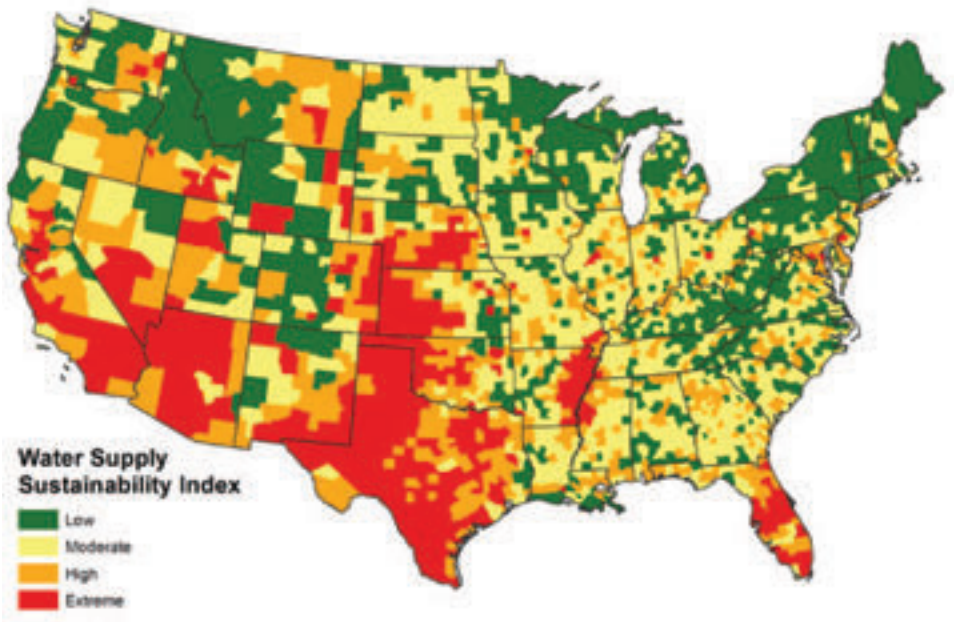
the Government Accountability Office (GAO) surveyed water managers from 47 states about water challenges. Thirty-six state water managers anticipated that their state would undergo a substantial degree of water shortage before 2013 under normal, non-drought conditions, most often due to increased water demands. And all but one of the respondents predicted their states would have water shortages if drought conditions occur (GAO 2003). Historically, many areas of the country have had severe or extreme drought at some point (Figure 1), with heightened drought in regions in the western U.S. A nationwide study analyzing water demand and supply under future climate change scenarios found that 70% of U.S. counties may be at moderate-to-extreme risk of their water demand surpassing water supply by 2050 (Figure 3).

Finally, the deteriorating state of the nation's water and wastewater infrastructure suggests that we are underinvesting in repair and upgrades. The majority of the estimated 600,000 miles of clean water piping in the U.S. was installed just after World War II and is now reaching the end of its useful life (EPA 2002a). The EPA projects that if we maintain current levels of investment in water systems through 2020, the percentage of the nation's water pipes considered "poor," "very poor," or "life elapsed" will reach 44%. Maintaining current funding levels would produce a 20-year capital investment funding gap of $102 billion for drinking water systems and $122 billion for wastewater systems, and even more for system operations and maintenance. This trend reflects a lack of attention to water infrastructure, but also presents an opportunity to design these investments to reflect best practices for more sustainable water management.

Polls have found that water issues are a top environmental concern and Americans believe they can be addressed in ways that support economic vitality. Gallup's annual poll on environmental concerns found that half of Americans in 2012 "worry a great deal" about pollution of drinking water and pollution of rivers, lakes, and reservoirs (Jones), a percentage that has been even higher historically. These water issues ranked as the top environmental concern. A poll recently presented by David Metz and Barry Barnes (2012) to the Green for All national stormwater working group found that by a four-to-one margin, voters think that protecting the environment and supporting the economy are compatible. Seventy-six percent of voters agreed with the statement "We can protect land and water and have a strong economy with good jobs for Americans at the same time, without having to choose one over the other," while only 19% believed that "Sometimes protections for land and water and a strong economy are in conflict and we must choose one over the other."

In the past, the traditional approach to meeting these challenges has almost entirely relied on building massive, centralized, capital-intensive infrastructure such as large dams and reservoirs. This has been called the "hard path" approach,

FIG. 3: WATER SUPPLY SUSTAINABILITY BY COUNTY PROJECTED FOR 2050



Source: NRDC 2010

because it focuses on centralized infrastructure and decision making using technology and institutions developed in the 19th and 20th centuries: large dams and reservoirs, pipelines and treatment plants, extensive levee systems, and far-reaching pipelines and aqueducts (Gleick 2012).

This approach has brought many benefits, permitting the nation to help feed a growing global population, reduce the incidence of water-related diseases, mitigate the threat of both floods and droughts, and support continued economic growth. But it has also come at great social, economic, and environmental costs, many of which were either ignored, undervalued, or unknown at the time (Gleick 2012). For example, many dams, including Kenzua Dam in Pennsylvania, Shasta Dam in California, the TVA dams in the Southeast, and American Falls Dam in Idaho, flooded communities and forced residents to relocate. Over time, the hard path contributed to severe damage to aquatic ecosystems. Currently, nearly 40% of North American freshwater and diadromous fish species are imperiled because of physical modifications to rivers and lakes (Jelks et al. 2008). Other consequences include loss of the ecological services that aquatic ecosystems provide, such as water filtration and retention, and massive energy demands to move water long distances and to treat increasingly contaminated water. Finally, hard path projects have been extremely costly but often, also heavily subsidized, resulting in significant economic distortions and lost opportunities to dedicate funding toward other public goods.

The water challenges our nation faces must be addressed with strategies that avoid the negative outcomes of the past. To develop these strategies, water managers and others are rethinking approaches to ensure that sufficient water resources are available to meet anticipated needs in ways that improve, rather than ignore, social equity, ecological conditions, and long-term sustainability of human-ecological systems. In 2010, the Johnson Foundation convened a Freshwater Forum, with the task of identifying the steps to achieving a sustainable and resilient freshwater system by the year 2025 (Johnson Foundation 2010). A diverse group of participants, representing industry, agricultural organizations, environmental organizations, and the water planning community, agreed on the following principles for addressing freshwater challenges as a national priority:

- Freshwater ecosystems have intrinsic value and are fundamental to our natural heritage and economic well-being.
- Ecosystems can experience abrupt, nonlinear change.
- Healthy and livable communities need clean and adequate freshwater.
- Reliable freshwater supplies are critical to U.S. economic security.

The "soft path" for water is a promising approach to respond to these realities. The soft path has a broader set of goals than conventional water management approaches. It is centered on the delivery of water-related services matched to resource availability and users' needs. It strives to improve the overall productivity of water use rather than seek endless sources of new supply.

The soft path starts with the recognition that freshwater resources and ecosystems have limits that must be respected. Soft path solutions take advantage of the potential for decentralized facilities, efficient technologies, flexible public and private institutions, innovative economics, and human capital. The soft path uses both centralized and decentralized infrastructure as part of an integrated array of strategies. It integrates decision-making across sectors to promote projects or facilities that produce multiple benefits. It works with water users at local and community scales and seeks to protect the critical ecological services that water provides, such as nutrient cycling, flood protection, aquatic habitat, and waste dilution and removal (Gleick 2002, Wolff and Gleick 2002).

Here, we use the soft path as a means to identify strategies to address the pressing water challenges outlined above. We define sustainable water strategies as those that reduce or eliminate water contamination, improve watershed system functioning, and increase efficiency of natural, social, and financial resources.

Source: US Department of Agriculture

II DEFINING WATER STRATEGIES FOR A SUSTAINABLE FUTURE

Achieving sustainable water conditions will require a combination of 'grey' conventional water infrastructure and services, and 'green' strategies. Here we describe the green strategies that are needed to supplement grey systems in order to sustainably address key water challenges. These green strategies do not fall neatly into a single sector or industry. For the purposes of this report, we group them into five categories: **urban water conservation and efficiency, stormwater management, environmental restoration and remediation, alternative water sources, and agricultural water efficiency and quality.**

Although these categories are not immutable or inseparable, they were created with consideration for the water challenge they address, the technical aspects of the activities involved, and the policy frameworks and financial mechanisms that shape implementation. For each category, we describe the types of activities that are known to improve water outcomes, the water benefits, and the policies and regulations, financing mechanisms, and education and outreach that drive their implementation.

Efforts to take advantage of the job creation potential of sustainable water management must design programs and policies based on an understanding of the activities and institutions involved in the implementation of sustainable water strategies, and the policies, regulations, and financing that drive them (see Table 3).

Some policy and regulations drive implementation of all five sustainable water strategies. For example, the federal Clean Water Act, particularly the National Pollutant Discharge Elimination System (NPDES) permitting program and Section 303(d), which mandate and promote techniques in each of the sustainable water strategies. NPDES requires permitting of all discharges to water resources, and promotes techniques that reduce discharge volume and improve water quality. Section 303(d) specifies that water bodies that do not meet applicable water quality standards must develop a Total Maximum Daily Load (TMDL). A TMDL is an estimate of the maximum amount of a pollutant a water body can receive and still meet water quality standards. Here too, techniques that reduce pollutant load can be used to meet TMDL requirements. These regulations have led to improvements in water quality as well as water efficiency, and are discussed in greater detail below.

State Revolving Funds (SRFs) and, more specifically, the Green Project Reserve (GPR), are a major source of funding for sustainable water projects in all five categories. The Drinking Water and Clean Water SRFs establish low-interest loan programs for public water utilities to invest in water infrastructure or projects that improve water quality. The American Recovery and Reinvestment Act (ARRA) of 2009 established specific requirements for the SRFs, mandating that 20% of funds go to projects with "green" components. These include projects addressing green infrastructure, water efficiency, energy efficiency, or "environmentally innovative" activities. Of the $3.8 billion allocated to the Clean Water SRF from the Recovery Act, 30% supported an estimated 649 GPR projects (see Table 2)(EPA 2012a). Although the ARRA funding was temporary, the GPR has now been incorporated into all Clean Water SRFs, with a permanent requirement that 10% of loans be dedicated to projects with green components (EPA 2012a).

The following sections describe each sustainable water strategy in detail, as well as the policy framework, financial incentives, educational and outreach programs, and emerging policies and funding sources.

TABLE 2: GREEN PROJECT RESERVE FUNDING THROUGH AMERICAN RECOVERY AND REINVESTMENT ACT

CATEGORY	NATIONAL GPR FUNDING *($ millions)*	NUMBER OF PROJECTS	NATIONAL AVERAGE GPR FUNDING PER PROJECT *($ millions)*
Energy Efficiency	$606	278	$2.2
Green Stormwater Infrastructure	$209	259	$0.8
Environmental Innovations	$160	113	$1.4
Water Efficiency	$153	103	$1.5
Total	$1128	649	$1.7

Source: EPA 2012a

TABLE 3: KEY DRIVERS OF SUSTAINABLE WATER STRATEGIES

WATER STRATEGY	MANDATES AND REGULATIONS	FINANCIAL INCENTIVES	EDUCATION AND OUTREACH	EMERGING POLICIES AND FUNDING MECHANISMS
Urban Water Conservation and Efficiency	• *Federal regulations (e.g. CWA: Water Quality Standards, NEPA)* • *State and local building codes and regulations (e.g., California's Water Conservation Act 2009)*	• *Water service providers: Customer revenue (e.g., SNWA Water Smart Landscapes Rebate)* • *Federal, state, and local government funding (e.g., SRF loans)*	• *Labeling (e.g., WaterSense)* • *Educational campaigns (e.g., Save our Water, Home Water Works, Neverwaste Consumer Media Campaign)*	• *Water service companies* • *PACE Programs* • *Water demand mitigation fees*
Stormwater Management	• *Federal regulations (e.g. CWA: NPDES, TMDL)* • *State and local building codes and regulations*	• *Local government and utility funding: Customer revenue and taxes* • *Federal and state funding (e.g., SRF loans)*	• *Labeling (e.g., LEED, Sustainable Sites Initiative)*	• *New federal regulations (e.g., EPA)* • *PACE Programs*
Restoration and Remediation	• *Federal regulations (e.g., CWA: TMDL, Section 404, compensation mitigation)* • *Regional or watershed plans (e.g. CERP)*	• *Federal and state funding (e.g., Superfund Trust)* • *Natural resource damage claims* • *Local government and water service provider funding: bond revenue, taxes, lottery, natural resource damage claims* • *Regional or watershed plans (e.g. CERP)*	• *Volunteer programs* • *Educational signs and materials*	• *RESTORE Act*
Alternative Water Source	• *State regulations (e.g., Florida Water Resource Caution Areas)* • *State or judicial mandates (e.g., CWA Section 316(b))*	• *Federal grants and loans (e.g., WRDA, Title XVI, Clean Water SRF)* • *State grants and loans (e.g., Florida Water Protection and Sustainability Program, California Water Recycling Funding Program)* • *Local government and water service provider funding: customer revenue and taxes*	• *Educational campaigns (e.g., San Diego Council Educational Campaign, Florida DEP campaign)* • *Labeling (e.g., Standard 350 certification program)*	• *Production tax credits* • *Tax exemptions* • *Investment tax credits*
Agricultural Water Efficiency and Quality	• *Federal regulations (e.g. CWA: NPDES for CAFOs, TMDLs)* • *State policy (e.g., California's Water Conservation Act of 2009)*	• *Federal funding (e.g., SRF, Section 319, Farm Bill)* • *State funding (e.g., State SRF, Sustainable Conservation BMP Challenge)*	• *Educational campaigns (e.g., NRCS programs*	• *New TMDLs*

TABLE 4: URBAN WATER CONSERVATION AND EFFICIENCY TECHNIQUES

APPLIANCES AND FIXTURES	*Installing water efficient appliances and fixtures in residential and in commercial, industrial, and institutional (CII) settings.*
LANDSCAPING	*Landscape efficiency improvements, including advanced irrigation technologies and controllers, mulching, and low water-use plants.*
REDUCING WATER LOSS	*Replacing and/or repairing pipes to reduce water loss within the water conveyance and distribution system.*
GREYWATER	*Water from clothes washers, showers, and faucets is collected, treated, and used on-site for outdoor irrigation, flushing toilets, or other non-potable uses.*

Urban Water Conservation and Efficiency

Techniques to improve urban water conservation and efficiency allow for the increased production of goods and services while maintaining or even reducing overall water use in urban areas. These efforts are also referred to as demand management or water productivity improvements. Urban water conservation and efficiency measures include: installing efficient appliances and fixtures, better water use metering, improving landscape efficiency, xeriscaping, and replacing and/or repairing pipes to reduce water loss within the water conveyance and distribution system (See table 4). Water treated and reused onsite at a smaller scale is often referred to as greywater, which includes water from clothes washers, showers, and faucets for use on outdoor landscapes, flushing toilets, or other non-potable uses.

Despite efficiency gains through conservation efforts over the past 25 years, current urban water use in the United States remains wasteful. Inefficient fixtures and appliances are still commonplace, particularly in homes built prior to 1994,[2] and in a range of commercial, institutional, and industrial settings. Even in a dry and densely-populated state like California, where many water agencies have taken the concerns about water supply constraints seriously, far more can be done. A 2003 analysis by the Pacific Institute found that existing, cost-effective technologies and policies can reduce California's urban water demand by more than 30% (Gleick et al. 2003) and a follow-up study done in 2005 found continued room for improvement (Gleick et al. 2005). These findings have been echoed by studies and programs in other regions. For example, a Seattle study found that installing new, water-efficient fixtures and appliances reduced single-family indoor use by nearly 40% (Mayer et al. 2000). Experiences from other countries, such as Australia, make clear the level of urban efficiency that is achievable. For example, in Southeast Queensland, Australia, total urban demand has dropped to only 67 gallons per capita per day (gpcd), and residential demand, including both indoor and outdoor uses, is a low 43 gpcd (Queensland Water Commission 2010).

In addition to saving water, water conservation and efficiency measures provide a number of other co-benefits. Conservation and efficiency techniques can reduce costs for drinking and wastewater treatment systems by reducing overall water delivery requirements. Reductions in demand can also reduce energy use and associated greenhouse gas (GHG) emissions for water systems. Landscape efficiency improvements reduce the amount of chemical and fertilizer application and subsequent runoff into local streams and waterways. High-efficiency appliances can also reduce detergent application for dishwashers and washing machines.

1. Policy Framework

There are several state, federal, and local regulations that mandate or promote water conservation and efficiency improvements. At the federal level, the Clean Water Act establishes water-quality standards for pollution discharged into the environment, which encouraged polluters to adopt more water-efficient technologies to reduce wastewater volumes and, therefore, costs (Hutson et al. 2005). Additionally, the National Energy Policy Act establishes efficiency standards for toilets, urinals, showerheads, clothes washers, dishwashers, and several other commercial products. Some states have enacted stricter

[2] *National water-efficiency standards for some fixtures were signed into law in 1992; implementation began in 1994.*

standards; for example, California, Texas, and Georgia have standards requiring all new toilets sold to use 1.28 gallons per flush (gpf) or less.

State and local governments can also use mandates and regulations to improve urban efficiency. State-level building codes mandate the use of some water- conserving fixtures and set maximum water use standards for specific appliances. The Cambria Community Services District, located on the California coast, requires developers to offset increases in water demand by retrofitting homes with more efficient fixtures. Regulations can also require water savings, without specifying how the savings are achieved. For example, California's Water Conservation Act of 2009 requires a 20% reduction in urban per capita water use statewide by 2020.

2. Financial Incentives

Water service providers can invest in efficiency improvements through direct install programs, rebates, or policies that reduce the payback time of installing water-saving devices, such as water rates that incentivize lower water usage. Direct-install programs replace inefficient appliances and fixtures with more efficient models at no cost, or a greatly reduced cost. In addition, water service providers can offer rebates for customers to install water efficient appliances or to replace water-intensive landscaping. For example, the Southern Nevada Water Authority offers rebates to homes and residents that replace turf with more water efficient landscapes. So far, this program has led to the removal of more than 155 million square feet of grass (SNWA 2012). These kinds of utility-scale investments are ultimately financed by revenue from customers or grants.

In 2009, the federal government gave a major boost to SRFs through ARRA, providing $6 billion for local water and wastewater infrastructure improvements. The USEPA reported that 14% of GPR funds were allocated for water efficiency projects, with an average of $1.5 million spent per project (EPA 2012a).For example, $300,000 of GPR funding was allocated to a program in Douglasville, Georgia that helped homeowners replace older toilets with newer, efficient models (American Rivers 2010).

3. Education and Outreach

Labeling and educational campaigns are used to promote urban water conservation and efficiency. The USEPA launched the WaterSense labeling program in 2006 to clearly identify devices that are water-conserving (or 20% more efficient than what is required by the national plumbing standards) and that meet rigorous performance criteria. Additionally, the state of California, in partnership with the Association of California Water Agencies, recently launched the "Save Our Water" program to develop a consistent statewide message on the importance of water conservation and efficiency and to disseminate consumer-oriented information and tools to reduce water use. The Alliance for Water Efficiency (AWE) has launched the Home Water Works website to help consumers learn about implementing water conservation efforts in their home (AWE 2012a). In 2013, AWE will launch the Never Waste Consumer Media Campaign. The campaign materials can be customized for use by individual water service providers (AWE 2012c).

4. Emerging Policies and Funding Mechanisms

New financial mechanisms for promoting water conservation and efficiency have been proposed, although their use is currently limited. One example from the energy sector is a Property Assessed Clean Energy (PACE) program. PACE programs help residential and commercial building owners finance renewable energy as well as energy and water conservation upgrades. These programs generally use bond revenue to finance the improvements, which is repaid through 20-year property tax assessments. Even when property changes owners, the tax assessment remains the same, thus tying the debt to the property instead of an individual (Valderrama et al. 2012). Twenty-nine states and the District of Columbia also have enacted PACE programs; however, the Federal Housing Finance Agency has effectively suspended all residential PACE programs indefinitely, citing concern over the potential impacts to the mortgage industry (Federal Housing Finance Agency 2012). Commercial properties are still eligible.

Another model for financing urban water conservation and efficiency projects is through water service companies. Water service companies are similar to energy service companies (ESCOs), which work with building owners to design and implement energy efficiency upgrades. So far, municipal, educational, and hospital buildings have utilized ESCOs, as they have the financial ability to invest in such projects as well as large enough footprints that offer the potential for significant savings. Water service companies have also helped implement plumbing retrofits in residential apartment buildings (Valderrama et al. 2012).

TABLE 5: STORMWATER TECHNIQUES

DOWNSPOUT DISCONNECTION	*Disconnect downspouts to reroute rooftop drainage pipes to drain rainwater to rain barrels, cisterns, or permeable areas instead of the storm sewer.*
RAINWATER HARVESTING	*Rainwater harvesting collects and stores rainfall for later use.*
RAIN GARDENS	*Rain gardens (also known as bioretention or bioinfiltration cells) collect run-off from rooftops, sidewalks, and streets into shallow, vegetated basins.*
PLANTER BOXES	*Planter boxes are urban rain gardens with vertical walls and open or closed bottoms that collect and absorb runoff from sidewalks, parking lots, and streets.*
BIOSWALES	*Bioswales can retain and filter stormwater as it moves through vegetated, mulched, or xeriscaped channels.*
PERMEABLE PAVEMENTS	*Permeable pavements can infiltrate, treat, and/or store rainwater where it falls.*
GREEN ROOFS	*Green roofs are covered with growing media and vegetation and enable rainfall infiltration and evapotranspiration of stored water.*
URBAN FORESTRY	*Trees in urban areas reduce and slow stormwater by intercepting precipitation in their leaves and branches.*
LAND CONSERVATION	*Land conservation can protect open spaces and sensitive natural areas within and adjacent to cities.*

Source: EPA 2012

Finally, some cities have begun levying a fee on new developments for increased water demand. For example, the Santa Monica Public Works Department charges a water demand mitigation fee: "A one-time fee the City charges new development to mitigate the total daily water consumption rate projected for the development. The total daily water demand for the project is calculated using standard water demand factors which have been developed by City staff. The water demand mitigation fee is set at $3.00 for each gallon of daily water demand which must be mitigated" (City of Santa Monica 2012).

Stormwater Management

Stormwater runoff is a major cause of water pollution in the United States. A one-inch rainfall event over a one-acre parking lot produces 27,000 gallons of stormwater runoff, and can carry a noxious mixture of soils, sediments, oils, chemicals, and other substances into local waterways. In some areas, combined sewers transport both stormwater and wastewater to treatment systems, which can be overwhelmed during high flows and release untreated wastewater into local waterways.

Green infrastructure practices and techniques include the following (EPA 2012c): rainwater harvesting, bioswales and other forms of stormwater retention, permeable pavement, green roofs, and other efforts to reduce impervious areas. For example, Portland and other cities have programs to disconnect downspouts, rerouting rooftop drainage pipes to rain barrels, cisterns, or permeable areas instead of the storm sewer.

The environmental benefits of green infrastructure include minimizing the impacts of urban runoff on local streams and the marine environment; reduced local flooding; recharged local groundwater supplies; and improved water supply reliability and flexibility.

There are also economic benefits to green infrastructure. It is typically less costly than conventional stormwater management techniques, with capital savings ranging from 15% to 80% (EPA 2007). A recent report showed that 75% of 479 green infrastructure projects either kept costs the same or reduced costs, compared to the same project that used more traditional infrastructure (American Rivers et al. 2012). Additionally, research has consistently shown a positive correlation between proximity to green spaces and home and property values (Crompton 2007). A 2004 study of a neighborhood in Philadelphia showed that planting a tree within 50 feet of a residence increased its value by 9% (Business United for Conservation 2010).

Upgrading existing conventional infrastructure to manage stormwater comes at considerable financial cost, which has encouraged urban areas to look for alternative ways to address stormwater runoff. According to the USEPA's 2008 Clean Watershed Need Survey, approximately $189 billion is needed for pipe repair, new pipes, combined sewer overflow (CSO) corrections, and stormwater management programs (EPA 2008). Low-impact development (LID) or "green infrastructure" are alternative approaches that include systems and techniques intended to infiltrate, evaporate, and reuse stormwater on the site where it is generated.[3] Of the $189 billion funding gap identified by the survey, $17.4 billion is related to green infrastructure projects (EPA 2008).

It is difficult to determine how much green infrastructure has been installed, although implementation of techniques in some areas has been tracked. According to the Greenroof & Greenwall Projects Database, more than 970 projects have installed more than 14 million square feet of greenroofs in the U.S. (Green Projects Database 2012), though this estimate likely underestimates the true extent of this practice. Other practices, such as rain gardens and urban tree planting, have not yet been comprehensively quantified.

1. Policy Framework

Federal and state regulations can be an important driver of LID techniques over traditional, gray infrastructure. Under the Clean Water Act, operators of municipal separate storm sewer systems (MS4s) as well as combined sewers are required to apply for an NPDES permit and develop management plans. These plans must outline the control measures and Best Management Practices (BMPs) that will be used to limit or minimize pollutant discharges. The USEPA has been promoting the use of green infrastructure techniques as a low cost, environmentally-friendly way to meet federal stormwater requirements, and, more generally, as a preventative measure against wet weather pollution.

Washington D.C., for example, recently updated their MS4 permit to emphasize the use of LID techniques, including green roofs, enhanced tree plantings, permeable pavements, and a performance standard to promote practices such as bio-retention and water harvesting (Government of the District of Columbia 2012). Similarly, the Northeast Ohio Regional Sewer District (NEORSD) is currently implementing Project Clean Lake as a result of a consent decree with the USEPA to reduce CSO events. NEORSD will spend approximately $42 million on green infrastructure projects in order to capture 44 million gallons of CSO water, above the 63 million gallons that will be captured using more traditional means (NEORSD n.d.). In addition, green infrastructure investment will target areas with low incomes or concentrated minority populations in order to improve the health, welfare, and socio-economic conditions of these priority communities (NEORSD 2012). Green infrastructure is also being incorporated into the planning processes designed to set TMDLs, estimate future loading scenarios, and meet water quality standards (EPA 2008b). The lower Charles River in Massachusetts, for example, is using green infrastructure as part of the plan to meet the required phosphorus load reductions (EPA 2012c).

Local regulations can also encourage LID. Green stormwater techniques have been incorporated into some building codes. The International Green Construction Code, for example, can be used to establish local or municipal codes that address a range of stormwater issues through building design, including site development, stormwater management, and land use.

2. Financial Incentives

Stormwater fees and loans are the most common sources of funding for municipal green infrastructure projects (EPA 2008c). Stormwater fees are easier to institute than taxes and are consider fairer, as they apply even to tax-exempt organizations. Stormwater user fees can be calculated based on the amount of impervious surfaces, and can be applied by zone or property type. Charges can be levied as part of a one-time fee for a particular project, or on a continuous basis to fund overall system-wide improvements. Orlando, Florida has authorized a stormwater fee to be collected on annual property tax rolls. "The annual utility fee for developed property is based

[3] According to the USEPA, LID is LID is "an approach to land development (or re-development) that works with nature to manage stormwater as close to its source as possible" (EPA 2012i). This report uses LID and green infrastructure interchangeably.

on the Equivalent Residential Unit (ERU). For a residential parcel of 1 ERU, the annual utility fee for the 2010 billing cycle is $119.88" (City of Orlando n.d.). In addition, stormwater fee discounts and credits can be given out to customers who have implemented green stormwater practices, and these can be used as a more proactive means of incentivizing projects.

Federal funds are also used for green infrastructure investment. Federal funding has traditionally been available for green infrastructure projects through the SRF loan programs. In total, ARRA's Green Project Reserve funded 259 green infrastructure projects, spending, on average, $800,000 per project (EPA 2012a). Other federal grant and cost-share funds are available. The Great Lakes Restoration Initiative (GLRI), a federal grant program designed to restore the Great Lakes, specifically notes that green infrastructure projects are eligible for funding to improve nearshore health and reduce non-point source pollution (GLRI Action Plan 2010). As of 2012, funding for the GLRI continues. State and local funds also exist to finance projects; in 2011, New York City's Department of Environmental Protection allocated $3.8 million in grants for community-based green infrastructure projects (NYCDEP 2011). Other funds exist through foundations and organizations that have an interest in green infrastructure, gardening, low-impact development, and more.

3. Education and Outreach

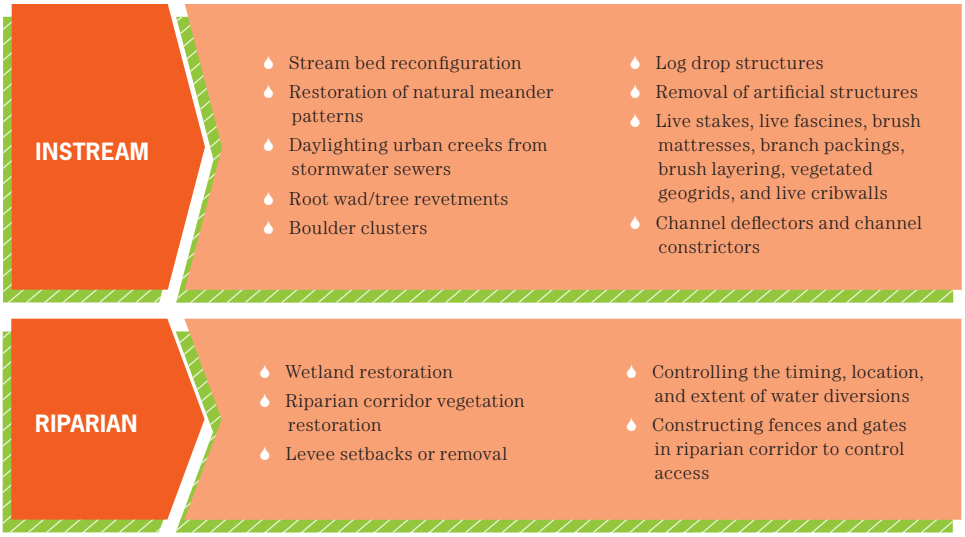
Leadership in Energy and Environmental Design (LEED) is a voluntary, consensus-based, market-driven program that provides third-party verification of green buildings (U.S. Green Building Council 2012). LEED incorporates stormwater management into their rating system so that projects may receive a higher rating when LID techniques are included. The Sustainable Sites Initiative has created voluntary national guidelines and performance benchmarks for sustainable land design, construction, and maintenance practices. Sites will be able to apply for and receive certification beginning in 2012. The U.S. Green Building Council anticipates incorporating these guidelines into future iterations of their LEED program (SITES 2012).

4. Emerging Policies and Funding Sources

USEPA is currently working to create new national stormwater regulations. USEPA is proposing these new regulations will, among other things, establish consistent standards for MS4s and set specific requirements to control stormwater discharges from new development and redevelopment. Although the USEPA has been promoting LID in existing stormwater regulations, advocacy organizations such as American Rivers are asking the USEPA to use the opportunity to advance implementation of green infrastructure (American Rivers 2012d).

Property Assessed Clean Energy (PACE) programs could be used as a model to encourage green infrastructure upgrades (See section 1.4 on Emerging Policies and Funding of Urban Water Conservation and Efficiency for more information about PACE programs). When a property with green infrastructure is at risk of changing owners, the financial investment might not be recovered. In addition, uncertainty in the long-term availability of credits or fee reductions can also increase risk (Valderrama et al. 2012).

TABLE 6: RESTORATION TECHNIQUES



Source: EPA 1995

TABLE 7: REMEDIATION TECHNIQUES

EXTRACTION OR REMOVAL TECHNIQUES	Multi-Phase Extraction Natural Attenuation	
CONTAINMENT TECHNIQUES	Evapotranspiration Covers	
IN-SITU TREATMENT TECHNIQUES	Thermal Treatment Flushing Oxidation Air Sparging Permeable Reactive Barriers	Phytotechnologies Ground-Water Circulating Wells Nanotechnology Natural Attenuation

Restoration and Remediation

Ecological restoration is the process of returning the chemical, physical, and/or biological components of a degraded ecosystem to a close approximation of pre-disturbance conditions. Restoration can improve water quality and aquatic ecosystem health. Restoration can be achieved through natural or artificial techniques. The USEPA has identified three restoration techniques that deal with water quality:

1. In-stream techniques applied within the water system. For example, streams that have been channeled can be restored to achieve more a natural geometry, meander, sinuosity, substrate composition, structural complexity, aeration, and stream bank stability.
2. Riparian techniques applied to the land area surrounding or bordering the water system. This can include planting of native riparian vegetation or construction of fencing to protect delicate riparian plants.
3. Upland or surrounding watershed techniques designed to reduce nonpoint source pollution from upstream lands within the watershed (EPA 1995).

Although they are integral aspects of environmental restoration, for the purposes of this report, techniques used for upland or surrounding watershed zones are cataloged under stormwater management and agricultural efficiency, and will not be discussed further in this section. Table 6 lists some examples of instream and riparian restoration techniques.

Environmental remediation – a subset of restoration – is the process of targeted removal of specific toxic substances or pollutants from soil or water. While restoration is generally focused on returning an ecosystem to its natural state, remediation targets lands contaminated with substances harmful to human health and the environment. Removal of these contaminants can be important, especially in aquatic systems where pollutant transport is a risk. A wide range of techniques can be used to remediate ground and surface water, include phytoremediation, where plants are used to absorb harmful contaminations and installation of permeable reactive barriers, where membranes are used to capture or degrade groundwater contaminant plumes. Another important aspect of environmental remediation is the use of new technologies to characterize and monitor contamination (EPA 2012h).

1. Policy Framework

Although most regulatory programs that address water quality deal with pollution prevention, state and federal regulations have been developed to promote restoration and remediation efforts. The Clean Water Act created the legal framework for water protection in the nation, utilizing restoration as a method to achieve this goal of preserving the ecological integrity of aquatic resources. TMDL implementation can include restoration or remediation as part of the strategy to achieve pollution limits set for that water body (EPA 1999b).

In addition, the CWA requires all dischargers to minimize and avoid impacts to wetlands, to the extent practicable. Where adverse impacts are unavoidable, the Act allows for replacing the lost wetlands through restoration, establishment, enhancement, or preservation of wetlands, streams or other aquatic resources. Restoration may result in a gain of wetland functioning or acreage, or both. The USEPA has also created a wetland mitigation banking system, where an area that has been restored, established, enhanced, or preserved serves as a bank from which new permitees can purchase credits in order to offset future development (EPA 2012d).

2. Financial Incentives

Local, state, and federal governments are the major funders of restoration activities (Hurd 2009). The term “Superfund” is a federal designation given to abandoned hazardous waste sites. The Superfund program, which was established by the Comprehensive Environmental Response,

Compensation and Liability Act of 1980, includes money to help pay for cleanup activities at sites placed on the National Priorities List (NPL) (NOAA n.d.). Today, more than 1,100 surface water and groundwater sites are on or are proposed to be added to the NPL list. Under the "polluter pays principle," responsible parties are charged for paying for Superfund cleanups (Ramseur, Reisch, and McCarthy 2008). When the USEPA cannot locate the responsible parties or those responsible cannot fund the cleanup, the Superfund Trust is used. Taxes on petroleum, chemical feedstock, and corporate income have historically provided the funding for the cleanup of Superfund sites. However, the Superfund taxes expired in 1995, leaving the trust without a dedicated source of funding, and so the U.S. Treasury has been funding the trust since then (Ramseur et al. 2008). In 2010, ARRA funds allocated $600 million to Superfund sites. This allowed new construction to begin at 26 Superfund sites and continued construction at 25 other sites (Virjee 2011).

Often, restoration and remediation projects require a mix of funding sources, particularly in regard to regional restoration planning. For example, the Everglades is a large freshwater ecosystem in Southern Florida that has decreased in size considerably due to urban development and agricultural use. In 2000, the Comprehensive Everglades Restoration Plan (CERP) was developed and approved in the 2000 Water Resources Development Act, and was estimated to cost over $11 billion over 30 years (Everglades Plan n.d.). As of 2011, Florida and the federal government have invested $6.5 billion to improve water quality under the Everglades Forever Act and CERP (Sheikh 2005; State of Florida 2011). The South Florida Water Management District is the largest funder for restoration work, expecting to spend $576.1 million for Fiscal Year 2012, with 70% of the budget dedicated to restoration (SFWMD 2011).

States also contribute to restoration funding through bond revenues, taxes, and the lottery. From 2000 to 2008, $41 million of California's restoration funding came from voter-approved bond revenues, more than half of all funding for restoration activities (California Department of Fish and Game 2008). In Oregon, the Pacific Coastal Salmon Recovery Fund, the Oregon Lottery, and the Oregon Salmon License Plate fund the Oregon Watershed Enhancement Board (Hurd 2009). The Chesapeake Bay receives funds from state retail taxes and motor fuel taxes.

Another financing mechanism that is being explored by Washington State for the Hood Canal watershed is an "in lieu" fee mitigation program, in order to offset the impacts of new construction (Washington State Office of the Governor 2012). The scale of the in-lieu fees could restore a larger area than the actual construction and can be a model for future projects.

Finally, natural resource damage (NRD) claims can provide funding for restoration and remediation activities. They are designed to compensate the public for the loss of services when publicly owned natural resources are damaged or destroyed (Ando et al. 2004). There are several federal statutes that allow lawsuits to be filed against responsible parties.[4] After an oil spill or hazardous substance release, response agencies like the USEPA conduct clean-up efforts, but these efforts may not fully restore natural resources or address their lost uses by the public.

3. Education and Outreach

Restoration and remediation projects can be used as educational tools; signs, websites, and other materials can be used to inform visitors to the site about the clean-up effort and the environmental benefits. The Duke University Wetland Center, for example, installed nine informational signs in the Stream and Wetland Assessment Management Park, some of which included information about the Sandy Creek Stream Channel Restoration Project (DUWC n.d.). Active projects can also enlist volunteers in the restoration tasks as a way of engaging and educating the public.

4. Emerging Policies and Funding Mechanisms

In June 2012, Congress enacted the Resources and Ecosystems Sustainability, Tourist Opportunities and Revived Economies of the Gulf Coast States Act (RESTORE Act). The RESTORE Act ensures that 80% of Deepwater Horizon civil and administrative penalties under the Clean Water Act will go to Gulf Coast restoration and establishes a Gulf Coast Restoration Trust Fund as well as a framework for allocation of the funds. Thirty-five percent of the funds will go equally to each of the five Gulf Coast states for local recovery; eligible activities include workforce development and job creation, among others (ELI 2012).

The amount of funding is still unknown; The Environmental Law Institute estimates the penalties could range from $3.3 million to $17.6 billion (Eli 2012). In 2010, President Obama through an executive order established the Gulf Coast Ecosystem Restoration Task Force in order to develop a restoration strategy for the Gulf. The

[4] *The best known of these is CERCLA, which provides that "damages for injury to, destruction of, or loss of natural resources, including the reasonable costs of assessing such injury, destruction, or loss resulting from such release" (CERCLA § 107(a)(4)(C)). The Clean Water Act (CWA) also provides a cause of action for recovery of NRDs. A party is liable under CWA § 311(b) for the discharge of "oil or hazardous substances" "into or upon the navigable waters of the United States, adjoining shorelines, or into or upon the waters of the contiguous zone."*

Task Force published their strategy in 2012, which includes upland and wetland restoration in order to improve ecosystem health in the Gulf. This plan will inform the allocation of the Trust Fund, once it becomes available (The White House 2012).

Alternative Water Sources

Traditional water sources include rivers, lakes, and groundwater, as well as artificial reservoirs created by dams. In the past few years, however, alternative water sources have begun to play an increasingly important role in supplementing water systems where traditional sources have become harder or more expensive to develop. Such alternative sources include a range of unconventional supplies, such as rainwater, stormwater, greywater, and reclaimed water. Projects to capture these alternative water sources can be implemented by a water utility or at the facility level by households or businesses. For the purposes of this report, this strategy focuses on activities at the utility-scale; other actions at the site level, such as rainwater harvesting and greywater reuse, are captured in other strategies. We also describe conjunctive use or aquifer storage and recovery (ASR) as a means of storing these alternative sources for later use.[5]

Broadly, water reuse refers to the process of treating and reusing wastewater for a beneficial purpose. Potential uses include agricultural and landscape irrigation, industrial processing and cooling, domestic uses, dust control, construction activities, concrete mixing, artificial lakes, and replenishing groundwater basins (referred to as groundwater recharge, discussed in more detail below). Treatment levels can be tailored for the intended purpose and the level of human contact, which can help save money and energy when the quality does not have to meet drinking water standards. Water can be distributed from a wastewater treatment facility, or treated and reused directly on site (such as at a home or an industrial facility). Techniques to treat and reuse greywater water onsite are discussed in the urban water conservation and efficiency strategy.

A growing number of communities across the U.S. are already beginning to move in the direction of encouraging and expanding use of reclaimed water. According to the USEPA's Clean Watersheds Needs Survey, an investment of approximately $4.4 billion is needed to build, rehabilitate, or replace infrastructure for reclaimed water distribution (American Rivers et al 2012). In 2004, USEPA estimated total wastewater reuse in the United States at 1.7 billion gallons per day, and growing at a rate of 15% per year. The same report estimates 32 billion gallons of wastewater are produced each day, of which 12 billion gallons per day are discharged directly to an ocean or estuary. As this flow is not relied upon by downstream users, it could be made available for reuse (EPA 2004).

Alternative sources can be captured and stored underground for later use. The term "conjunctive use" describes the coordinated use of ground and surface water to optimize supply and storage. When surface water supplies are plentiful, they can be used instead of groundwater or to recharge groundwater basins. Also known as ASR, this technique can recharge groundwater through surface spreading, infiltration pits and basins, or subsurface injection. Not only does this practice increase the availability of water when it is most needed, it can add an additional treatment step, reduce evaporation and evapotranspiration as compared to surface storage, and enhance the sustainability of groundwater storage by preventing subsidence. The USEPA is aware of 1,203 aquifer recharge and ASR injection wells that are capable of operating; however, it is unclear how much water is injected into these wells each year (EPA 2009).

1. Policy Framework

Regulations that mandate the use of reclaimed water have been implemented at the state and local level. In Florida, for example, regional water management districts must designate "water resource caution areas," defined as those areas that have or are expected to have critical water supply problems within the next 20 years. These designated areas are then required to develop a regional water supply plan that identifies supply options, including reclaimed water and ASR (Florida DEP 2011). Reuse of reclaimed water in these areas is mandatory, unless reuse is not economically, environmentally, or technically feasible (Florida DEP n.d.).

State or judicial mandates may require an entity to reduce dependence on existing supplies, either permanently or during certain times of the year. In 1995, California's State Water Resources Control Board (State Water Board) instructed the California American Water Company to reduce pumping from the Carmel River Aquifer and Valley (CA State Water Board 1995). As a result, the water company is now examining options for wastewater reuse, ASR, and desalination (Monterey Peninsula Water Supply Project 2012). Additionally, Section 316(b) of the Clean Water Act requires industrial facilities employing a cooling water intake to use the best available technology, such as

[5] *Aquifer Storage and Recovery is the recharge and subsequent reuse of groundwater through surface spreading, infiltration pits and basins, or subsurface injection.*

recirculating cooling systems and reclaimed water, to reduce the environmental impact of water withdrawals. As of 2007, 50 power plants were using reclaimed water for cooling purposes (Veil 2007).

2. Financial Incentives

A variety of financing mechanisms are used for reclaimed water projects, including cash financing, debt financing, and private equity. Funding for these mechanisms can originate from federal and state grants and loans, utility revenue, local taxes, etc. (Marsh 2007). Federal funds are available through eight federal agencies that administer 17 different programs to provide grants and loans for municipal reclaimed water projects (CH2MHILL 2004). As part of the Recovery Act, for example, the Department of the Interior administered $134.3 million in funds for 27 water reclamation and reuse projects (Moody 2009). Federal funding includes, for example, the Water Resources Development Act's Section 219 grants and the Clean Water SRF. However, federal funding is generally provided for treatment, storage, and distribution, while funding to connect customers to the system is left to local funds (Cooley 2012).

One of the major sources of federal funding for reclaimed water projects is Title XVI of the Reclamation Projects Authorization and Adjustment Act of 1992, which directs the Secretary of the Interior to explore opportunities to reclaim and reuse wastewaters and naturally impaired ground and surface water in 17 Western States and Hawaii (Catalog of Federal Domestic Assistance). Since 1992, Title XVI has provided more than $556 million in Federal cost-share with more than $1.7 billion provided by non-Federal funding sources (Bureau of Reclamation 2012). While a number of projects have been authorized under Title XVI, demand for additional support is high: about $600 million in projects remains unfunded and the Bureau has indicated they will not add any new projects to the queue until the existing backlog is clear (American Water Intelligence 2012).

State- and local-level programs also fund alternative water supplies projects. In 2005, Florida implemented the Water Protection and Sustainability Program, which provides consistent funding for reclaimed water projects. As of 2011, this program funded 202 reclaimed water projects and 17 ASR projects (Florida DEP 2011). Similarly, California's State Water Resources Control Board maintains the Water Recycling Funding Program (WRFP) which provides technical and financial assistance to project developers. As of 2007, WRFP had distributed nearly $132 million in grants and $509 million in low-interest loans for water reclamation planning and construction (CA State Water Board n.d.). Local, utility-scale programs can also promote use of alternative water sources. For example, the Metropolitan Water District of Southern California pays its member agencies for water that is returned to the groundwater supply (MWDSC n.d.).

3. Education and Outreach

Public perception has been a challenge for alternative water supplies, especially reclaimed water. Several educational campaigns have been developed to address this issue. In 2010, the San Diego City Council approved a $3.28 million campaign to educate residents about the potential benefits of reclaimed wastewater (San Diego Newsroom 2010). Florida's Department of Environmental Protection has assembled educational materials, including factsheets, flyers, guides, brochures, and videos, about reclaimed water (Florida DEP n.d.).

NSF International and the American National Standards Institute have created certification system for water reuse treatment systems. Standard 350: Onsite Residential and Commercial Water Reuse Treatment Systems (NSF-350) establishes minimum material, design, construction, and performance requirements for onsite greywater, residential, and commercial water treatment systems. The U.S. Green Building Council's LEED program offers points for buildings that utilize NSF-350-certified products.

4. Emerging Policies and Funding Mechanisms

A number of innovative funding mechanisms are available to promote reclaimed water, some of which are based on approaches used in the energy sector. Production tax credits (PTCs) have been used in the energy industry to promote the use of renewable energy sources. The PTC provides a credit of a small amount of money per unit of energy produced. Similarly, companies that reuse their wastewater, or utilities that provide reclaimed water, could receive a tax credit from the state or municipal government. For example, Washington State levies a Public Utility Tax on income of public and privately owned utilities. Water utilities may receive an exemption for a portion of the tax paid on income received for reclaimed water services for commercial and industrial uses (Washington State Department of Ecology 2001). Similar to

TABLE 8: AGRICULTURAL WATER MANAGEMENT TECHNIQUES

AGRICULTURAL WATER EFFICIENCY TECHNIQUES	• Improving irrigation scheduling • Improving irrigation technology (e.g. sprinkler and drip irrigation systems) • Lining canals and other seepage control options • Recycling tailwater on-farm • Increasing pump efficiency	• Constructing spill reservoirs and district reoperation to reduce water waste • Mulching and other techniques to increase soil water-holding capacity • Capturing stormwater flows for later use (e.g., on-farm ponds for frost/heat control and irrigation)
AGRICULTURAL WATER QUALITY IMPROVEMENT TECHNIQUES	• Planting cover crops • Constructing fencing around water bodies/streams • Utilizing conservation tillage/ no till	• Restoring riparian zones or constructing buffer zones • Improving irrigation scheduling and technology that reduces runoff

the PTC, an investment tax credit (ITC) offers a credit on investment in particular technologies. For example, New Jersey provides a sales tax refund as well as a corporate business tax credit for up to 50% of the cost for treatment and conveyance equipment for industries that utilize water reclamation technologies as part of their processing (NJDEP 2002). Congress also proposed implementation of an ITC for certain industrial and manufacturing facilities that invest in water reuse, recycling, and efficiency projects (Democratic News 2012).

Agricultural Water Efficiency and Quality

Agriculture is the largest consumer of water in the nation, and while great advances in water efficiency in this sector have been made, additional gains are available through implementation of improved water management techniques (Christian-Smith 2012). These practices are meant to reduce water waste and, in some cases, improve crop quality and yield. They include improved irrigation technologies and scheduling, reducing erosion, lining canals, increasing pump efficiency, restoring riparian areas, recycling tailwater on-farm, and constructing spill reservoirs at the water supplier scale.

Practices such as these can help reduce on-farm water use as well as improve water quality. Farmers are constantly implementing new technologies and management practices to improve their products. In many cases, water savings are a co-benefit of practices that are meant to decrease input costs or improve crop quality. Precision irrigation, in particular, has been shown to do both. And, according to the Census of Agriculture, flood irrigation declined 5% nationwide between 2003 and 2008, replaced by more precise sprinkler and drip irrigation. Nevertheless, 39% of irrigated land nationwide is still flood irrigated and there is significant room for improvement in all areas of agricultural water management. The 2007 U.S. Census of Agriculture found that at least 23% of farms and ranches surveyed[6] utilized conservation methods such as no-till or conservation tillage, runoff collection or filtration, fencing animals from streams, and other practices (NASS 2007). Agricultural runoff is also a major source of pollution of surface and groundwater, and thus conservation practices designed to reduce runoff can also contribute to improved water quality and ecosystem health.

1. Policy Framework

For regulatory purposes, agricultural runoff is considered nonpoint source pollution, and therefore does not require the same permitting under the Clean Water Act as point source pollution. One notable exception is concentrated animal feeding operations or CAFOs, a subset of livestock and poultry animal feeding operations where animals are kept and raised in confined situations and do not graze. In 2003, the USEPA began requiring CAFOs to apply for NPDES permits for their waste discharges to receiving waters, and later added requirements for submission of nutrient management plans.

In some cases, agricultural runoff is included as part of TMDL requirements. For example, in 2010, the USEPA established the largest ever TMDL for the Chesapeake Bay watershed, and required actions to reduce nitrogen, phosphorus, and sediment pollution from major agricultural lands across the region (EPA and CBP 2010). In total, more than $490 million is targeted in FY 2011 toward meeting the outcomes and goals set forth in the Strategy, contingent upon appropriations by Congress (EPA et al. 2011). The federal government is closely linked to agricultural water supply as the Bureau of Reclamation provides irrigation water to approximately 1 out of every 5 farmers in the nation. In some cases, the

[6] *Although the number of farms is given, it is unclear how much land this number represents.*

Bureau has encouraged water conservation through measures such as conservation water pricing and accurate water measurement and reporting (pursuant to the Central Valley Project Improvement Act).

Most often, agricultural water efficiency is driven by state and local efforts, particularly in areas that experience frequent droughts. For example, California recently passed the Water Conservation Act of 2009, which, for the first time, requires that large irrigation water providers in the state measure the quantity of water delivered to customers and begin to charge their customers based on their water use (known as volumetric pricing). Volumetric pricing is intended to send better price signals to agricultural water users and encourage water conservation and efficiency.

2. Financial Incentives

Implementation of improved on-farm water management techniques can be financed directly by individual farmers, or through state and federal cost-shares, loans, and grants. The federal Farm Bill offers a variety of programs to provide funding for water conservation and efficiency, along with agricultural runoff management. These programs are described in Title II of the bill and include the Environmental Quality Incentives Program (EQIP), the Agricultural Water Enhancement Program (AWEP), the Conservation Security Program (CSP), and the Conservation Reserve Program (CRP). All offer cost-shares to agricultural producers that implement projects that improve water quality or efficiency. According to the Congressional Research Service, Title II conservation programs were allocated an average of $4.5 million annually between 2008 and 2012, or $22 million over the five-year time period (Monke and Johnson 2010).

Other federal funding sources are also available. Section 319 of the Clean Water Act allows states, territories, and tribes to receive grant money to support a wide variety of activities including technical assistance, financial assistance, education, training, technology transfer, demonstration projects, and monitoring. Over $3 billion has been granted to states through this program since 1990 (EPA 2012b). SRFs can be used to support a variety of on-farm practices including terraces, waterways, filter strips, buffers, field borders, windbreaks, erosion control structures, storm water management, and other conservation practices. In addition, some states have implemented specialized SRF programs. In 1983, Iowa established the conservation practices revolving loan fund, which provides zero-interest loans up to $10,000 to eligible landowners to implement soil conservation practices (Iowa Code 161A.71).

Some states and regions have funded agricultural water efficiency improvements through bond measures. California passed a series of statewide water-related bond measures over the last decade, including Proposition 84: The Safe Drinking Water, Water Quality and Supply, Flood Control, River and Coastal Protection Bond Act of 2006, which provided $15 million for "projects that reduce the discharge of pollutants from agricultural operations into surface waters of the state" (State Water Boards 2012). Other initiatives are designed to defray costs associated with better agricultural water management. For instance, Sustainable Conservation offers the Best Management Practices (BMP) Challenge to dairy farmers to give them the chance to try out innovative nutrient management practices and tillage systems on their own operations by reimbursing farmers for any reductions in crop yields (Sustainable Conservation 2012).

3. Education and Outreach

The Natural Resources Conservation Service (NRCS) plays a leading role in farmer education and outreach. NRCS, an agency in the U.S. Department of Agriculture, provides technical assistance to landowners, conservation districts, tribes, and other organizations to improve, protect, and conserve natural resources on private lands. NRCS operates a variety of programs aimed at improving water management on-farm, for example, the Conservation Technical Assistance Program and the National Ag Water Management Team (USDA 2012). NRCS administers many of the Farm Bill's conservation programs by choosing which agricultural producers and projects to fund. In addition, many states have local resource conservation districts, which are non-regulatory organizations focused on rural resource management issues. Finally, Western states often have extension programs related to land-grant universities, with a mission to extend research and science to rural communities.

4. Emerging Policies and Funding Sources

The TMDL program will continue to be a major driver and source of funding for agricultural water efficiency and quality improvement. As of January 2011, over 45,000 TMDLs have been developed (EPA 2012f), however, many impaired water bodies still require TMDL development and implementation. In addition, the Farm Bill

is currently being revised and additional funding for conservation programs could be provided through Title II.

Conclusions

The sustainable water strategies defined in this report address important challenges to long-term management of water resources and ensuring safe and equitable access for all. It is important, though difficult, to clearly identify the drivers of projects in these categories as these strategies are not easily compartmentalized. This is due, in part, to the fact that the water sector is fragmented, with highly localized management. For example, there are hundreds of thousands of water providers nationwide, while there are only hundreds of energy providers.

Thus far, federal statutes and related funding streams have played a significant role in helping to define and implement these strategies. The consistent enforcement and funding of activities associated with federal mandates that support clean water and healthy watersheds can support job growth and allow for more effective planning. The Aspen Institute and others argue that the federal government continues to have an important role in support of more sustainable water management. "The federal government shares the responsibility for achieving the Sustainable Path. Therefore, federal funding should target investments in 21st century priorities, including 'green infrastructure;' water and energy efficiency; climate change adaptation; clean and safe water for economically distressed households; research, development and demonstration projects for integrated water management; and incentives for sustainable utilities" (Aspen Institute 2009).

Yet, the federal government cannot do it alone. Federal financial support will not be able to fill the large infrastructure gap, and local funding must be increased. The EPA identified major capital costs and operations and maintenance costs for public water systems, finding a $533 billion investment gap between 2000 and 2019 with current levels of investment (Cooley 2012). Yet, the report also found that with a slight increase in local financing, this gap could be narrowed greatly. The gap narrows from $533 billion to $76 billion "if (on average) municipalities increase clean water and drinking water spending at a real rate of growth of three percent per year" (EPA 2002a). Indeed, the sections above describe many innovative sources of local funding from local stormwater utility fees, to state tax credits, to the use of property assessments to pay back household green investments. While the economic recession has reduced the availability of funds, this report argues that increased spending in the water sector can drive economic prosperity by creating jobs, while at the same time improving quality and access to safe water.

Source: Amigos de los Rios

Source: US Department of Agriculture

III SUSTAINABLE WATER OCCUPATIONS

Who is hired and does the work when sustainable water practices are put in place? How many jobs are created? Implementing sustainable water strategies can increase demand for workers in traditional occupations, such as truck drivers and receptionists, where no new or enhanced skill sets will be required. Additionally, these strategies can increase demand for workers who will have to perform distinct tasks and learn new and enhanced skills, such as a plumber who installs residential grey-water systems. Less frequently, entirely new occupations may be created. Shifts in demand, skills, and occupations are what the Occupational Information Network (O*NET) refers to as the 'greening of the world of work':

> The 'greening' of occupations refers to the extent to which green economy activities and technologies increase the demand for existing occupations, shape the work and worker requirements needed for occupational performance, or generate unique work and worker requirements. (O*NET 2011)

This section looks at the workers involved in implementing sustainable water strategies and reports their occupations and the phases in the broader economic process of each strategy. Three basic questions are our focus:

- What types of occupations do sustainable water projects support?
- What are the major phases in implementing sustainable water strategies?
- How many jobs are created when these water strategies are implemented?

Our analysis starts with the sustainable water strategies described above, identifies the occupations of the workers involved in each strategy, groups them into the various implementation phases, and reports available research on the numbers of jobs generated.

Data for this analysis was drawn from previously published reports on specific projects or local studies, a limited set of relevant data from the American Recovery and Reinvestment Act (ARRA), semi-structured interviews and focus groups with two dozen practitioners and researchers, and in-house expertise (see Appendix A for a detailed discussion on the data sources). Based on these data, we compiled a list of the occupations within each of the five sustainable water strategies. We then grouped the occupations into the development phases of the strategy, which include the research, manufacturing and distribution, wholesale and retail sales, design and planning, installation, and operation and maintenance. This approach is adapted from Eco Canada (2010) and is similar to a supply chain or commodity chain analysis, commonly used in industry and workforce analyses.[7] Most analyses have focused on the occupations involved in the installation of a high-efficiency device while missing occupations involved in the design or ongoing maintenance of the device. Identifying the occupations involved in all phases of the process allows for a more complete analysis of opportunities for workforce development and investment strategies. Lastly, we reviewed the available data on the numbers of jobs created for sustainable water projects.

The limitations of this analysis are primarily due to a lack of occupational data. The few studies available are limited to local regions and case studies, and modeled estimates, that a limited basis to draw broad conclusions. The studies that have used modeling such as IMPLAN to estimate occupational effects of water projects are limited by the fact that the sustainable water strategies we present often involve non-traditional industrial activities, and as a result, models based on historic trends may not fully capture emerging and changing occupations. Where the authors of this report were sufficiently confident to add occupations that have not been noted in the literature, we recognize that our knowledge may also not be representative of all areas in the country. Therefore, these lists of occupations cannot be treated as comprehensive or universally applicable. Nonetheless, it is a useful and an important step to understanding the nature of jobs supporting sustainable water outcomes.

[7] *See for example Hamilton, James and Drew Liming (2010) Careers in Wind Energy. U.S. Bureau of Labor Statistics.*

Urban Conservation and Efficiency Jobs

The development process for urban conservation and efficiency jobs includes a variety of activities. Research and development, for example, generates new water-efficient technologies and practices, including mobile applications, soil moisture sensors, weather-based irrigation controllers, appliances and fixtures, and sensors (e.g., for cooling towers). Manufacturing activity produces these new tools and products, which are then distributed through wholesale and retail sales to businesses, utilities, and homeowners. A design and planning phase may also exist, e.g., in the case of utility-sponsored efficiency program.

Figure 4 provides a summary of the occupations associated with urban efficiency projects. These occupations range from scientists developing new technologies to surveyors and landscape architects measuring water use and planning for improvements. Plumbers, construction laborers, and landscaping workers install and often maintain efficient technologies and vegetation, while public relations specialists raise awareness among community members and consumers.

Urban water efficiency projects create jobs, although limited data are available to develop accurate estimates (Table 9). Early efforts to quantify the number of jobs created by urban efficiency projects include the 1992 Madres del Este de Los Angeles Santa Isabel partnership, which estimates that a community-based program to install low-flush toilets created 25 full-time and three part-time jobs (Lerner 1997). In a more recent analysis, the Alliance for Water Efficiency modeled the jobs created by investments in seven types of water conservation and efficiency programs, finding 14.6 to 21.6 jobs in total employment generated per $1 million invested (AWE 2008). A similar study in Los Angeles by the Economic Roundtable gathered information on 11 urban efficiency projects, ranging from bathroom retrofits to a green garden program, and found that the projects generated 11.8 jobs per $1 million invested, including 6 direct, 2.6 indirect, and 3.3 induced jobs.

TABLE 9: JOBS PER $1 MILLION INVESTED IN URBAN CONSERVATION AND EFFICIENCY PROJECTS

PROJECT TYPE	EMPLOYMENT	UNITS AND METHODS	SOURCE
11 water conservation projects in Los Angeles County	11.8	*Total employment including direct employment from expense reports and modeled indirect and induced employment*	*Los Angeles Economic Roundtable (2011)*
Evapotranspiration (ET) Irrigation Controller Rebate/ Direct Install Programs	20.4	*Total employment modeled using categorized program expenses as inputs*	*Alliance for Water Efficiency (2008) $0.8*
Water System Loss Control	21.6	*(same as previous)*	*Alliance for Water Efficiency (2008) $0.8*
High Efficiency Toilet Rebate Program	18	*(same as previous)*	*Alliance for Water Efficiency (2008) $0.8*
High Efficiency Toilet Direct Install Program	17.2	*(same as previous)*	*Alliance for Water Efficiency (2008) $0.8*
Industrial Water/Energy Survey and Retrofit Program	15.6	*(same as previous)*	*Alliance for Water Efficiency (2008) $0.8*
Retrofit Cooling Towers with Conductivity and Ph Controllers	15.4	*(same as previous)*	*Alliance for Water Efficiency (2008) $0.8*
Restaurant Surveys and Direct Install Equipment Retrofits	14.6	*(same as previous)*	*Alliance for Water Efficiency (2008) $0.8*
The installation of 5,439 greywater systems in new residential properties in LA County	5.3	*Modeled total jobs (direct/ indirect/induced) using IMPLAN System 2009 data and 2011 software*	*Los Angeles Economic Roundtable (2011)*

FIG. 4: URBAN WATER EFFICIENCY OCCUPATIONS

RESEARCH AND DEVELOPMENT
e.g. development of water efficient technologies/ fixtures for residential and commercial

- Environmental Engineers
- Soil and Plant Scientists
- Geologists
- Environmental Scientists and Specialists, Including Health Industrial Designers
- Conservation Scientists

MANUFACTURING AND DISTRIBUTION
e.g. production of water efficient fixtures

- Truck Drivers–Heavy and Tractor-Trailer
- Laborers and Freight, Stock, and Material Movers, Hand Milling and Planing Machine Setters, Operators, and Tenders, Metal and Plastic
- Shipping, Receiving, and Traffic Clerks
- Truck Drivers, Light or Delivery Services
- Stock Clerks and Order Fillers
- Industrial Designers

WHOLESALE AND RETAIL SALES
e.g. sales of low-flow toilets or drip irrigation equipment

- Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products
- Stock Clerks and Order Fillers
- Cost Estimators

DESIGN AND PLANNING
e.g. conducting an audit of residential or commercial water use

- Architectural and Civil Drafters
- Cartographers and Photogrammetrists
- Landscape Architects
- Surveyors
- Surveying and Mapping Technicians
- Environmental Engineers
- Commercial and Industrial Designers
- Environmental Restoration Planners
- Social and Community Service Managers
- Forest and Conservation Technicians
- Graphic Designers

INSTALLATION
e.g. install and upgrade efficient fixtures and appliances

- First-Line Supervisors/Managers of Construction Trades and Extraction Workers
- Construction Managers
- Landscaping & Groundskeeping Workers
- Carpenters
- Construction Laborers
- Operating Engineers and other Construction Equipment Operators
- Electricians
- Pipelayers
- Plumbers, Pipefitters, and Steamfitters
- Helpers–Carpenters
- Helper–Construction Trades, All Other Helpers—Pipelayers, Plumbers, Pipefitters, and Steamfitters
- First-Line Supervisors of Landscaping, Lawn Service, and Groundskeeping Workers
- Control and Valve Installers and Repairers, Except Mechanical Door
- Farmworkers and Laborers, Crop, Nursery, and Greenhouse
- Recreation Workers
- Tree Trimmers and Pruners
- Pesticide Handlers, Sprayers, and Applicators, Vegetation
- First-Line Supervisors/Managers of Farming, Fishing, and Forestry Workers
- First-Line Supervisors of Agricultural Crop and Horticultural Workers
- Agricultural Workers, All Others
- Forest and Conservation Workers

OPERATIONS AND MAINTENANCE
e.g. repair, maintain, and upgrade efficient fixtures and appliances

- Landscaping & Groundskeeping Workers
- Operating Engineers and Other Construction Equipment Operators
- Maintenance and Repair Workers, General
- Helpers--Installation, Maintenance, and Repair Workers
- Septic Tank Servicers and Sewer Pipe Cleaners
- General and Operations Managers
- Farmworkers and Laborers Crop, Nursery, and Greenhouse
- Control and Valve Installers and Repairers, Except Mechanical Door
- Grounds Maintenance Workers, All Other
- Home Appliance Repairers
- Janitors and Cleaners, Except Maids and Housekeeping Cleaners
- Tree Trimmers and Pruners
- Pesticide Handlers, Sprayers, and Applicators, Vegetation

TABLE 10: JOBS PER $1 MILLION INVESTED IN STORMWATER MANAGEMENT PROJECTS

PROJECT TYPE	TOTAL EMPLOYMENT (Jobs per $1 million invested)	UNITS AND METHODS	SOURCE
Washington, DC Green Roofs Initiative[8]	19.65	Total jobs based on total green roof area covered in square feet	American Rivers (2008)
National investment in green stormwater infrastructure	10	Modeled total jobs (direct/indirect/induced) using macroeconomic and respending multiplier[9]	Green for All (2011)
Operations and maintenance budget of four stormwater projects in Los Angeles	13.8	Modeled total jobs (direct/indirect/induced) using IMPLAN System 2009 data and 2011 software	Los Angeles Economic Roundtable (2011)
Montgomery County Stormwater System Construction	10.8	Montgomery County expects to employ 3,300 in the next 3 years	Chesapeake Bay (2011)
Philadelphia stormwater investment	5.3	Modeled total jobs (direct/indirect/induced) using IMPLAN over next 20 years	Business United for Conservation Industry Partnership (2010)

Stormwater Jobs

The major phases of stormwater management projects are planning and design, installation, and operations and maintenance. The planning and design period is comprised of collecting site, soil, and runoff water information and selecting the most appropriate erosion and sedimentation controls for the project. Site planning entails a large amount of data collection and identification of soils, slopes, natural features, and drainage patterns performed by civil engineering, architecture, and planning firms. The most labor intensive stage is installation, which includes activities such as clearing, grading, and the installation of stormwater controls. During the installation stage, general construction services, paving, roofing, landscaping, and other construction services implement the stormwater plan, by constructing detention basins or installing porous pavement, rain gardens, or other stormwater controls. Ongoing operations and maintenance include weed and pest control, fertilizing, mowing, draining water, as well as inspecting and monitoring pollutants. The amount of operations and maintenance needed depends on the stormwater practice; rain barrels and detention basins, for example, simply require adequate drainage while vegetative filters require far more attention.

Figure 5 shows occupations involved in stormwater management. The range of occupations includes septic tank servicers and sewer pipe cleaners for operations and maintenance to welders, cutters, and welder fitters for manufacturing. Most of the occupations listed are traditionally within the landscaping and engineering sector and utilize similar techniques to address stormwater issues. Yet, the sustainable water strategies that are the focus of this report are designed to prevent and control stormwater runoff rather than simply diverting it to stormwater drains. Therefore, new skills for these traditional occupations include knowledge of green roof design and installation, working with new building materials (e.g. permeable pavement), and familiarity with land-use planning, site design, slope, and drainage.

Several studies have sought to quantify the number of jobs created through sustainable stormwater management projects. A recent analysis found that four stormwater projects in Los Angeles generated 13.8 jobs per $1 million invested, with average wages of $52,800. An estimated 73% of workers involved in these projects lived within the county, an indication of the local economic activity that these projects can generate. Likewise, stormwater projects in Washington, DC's Green Roofs Initiative produced 19.7 jobs for every $1 million invested. A prospective analysis of proposed investments in Philadelphia findsthat committing $1.6 billion over the next 20 years will create over 8,600 jobs, or about 5.3 jobs per $1 million invested (SBN 2010).

However, there is one caveat to mention in these economic and job impacts. Estimates show promising overall workforce growth, but the anticipated demand for entry-level work in stormwater projects is lower than in other sectors. Professional services such as architectural and engineering, financial institutions, and scientific and technical consulting tend to benefit from these economic impacts, while the construction services experience disproportionately low growth (Burns and Fleming 2011). Many of the top occupations involved in stormwater projects are in skilled trades or professional services, such as Environmental Engineers and Construction Managers. The driving factors for this difference in growth can be attributed to 1) the increased demand

[8] *Washington DC Office of Planning. Draft data from forthcoming report. Green Jobs from Green Roofs 2009.*
[9] *Green for All. Appendix A: Jobs Projection Methodology, 2011.*

FIG. 5: SUSTAINABLE STORMWATER MANAGEMENT OCCUPATIONS

RESEARCH AND DEVELOPMENT
e.g. development of stormwater management techniques

- Civil Engineers
- Conservation Scientists
- Environmental Engineers
- Environmental Scientists and Specialists, Including Health Hydrologists Soil and Plant Scientists
- Materials scientists

MANUFACTURING AND DISTRIBUTION
e.g. production of building materials and products

- General and Operations Manager
- Industrial Truck and Tractor Operators
- Truck Drivers–Heavy and Tractor-Trailer
- Welders, Cutters, Solderers, and Brazers

WHOLESALE AND RETAIL SALES
e.g. sales of products

- Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products

DESIGN AND PLANNING
e.g. stormwater planning: analyze site, evaluate site context, lay out infrastructure, landscape design and cost estimates, permitting and stakeholder engagement

- Architects, Except Landscape and Naval
- Architectural and Civil Drafters
- Cartographers and Photogrammetrists
- Civil Engineers
- Environmental Engineers
- Hydrologists
- Landscape Architects
- Natural Sciences Managers
- Surveyors
- Surveying and Mapping Technicians
- Urban and Regional Planners

INSTALLATION
e.g. installation of subsurface systems and rooftop systems require knowledge of draining systems, excavation, piping, and native plantings for stormwater infiltration

- Construction Managers
- Construction & Building Inspectors
- Cement Masons and Concrete Finishers
- Construction Laborers
- Electricians
- Earth Drillers, except oil and gas Carpenters
- Cement Masons and Concrete Finishers
- Construction & Building Inspectors
- Construction Laborers
- Construction Managers
- Earth Drillers, except oil and gas Electricians
- Extraction Workers
- First-Line Supervisors of Landscaping, Lawn Service, and Groundskeeping Workers
- First-Line Supervisors/Managers of Construction Trades and Helper–Construction Trades, All Other Helpers—Carpenters
- Landscaping & Groundskeeping Workers
- Natural Sciences Managers
- Pipelayers
- Plumbers, Pipefitters, and Steamfitters

OPERATIONS AND MAINTENANCE
e.g. landscape and drainage systems maintenance

- Crop, Nursery, and Greenhouse
- Farmworkers and Laborers
- General and Operations Managers
- Landscaping & Groundskeeping Workers
- Maintenance and Repair Workers, General Operating Engineers and Other Construction Equipment Operators
- Pump Operators, Except Wellhead Pumpers
- Septic Tank Servicers and Sewer Pipe Cleaners
- Water and Liquid Waste Treatment Plant and System Operators

Source: US Department of Agriculture

for skilled workers; 2) shift in the economy to smaller firms with a broader skillset; 3) overall growth in the economy (BUCIP 2010). Technological improvements in the industry have increased the demand for a more educated and high-skilled workforce.

Restoration and Remediation Jobs

Restoration and remediation projects require research into plant species, erosion prevention techniques, river ecology, and other practices and products occur early in the development process. These efforts then inform the intensive and highly technical planning and design processes. This is followed by construction and ongoing maintenance and monitoring. Some manufacturing activities are also involved in the production of heavy equipment and tools.

The work of restoration and remediation planning and design involves various technical assessments, coordinated planning, permitting, design, and cost estimating. Planning and assessment activities include the review of aerial photographs and topographical maps, results from soil tests and borings, and engaging regulatory agencies and stakeholders (National Oceanic and Atmospheric Administration. n.d). Design of restoration projects typically entails the application of engineering, landscape architecture, ecology, and geomorphology expertise. Cost estimates are developed using standardized unit material and labor costs and regional/municipal multipliers. Once the design and cost estimate have been produced, a bidding process is held to choose a firm to carry out the construction phase. Some firms do both restoration design and construction, while others specialize in one.

FIG. 6: RESTORATION AND REMEDIATION OCCUPATIONS

RESEARCH AND DEVELOPMENT
e.g. development of new restoration techniques, and conducting watershed assessments

- Chemists
- Civil Engineers
- Environmental Engineers
- Environmental Scientists and Specialists, Including Health Hydrologists
- Landscape architects

MANUFACTURING AND DISTRIBUTION
e.g. production of heavy equipment and tools

- Chemists
- Farmworkers and Laborers, Crop, Nursery, and Greenhouse
- Mechanical Engineers
- Production Workers
- Truck Drivers
- Welders, Cutters, Solderers, and Brazers

WHOLESALE AND RETAIL SALES
e.g. sales of plants and equipment

- Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products

DESIGN AND PLANNING
e.g. soil and water testing, project design and cost estimates, permitting and stakeholder engagement

- Architects
- Architectural and Civil Drafters
- Brownfield Redevelopment Specialists and Site Managers
- Civil Engineers
- Commercial and Industrial Designers
- Environmental Engineers
- Environmental Restoration Planners
- Environmental Scientists and Specialists, Including Health
- Executive Secretaries and Administrative Assistants
- Hydrologists
- Industrial Ecologists
- Landscape Architects
- Natural Sciences Managers
- Soil and Plant Scientists
- Soil Conservationists
- Training and Development Specialists
- Urban and Regional Planners
- Zoologists and Wildlife Biologists

INSTALLATION
e.g. removal of artificial structures, contaminated soil and invasive species; alteration to river-bed; planting new vegetation

- Agricultural Workers
- Brownfield Redevelopment Specialists and Site Managers
- Cement Masons and Concrete Finishers
- Construction Laborers
- Construction Managers
- Electrical Engineers
- Electricians
- Engineering Managers
- Environmental Restoration Planners
- Environmental Science and Protection Technicians, Including Health
- Executive Secretaries and Administrative Assistants
- Farmworkers and Laborers, Crop, Nursery, and Greenhouse
- First-Line Supervisors/Managers of Construction Trades and Extraction Workers
- First-Line Supervisors/Managers of Farming, Fishing, and Forestry Workers
- First-Line Supervisors/Managers of Landscaping, Lawn Service, and Groundskeeping Workers
- Forest and Conservation Technicians
- Forest and Conservation Workers
- General and Operations Managers
- Hazardous Materials Removal Workers
- Industrial Truck and Tractor Operators
- Laborers and Freight, Stock, and Material Movers
- Landscaping and Groundskeeping Workers
- Occupational Health and Safety Technicians
- Operating Engineers and Other Construction Equipment Operators
- Pipelayers
- Plumbers, Pipefitters, and Steamfitters
- Refuse and Recyclable Material Collectors
- Training and Development Specialists
- Truck Drivers, Heavy and Tractor-Trailer

OPERATIONS AND MAINTENANCE
e.g. landscape maintenance and soil and water testing

- Farmworkers and Laborers, Crop, Nursery, and Greenhouse
- First-Line Supervisors/Managers of Landscaping, Lawn Service, and Groundskeeping Workers
- Industrial Truck and Tractor Operators
- Laborers and Freight, Stock, and Material Movers
- Tree Trimmers and Pruners

TABLE 11: JOBS PER $1 MILLION INVESTED IN RESTORATION AND REMEDIATION PROJECTS

PROJECT TYPE	TOTAL EMPLOYMENT (Jobs per $1 million invested)	UNITS AND METHODS	SOURCE
Cache River Restoration Project	36	Includes direct jobs recorded in project reports, and modeled indirect and induced jobs	Caudill (2008)
Everglades Restoration	20	Modeled total jobs (direct/indirect/induced) using generic Sector 36 national multipliers	Everglades Foundation (2009:125)
In-stream Restoration Projects in Oregon	14.7	Modeled total jobs (direct/indirect/induced) using data from survey of grants and contractors	Institute for Sustainable Environment (2010)
Riparian Restoration Projects in Oregon	23.1	Modeled total jobs (direct/indirect/induced) using data from survey of grants and contractors	Institute for Sustainable Environment (2010)
Wetlands Restoration Projects in Oregon	17.6	Modeled total jobs (direct/indirect/induced) using data from survey of grants and contractors	Institute for Sustainable Environment (2010)
Restoration of four Rivers in Massachusetts	10-13	Modeled total jobs (direct/indirect/induced) using generic state-level multipliers	Massachusetts Division of Ecological Restoration (2012)
Watervliet Dams Removal	19	Total jobs noted in project summary	Great Lakes Coalition (2012)
Euclid Creek Dam Removal	72.2	Jobs noted in project summary; may not be full-time equivalents	Great Lakes Coalition (2012)

The construction phase of restoration and remediation projects is typically labor intensive and involves some use of heavy machinery. In-stream and riparian restoration is largely implemented with hand labor and some heavy machinery used to dig trenches and alter river banks. Workers arrange and fasten rocks and logs using rock drills and heavy cables, remove invasive species and plan riparian vegetation. Removing artificial structures, such as tide gates or dikes to restore hydrologic flow, also involves the use of heavy equipment and manual labor.

A large number of occupations are involved in restoration and remediation activities (Figure 6). These occupations range from the environmental and civil engineers that develop designs, to sales representatives and truck drivers that sell and deliver products, to masons and laborers that construct the projects. Newer occupations, such as brownfield redevelopment specialists and conservation technicians, have been created due to the significant new skills required for these projects.

The number of jobs created by a restoration or remediation project is highly variable, ranging from about 15 to 72 total jobs per $1 million invested (Table 11). For example, $10.6 million in expenditures on restoration of Illinois' Cache River basin generated approximately 36 jobs for each $1 million invested (Caudill 2008). This includes 22 workers directly employed in the project, and an additional 14 indirect and induced jobs, according to a study commissioned by the U.S. Fish and Wildlife Service. About half of the direct jobs and 85% of the indirect and induced jobs were created locally in the four counties where the project took place. Likewise, dam removal on Ohio's Euclid Creek cost more than $500,000 and generated 38 jobs, or 72 jobs per $1 million invested.

Studies have found that the number of jobs created can vary depending on how much labor-intensive or equipment-intensive work must be done. For instance, a study by the Institute for Sustainable Environment estimates that direct employment in equipment-intensive watershed contracting is only 4.8 jobs per $1 million invested because labor is a relatively small proportion of total spending (36%) and worker payroll costs are relatively high (about $55,000 per job). By contrast, direct employment in labor-intensive projects is 13.8 jobs per $1 million, with labor making up 67% of spending and payroll costs averaging $31,000 per job, resulting in more and lower-wage jobs (Institute for Sustainable Environment 2010).

Alternative Water Supply Jobs

There are multiple activities involved with developing alternative water supply sources throughout the development process.[10] Research and development includes developing new membranes with higher recovery rates and sensors

FIG. 7: ALTERNATIVE WATER SUPPLY OCCUPATIONS

RESEARCH AND DEVELOPMENT
e.g. identify water supply and demand in area, and develop alternative water sources to meet future need

- Agricultural Engineers
- Chemists
- Environmental Engineers
- Environmental Scientists and Specialists, Including Health Geologists
- Hydrologists
- Soil and Plant Scientists

MANUFACTURING AND DISTRIBUTION
e.g. manufacturing of pipes

- Reinforcing Iron and Rebar Workers
- Laborers and Freight, Stock, and Material Movers, Hand Milling and Planing Machine Setters, Operators, and Tenders, Metal and Plastic
- Shipping, Receiving, and Traffic Clerks
- Stock Clerks and Order Fillers
- Tank Car, Truck, and Ship Loaders
- Truck Drivers–Heavy and Tractor–Trailer
- Truck Drivers, Light or Delivery Services
- Welders, Cutters, Solderers, and Brazers

WHOLESALE AND RETAIL SALES
e.g. estimate cost for ratepayers, purchase materials for installation

- Cost Estimators
- Purchasing Agents and Buyers, Farm Products
- Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products
- Shipping, Receiving, and Traffic Clerks
- Stock Clerks and Order Fillers

DESIGN AND PLANNING
e.g. site plan and design new alternative water supply (conjunctive use, recycled water) for area needs this includes hydrologic and water quality data collection, monitoring, and analysis. coordinate demand projections among utilities and water suppliers

- Architects, Except Landscape and Naval
- Architectural and Civil Drafters
- Cartographers and Photogrammetrists
- Civil Engineers
- Engineering Technicians, Except Drafters, All OtherEnvironmental Engineers
- Graphic Designers
- Landscape Architects
- Landscape Architecture & Engineering Occupations
- Surveying and Mapping Technicians
- Surveyors
- Urban and Regional Planners

INSTALLATION
e.g. Installation of piping to distribute recycled water

- Carpenters
- Cement Masons and Concrete Finishers
- Construction and Building Inspectors
- Construction Laborers
- Construction Managers
- Control and Valve Installers and Repairers, Except Mechanical Door
- Earth Drillers, Except Oil and Gas
- Electricians
- Excavating and Loading Machine and Dragline Operators
- First-Line Supervisors of Landscaping, Lawn Service, and Groundskeeping Workers
- Helpers--Extraction Workers
- Helpers--Pipelayers, Plumbers, Pipefitters, and Steamfitters
- Landscaping & Groundskeeping Workers
- Managers of Construction Trades Workers
- Occupational Health and Safety Technicians
- Operating Engineers and other Construction Equipment Operators
- Paving, Surfacing, and Tamping Equipment Operators
- Pesticide Handlers, Sprayers, and Applicators, Vegetation
- Pipelayers
- Plumbers, Pipefitters, and Steamfitters
- Tree Trimmers and Pruners

OPERATIONS AND MAINTENANCE
e.g. facilities operations and maintenance for distributing water to end users

- Construction and Building Inspectors
- Control and Valve Installers and Repairers, Except Mechanical Door
- Farm Equipment Mechanics
- General and Operations Managers
- Grounds Maintenance Workers, All Other Helpers—Installation, Maintenance, and Repair Workers
- Janitors and Cleaners, Except Maids and Housekeeping Cleaners
- Landscaping & Groundskeeping Workers
- Maintenance and Repair Workers, General
- Operating Engineers and Other Construction Equipment Operators
- Pesticide Handlers, Sprayers, and Applicators, Vegetation
- Tree Trimmers and Pruners
- Water and Wastewater Treatment Plant and System Operators

TABLE 12: JOBS PER $1 MILLION INVESTED IN ALTERNATIVE WATER SUPPLY PROJECTS

PROJECT TYPE	TOTAL EMPLOYMENT (Jobs per $1 million invested)	UNITS AND METHODS	SOURCE
Eighteen recycled water design and installation projects in LA and surrounding region	12.5	Modeled total jobs (direct/indirect/induced) using IMPLAN System 2009 data and 2011 software	Los Angeles Economic Roundtable (2011)
Operations and maintenance of two recycled water projects	9.8	Modeled total jobs (direct/indirect/induced) using IMPLAN System 2009 data and 2011 software	Los Angeles Economic Roundtable (2011)
Two groundwater remediation design and Installation	12.8	Modeled total jobs (direct/indirect/induced) using IMPLAN System 2009 data and 2011 software	Los Angeles Economic Roundtable (2011)
Operations and maintenance of the Tujunga Wellfield Liquid Phase Granular Activated Carbon Project Two	13.9	Modeled total jobs (direct/indirect/induced) using IMPLAN System 2009 data and 2011 software	Los Angeles Economic Roundtable (2011)

that can provide real-time water quality readings. Manufacturing and distribution requires producing and delivering all of the products used throughout the process, including membranes, chemicals, and pumps. The planning phase can be extensive and include a technical analysis of the existing water supply conditions and the future needs. Construction of treatment and storage facilities include grading and paving the site and constructing the buildings. Ongoing operations and maintenance are needed to ensure compliance with treatment requirements, reading meters, replacing membranes, and repairing the system.

Figure 7 provides a summary of the many occupations engaged in developing alternative water supplies throughout the development process. The planning phase, for example, employs environmental engineers, hydrologists, landscape architects, hydrologists, urban planners, and other highly-skilled professionals. Facilities and water and sewage operations staff are responsible for ongoing operations and maintenance.

Studies on the number of jobs generated by alternative supply projects are limited. Table 12 is based on several case studies in Los Angeles County, where there have been major investments in recycled water and groundwater facilities (Los Angeles Economic Roundtable 2011). These case studies suggest that roughly 10 to 14 jobs are created per $1 million dollars invested. For example, designing and installing recycled water projects produced 12.5 jobs per $1 million invested, including 6.6 direct jobs, 2.3 indirect jobs, and 3.7 induced jobs. Most of the direct work was performed by companies located in the area. Likewise, groundwater projects in Los Angeles generated 12.8 jobs per $ 1 million invested.

Agricultural Efficiency and Runoff Jobs

Agricultural efficiency and runoff management is designed to improve the productivity of agricultural water use and water quality through more efficient irrigation management techniques, such as irrigation scheduling, tailwater recycling, drip irrigation, and conservation tillage. Figure 8 provides an indication of the occupations associated with this strategy. We note, however, that thus far there has been little attention given to the amount and types of jobs related to improved agricultural water management. Additional research and analysis is needed to develop a more comprehensive list.

Installation and operations and maintenance are the two most labor-intensive phases of the process. Installation can entail trenching, piping, earth moving, and installing pumps, water filters, water meters, water control devices, and irrigation equipment. A majority of this work is performed by construction laborers

[10] *The focus of this section is utility-scale alternative water supplies. Greywater systems are included as an urban efficiency strategy.*

FIG. 8: AGRICULTURAL WATER EFFICIENCY AND QUALITY OCCUPATIONS

RESEARCH AND DEVELOPMENT
e.g. development of new irrigation techniques, and conducting soil and crop analyses

- Agricultural Engineers
- Agricultural Science Teachers, Postsecondary
- Environmental Engineers
- Hydrologists
- Materials Engineer
- Natural Sciences Managers
- Precision Agriculture Technicians
- Soil and Plant Technicians
- Soil Scientists

MANUFACTURING AND DISTRIBUTION
e.g. production of irrigation technologies and products

- Electricians
- General and Operations Manager
- Machinist
- Materials Engineer
- Milling and Planing Machine Setters, Operators, and Tenders, Metal and Plastic
- Team Assembler
- Truck Drivers, Heavy and Tractor-Trailer
- Welders, Cutters, Solderers, and Brazers

WHOLESALE AND RETAIL SALES
e.g. sales of irrigation products

- Buyers and Purchasing Agents, Farm Products
- Sales Representatives, Agricultural

DESIGN AND PLANNING
e.g. irrigation and landscape design and cost estimates, permitting and stakeholder engagement

- Conservation of Resources Commissioners
- Conservation Policy Analysts and Advocates
- Engineering Managers
- Engineering Technicians, Except Drafters, All Other Irrigation Designer
- Permaculture Designers/Contractors
- Precision Agriculture Technicians
- Surveying and Mapping Technicians
- Surveyors
- Sustainable Agriculture Specialists

INSTALLATION
e.g. trenching, connecting water source, installing valves, assembling pipes and pump stations, connecting wires, installing sprays, landscape drip

- Agricultural Technician
- Agricultural Workers, All Other Agriculture Irrigation Specialist
- Carpenters
- Cement Masons and Concrete Finishers
- Construction Laborers
- Construction Managers
- Electricians
- Farm Labor Contractors
- Farmworkers and Laborers, Crop, Nursery, and Greenhouse Helpers—Carpenters
- Operating Engineers and Other Construction Equipment Operators
- Paving, Surfacing, and Tamping Equipment Operators
- Pipelayers
- Plumbers, Pipefitters, and Steamfitters
- Precision Agriculture Technicians
- Pump Operators, Except Wellhead Pumpers
- Soil and Plant Technicians
- Truck Drivers, Heavy and Tractor-Trailer
- Welders, Cutters, Solderers, and Brazers

OPERATIONS AND MAINTENANCE
e.g. landscape maintenance, soil and crop testing

- Agricultural Inspectors
- Agricultural Workers, All Other
- Agriculture Irrigation Specialist
- Construction Laborers
- Construction Managers
- Farm Equipment Mechanics and Service Technicians
- Farm Labor Contractors
- Farmers, Ranchers, and Other Agricultural Managers
- Farmworkers and Laborers, Crop, Nursery, and Greenhouse
- Farmworkers, Farm, Ranch, and Aquacultural Animals
- Maintenance and Repair Workers, General Precision Agriculture Technicians

and agricultural technicians. In order for these technologies to work effectively, operations and maintenance must be performed regularly by maintenance and repair workers, agricultural inspectors, and service repair workers. Irrigation systems are often installed by construction crews, typically made up of a foreman and skilled laborers. They are often trained by the dealer/contractor or water supplier and have very specific skillsets that are difficult to find.[11] The labor-intensive components occur in implementing the installation and operations stage, while the irrigation technologies dominate the business aspect of the process.

Occupations essential to installation include precision agriculture technicians, agricultural technicians, purchasing agents, and buyers of farm products. Precision Agricultural Technicians apply geospatial technologies, including geographic information systems (GIS) and Global Positioning System (GPS), to agricultural production or management activities. They may use computers to develop or analyze maps or remote sensing images to compare physical topography with data on soils, fertilizer, pests, or weather. Agricultural Technicians set up and maintain laboratory and collect and record data to assist scientist in biology or related agricultural science experiments. Purchasing Agents and Buyers buy and sell farm products either for further processing or resale (BLS 2010).

A recent analysis found that implementation of a range of agricultural best management practices would generate 14.6 jobs per $1 million invested (Rephann 2010). Researchers found that if full implementation of agricultural practices outlined in the 2005 Commonwealth of Virginia Chesapeake Bay Nutrient and Sediment Reduction Strategy were achieved, 11,751 person-years of employment would be created. The majority of directs jobs generated were in construction, construction-related services, and agricultural and forestry support industries. Additional indirect and induced jobs were also created in other industries.

Conclusions

Taken as a whole, we identified 136 separate occupations involved in sustainable water projects. Of these, 48 occupations were listed in only one of the five strategies, 34 occupations were involved in two strategies, 24 in three strategies, 15 in four, and 13 occupations appear in all five strategies (see Appendix A for the full list of sustainable water occupations and their corresponding water strategies). For communities and institutions considering investments in multiple types of sustainable water projects, the occupations involved in multiple strategies are likely worth exploring for training and job opportunity efforts. In the following section we note warnings against training for occupations that do not have projected growth in the overall economy, however, in a local context where a major investment is planned for particular multiple water strategies, the local job opportunities in associated occupations may outweigh weak national trends in job openings.

An additional set of occupations that appear in multiple sustainable water strategies are general roles that we did not include in the description of each different strategy. These include:

- Accountants and Auditors
- Bookkeeping, Accounting, and Auditing Clerks
- Building Cleaning Workers, All Others
- Business Operations Specialists, All Other
- Chief Executives Executive Secretaries and Administrative Assistants
- First-Line Supervisors/Managers of Office and Administrative Support Workers
- General and Operations Managers
- Human Resources Manager
- Management Analysts
- Managers of Office and Admin. Support Workers
- Marketing Managers
- Office and Administrative Support Workers, All Other
- Office Clerks – general
- Public Relations Specialists
- Receptionists and Information Clerks
- Secretaries, Except Legal, Medical, and Executive
- Vocational Education Teachers Postsecondary

The available data, although limited, suggest that sustainable water projects generate large numbers of jobs and in many cases, more jobs than traditional water infrastructure. The data include some broad ranges of employment numbers: 10-15 jobs per $1 million invested in alternative supplies; 5-20 jobs per $1 million invested in stormwater management; 12-22 jobs per $1 million invested in urban conservation and efficiency; 15 jobs invested per $1 million in agricultural efficiency and quality; and 10-72 jobs per $1 million invested in restoration and remediation. In comparison, traditional water infrastructure is estimated to generate

[11] *In addition to traditional construction functions, e.g., backhoe, trencher, tractor, and pipe fitting, foremen must also possess knowledge agricultural practices according to site-specific factors, such as soil type, water sources, crop rotations, water district practices, local labor laws, and Occupational Safety and Health Administration (OSHA) rules. It takes a new laborer three or more years to achieve a foreman level of knowledge and proficiency.*

Source: Pacific Institute

10-26 jobs per $1 million invested (Green for All 2011). Although these numbers are based on local studies and modeled projections, they suggest that assumptions that environmental conservation produces net job losses is not supported by data on sustainable water projects.

Much more must be documented and analyzed to understand the nature of employment generated by sustainable water projects. The proportion of jobs generated locally versus those outside the local area is an important consideration for gaging the opportunity for employment and economic impact. In its 2011 study, the Economic Roundtable found that "LA's water conservation projects stimulated a greater volume of non-local employment, even though the portions of those programs carried out in Los Angeles supported more person-years of employment per $1 million invested." Their analysis of eleven water conservation projects found that local spending produced 16.6 jobs per million dollars while non-local spending produced 11.8 jobs. This suggests that not just local workers benefit from more local spending, but that the net employment impact may be greater with local spending.

Additional research is needed to determine how employment generated by sustainable water projects may differ from their conventional counterparts with respect to how work is distributed over time. Many sustainable strategies are less capital-intensive and involve more ongoing operations and maintenance. Distributed infrastructure, like rain gardens or water efficient appliances, begin generating the desired water benefits when the first one is installed, whereas an expanded treatment plant cannot deliver water outcomes until it is complete. This allows for stretching out the timeframe of the project, an option that may be desirable for funding agencies with limited funding or revolving funds. Similarly, the operations and maintenance required for sustainable water projects appears greater than their conventional counterparts, raising the possibility of employment that is more sustained over time.

Source: Amigos de los Rios

IV JOB QUALITY AND GROWTH IN SUSTAINABLE WATER OCCUPATIONS

Who is currently working in sustainable water occupations, and in what conditions? Which of these occupations would be appropriate for focusing efforts to increase opportunities for disadvantaged communities? These questions are core to identifying strategies that advance ecological preservation and address economic inequality. It is clear from the previous section and other analyses that significant jobs are created when many types of sustainable water strategies are implemented. For these strategies to achieve the goal of advancing economic equality, there must be sufficient opportunity and appropriate pathways for disadvantaged communities to access these opportunities.

Approach

Our approach to identifying green jobs opportunities is to focus on jobs that are already growing in the overall economy, recognizing we may be able to take action to make them grow greener and faster. This is rooted in some important lessons from past green jobs efforts. Much of the previous green jobs investment went into preparing workers for occupations that were green and entirely new, such as solar installers and energy auditors, yet the demand for graduates of these programs fell short. Because these workers were not prepared with a broader set of skills that qualified them for conventional occupations, they were left with limited options for employment. We follow the Center on Wisconsin Strategy (2012) and others who recognize that all occupations will likely change as sustainable strategies reshape the tasks they carry out, but the priority for training new workers should be on green skills embedded in a broader set of skills for growing occupations. Our analysis to identify sustainable water occupations that are more opportune is guided by the following questions:

- Which sustainable water occupations are expected to have significant future growth beyond any growth in the water-related industries?
- What level of education and experience is required to gain employment in these occupations?
- What are the wages and the level of union representation in these occupations?
- What are the demographics of the current workforce in sustainable water occupations?
- In which occupations are workers required to have unique skills in order to be able to work on sustainable water projects?
- What educational pathways and barriers may exist to workers from disadvantaged communities seeking employment in these occupations?

Focusing on occupations with high numbers of projected openings in the overall economy is important for multiple reasons. As noted above, the workers trained for these occupations will have a greater chance of gaining employment. Secondly, the fact that there will be many openings means that there will necessarily be many workers who are learning the skills for the occupation for the first time, creating the opportunity for integrating green skills into the workforce.

The projected number of job openings due to replacements and growth is a useful indicator for estimating the level of future opportunity for job-seekers to access employment in a particular occupation (BLS 2012a). The Bureau of Labor Statistics (BLS) develops these projections by analyzing occupational employment for age-groups of workers over five-year periods, covering each of more than 1,000 detailed occupations (BLS 2012a). Using the net change in employment of each age group in each occupation, the BLS develops estimates of the future number of workers who will leave the occupation. The BLS states that the projected number of replacements added to the change due to growth "may be used to assess the minimum number of workers who will need to be trained for the occupation." We focus on occupations for which at least 100,000 job openings are projected for the year 2020. This is the threshold used by the Occupational Information Network (O*NET) for its "Bright Outlook" status.

Focusing only on occupations with projected openings can be limiting as a result of some inherent weaknesses in the data. Analyses restricted to occupations with projected openings would miss opportunities that would be created by new policy that has not been included in the projection scenarios of the BLS. The BLS projected openings are based on

TABLE 13: DEFINITIONS OF BUREAU OF LABOR STATISTICS (BLS) JOB ZONES

JOB ZONE	EXPERIENCE	EDUCATION	JOB TRAINING	EXAMPLES
1 [little or no preparation]	*No previous work-related skill, knowledge, or experience needed.*	*May require a high school diploma or GED. Some may require a training course to obtain a license.*	*A few days to a few months of training.*	*Forest and Conservation Workers, Graders and Sorters of Agricultural Products, Grounds Maintenance Workers, Truck Drivers.*
2 [some preparation]	*Some previous work-related skill, knowledge, or experience may be helpful, but usually is not needed.*	*Usually require a high school diploma and may require some vocational training or job-related course work.*	*A few months to one year of working with experienced employees.*	*Foremen, Pump Operators, Agricultural Technicians, Helpers to Roofers, Water Treatment Plan Operators, Carpenters.*
3 [medium preparation]	*Previous work-related skill, knowledge, or experience is required. E.g. an electrician must have apprenticeship and/or vocational training, and a licensing exam.*	*Most require training in vocational schools, related on-the-job experience, or an associate's degree. Some may require a bachelor's degree.*	*1-2 years of training involving both on-the-job experience and informal training with experienced workers.*	*Brownfield Redevelopment Specialists, Home Appliance Repairers, Occupational Health and Safety Technicians, Environmental Restoration Planners.*
4 [considerable preparation]	*A minimum of two to four years of work-related skill, knowledge, or experience is needed for these occupations.*	*Most of these occupations require a four - year bachelor's degree, but some do not.*	*Employees in these occupations usually need several years of work-related experience, on-the-job training, and/or vocational training.*	*Soil Conservationists, Public Relations Specialists, Construction Managers, Cost Estimators, Surveyors, Urban and Regional Planners, Agricultural Inspectors*
5 [extensive preparation]	*Many of these occupations require more than five years of experience.*	*A bachelor's degree is the minimum formal education required for these occupations, and many also require graduate school.*	*Employees may need some on-the-job training, but most of these occupations assume that the person will already have the required skills, knowledge, work-related experience, and/or training.*	*Chief Executives, Environmental Scientists, Engineers, Landscape Architects.*

past trends and do not incorporate new changes in the economy or policy environment. For example, the economic impact of polices such as the federal Restore Act or California's spending of revenue from its new cap-and-trade program (AB32) may significantly increase the numbers of openings in water-related occupations.

The level of education and experience required for workers to access employment can be a barrier or a pathway depending on the accessibility of educational opportunities that match time availability, language, cost, and pre-requisites to the worker. The appropriate level of education and experience also depends on aspirations of the prospective workers. An occupation that requires higher education may be completely appropriate for a community college student setting a ten-year goal, whereas an adult parent with little time for going back to school may looking for a shorter pathway into an occupation with family-supporting wages.

The BLS system for categorizing education and experience required for an occupation is based on the formal education, on-the-job training, and work experience. The BLS has created five levels or "Job Zones" that each correspond to a level of education, training, and experience (See Table 13).

We distinguish between occupations in Job Zones 1 through 3 from those that are in Job Zones 4 or 5 due to the difference in length of time needed for disadvantaged workers to obtain advanced degrees needed for occupations in 4 and 5. Clearly, disadvantaged workers may be well-positioned to pursue occupations in Job Zones 4 and 5 if they are early in their career, have the opportunity to complete several years of education, or already have degrees and experience.

Median wages for the country may not reflect the median wages in a local area or state, as actual wages vary by region, industry, and employer.[12] An analysis of wage

[12] *To obtain estimates of the median wage for an occupation in a particular state, see the Career One-Stop website: http://www.careerinfonet.org/Occupations/select_occupation.aspx.*

differentials across the US found that the county in which a job is located accounts for one-fifth of the estimated establishment wage differentials (Lane et al. 2007).

The job establishment accounted for the greatest portion of wage differentials, and small contributions were also associated with the establishment's age, size, and industry.

To gage the quality of sustainable water occupations, we compare the median wages to estimates of the income required to cover basic expenses for one adult and one child in 521 US regions (Economic Policy Institute 2008). These cost estimates are based on the income "required to maintain a safe and comfortable, but modest standard of living" and take into consideration rent, food, transportation, child care, health care, taxes, and other expenses for items of necessity.

We also look at the race and gender demographics of the existing workforce in sustainable water-related occupations to identify occupations with disproportionate representation. Understanding their current representation is relevant to efforts at achieving equity, as under-representation suggests there may be barriers that pose a challenge to women and people of color seeking work.

Following review of the occupational growth and wages, we examine a subset of occupations with high growth that require unique skills when involved in sustainable water projects. The purpose of this analysis is to identify those opportunities where job seekers trained for these projects can gain a competitive advantage through unique skills that contribute to sustainable water outcomes. We select these occupations by reviewing the tasks listed in the O*NET database and technical information on the associated water projects. For these occupations, we summarize the tasks carried out by workers involved in sustainable water projects, the wage and growth indicators, and briefly explore the existing resources and potential barriers related to training, licensing, and certification. This analysis of resources and barriers is largely anecdotal as there is much variation between states and regions.

Job Quality, Workforce, and Projected Openings

Twenty seven sustainable water occupations have more than 100,000 job openings projected for 2020 in the overall economy and have relatively accessible education and experience requirements consistent with Job Zones 1 through 3 (See Table 14). One-third of these occupations require little or no previous work experience or education (job zone 1), while eight require some experience and education (job zone 2), and ten require experience and some formal education (job zone 3).

The projected openings for some occupations are driven more by the high rate of workers leaving the profession, while for others the overall growth of the occupation is expanding the demand for workers. In the case of farmers, ranchers, and agricultural managers, the growth rate is negative and one of the lowest of any occupation nationally (-8%) yet the high rate of workers retiring and otherwise leaving is expected to create 235,000 openings. The high numbers of openings for office clerks, truck drivers, and laborers/freight movers are due to growth rates that puts these occupations in the top ten nationally.

Of the 27 sustainable water occupations with high projected openings, half have median wages above the national median wage of $16.57 per hour. Of those in job zone 1, the median hourly wage ranges from $10.50 to $14.50. In job zone 2, median hourly wage ranges from the $11.50 earned by laborers and freight movers to the $20 of operating engineers. Median wages of occupations in job zone three vary widely, with recreation workers and maintenance and repair workers earning $10.50 and $17, while business operations specialists and agricultural managers earn more than $30 per hour.

The median wages of many of these sustainable water occupations may not currently provide enough income to support a modest living in regions across the country. Ten of the occupations in Table 14 have median hourly wages under $13.25 that would be sufficient to cover basic expenses in less than 25% of the regions in the country. The eight occupations with median hourly wages of $19.50 or higher would be sufficient to cover basic expenses in 90% or more of the regions.

Unionization in these occupations varies from the low 4-7% of farmworkers and recreation workers, to 20% of construction workers and plumbers. For the management-level occupations, union representation is not applicable, but for occupations such as brownfields site managers, business operations specialists, and first-line office supervisors, workers may be eligible for union representation. These latter three occupations are notable because they have low union representation yet have among the highest median hourly wages. The occupations with higher levels of union representation are also

1

3

2

4

TABLE 14: SUSTAINABLE WATER OCCUPATIONS WITH OVER 100,000 PROJECTED JOB OPENINGS IN THE OVERALL ECONOMY AND MORE ACCESSIBLE EDUCATION AND TRAINING REQUIREMENTS (JOB ZONES 1-3)

KEY

Jobs Requiring Little or No Education and Training (Zone 1)

TABLE 14: SUSTAINABLE WATER OCCUPATIONS WITH OVER 100,000 PROJECTED JOB OPENINGS IN THE OVERALL ECONOMY AND MORE ACCESSIBLE EDUCATION AND TRAINING REQUIREMENTS (JOB ZONES 1-3)

KEY

Jobs Requiring Basic Education (Zone 2)

* For Agricultural Equipment Operators, the total number of employees and the projected number of openings reported by BLS corresponds to the more general occupational category of General Farm Worker.

TABLE 14: SUSTAINABLE WATER OCCUPATIONS WITH OVER 100,000 PROJECTED JOB OPENINGS IN THE OVERALL ECONOMY AND MORE ACCESSIBLE EDUCATION AND TRAINING REQUIREMENTS (JOB ZONES 1-3)

KEY

Jobs Requiring Some Previous Education, Training and Experience (Zone 3)

TABLE 15: SUSTAINABLE WATER OCCUPATIONS WITH OVER 100,000 PROJECTED JOB OPENINGS IN THE OVERALL ECONOMY, AND HIGHER EDUCATION AND TRAINING REQUIREMENTS (JOB ZONES 4-5)

KEY

Jobs Requiring Multiple Years of Experience, College, and/or Training (Zone 4)

Jobs Requiring Advanced Degrees and Experience (Zone 5)

5

7

6

Photo 1: *Gray water from washing machine drains through three-way vale allowing user to direct it toward garden or sewer. (Source: Grey Water Action)*

Photo 2: *Strawberry fields irrigated with recycled water in Watsonville, CA. (Source: Pajaro Valley Management Agency)*

Photos 3-4: *Downspouts drain stormwater into gardens, irrigating plants and reducing runoff. (Source: EPA)*

Photo 5: *Field training of restoration workers. (Source: Sustainable South Bronx)*

Photo 6: *Restoration work in Los Angeles. (Source: Amigos de Los Rios)*

Photo 7: *Rain Gardens receive stormwater draining off a street. (Source: Philadelphia Water Department)*

among those with extremely low percentages of women workers.

The gender make-up of the workforce in these sustainable water occupations suggests a dividing line between clerical occupations and those that involve managerial or manual labor roles. For all but four of the fifteen occupations for which worker demographic data is available, the percentage of women workers is well below the national average of 47%. The four occupations with above average percentages of women workers are office clerks, receptionists and information clerks; bookkeeping, accounting, and auditing clerks; and business specialists, all of which are at least two-thirds women.

The racial make-up of workers in sustainable water occupations ranges from the predominantly white Agricultural Managers to the disproportionately Latino and African American laborers and truck drivers. Latino, African American, and Asian American workers comprise 30% of US workers, and comprise a similar proportion of the workers in clerical occupations and carpenters. These workers are under-represented in positions as farmers, ranchers, and other agricultural managers (6%), general and operations managers (17%), bookkeeping, accounting, and auditing clerks (20%), electricians (22.5%), operating engineers and other construction equipment operators (22%), and business operations specialists (25%).

The under-representation of people of color working as agricultural managers and general managers is concerning given that they are the two of the highest paid sustainable water occupations that do not require advanced degrees. Agricultural managers and general managers are projected to have 235,000 and 410,000 openings in 2020, and currently have median hourly wages of $31 and $45.75, respectively.

Ten sustainable water occupations are projected to have more than 100,000 jobs openings by 2020 and require higher education and experience consistent with Job Zones 4 and 5 (See Table 15). These occupations tend to have higher median wages and lower percentages of women, workers of color, and union representation than those requiring less education and training. Median hourly wages range from the $21 and $22 earned by executive secretaries and graphic designers, to above $35 for sales representatives of wholesale and manufacturers of technical products, civil engineers, management analysts, and construction managers. Women are less than half the national average percentage of the workforce in positions as construction managers, cost estimators, and civil engineers, and also under-represented as chief executives and management analysts. Union representation among these occupations is expectably low considering they are commonly management-level positions. Chief executives are the only occupation categorized in Job Zone 5, requiring the highest level of education and experience, and receive a median wage of $80 hourly.

Skills and Pathways of Key Sustainable Water Occupations

The sustainable water occupations that hold the greatest promise for disadvantaged communities will be those for which pathways of training and support exist to prepare and place these workers in new positions. Knowing which occupations require unique skills when involved in sustainable water projects will allow workers and organizations to focus on the training that can provide a competitive edge in the labor market. Here we highlight nine of these occupations that require unique skills when involved in a sustainable water project, and describe some of the skills needed, and existing resources for training and certification. Six of these are from the above list of occupations with more than 100,000 openings projected for 2020: Landscaping and Groundskeeping Workers; Construction Laborers; Brownfield Redevelopment Specialists and Site Managers; Farmers/Ranchers and Other Agricultural Managers; Plumbers; and Roofers. We also include three occupations that have fewer, but still substantial, projected openings: Construction and Building Inspectors; Water and Liquid Waste Treatment Plant and System Operators; and Precision Agriculture Technicians. We include these latter three because we expect water expertise to contribute a more significant value to workers.

Agricultural Skills and Pathways

Agricultural workers are responsible for the day-to-day labor on the farm, including planting, harvesting, irrigating, weeding, fertilizing, tending to livestock,

TABLE 16: AGRICULTURAL OCCUPATIONS AND SUSTAINABLE WATER SKILLS

FARMERS, RANCHERS, AND OTHER AGRICULTURAL MANAGERS

Projected Openings: 234,500 // Median Hourly Wage: $31.09

Plan, direct, or coordinate the management or operation of farms, ranches, greenhouses, aquacultural operations, nurseries, timber tracts, or other agricultural establishments.

Tasks Relevant to Sustainable Water Projects:

- Determine types and quantities of horticultural plants to be grown.
- Monitor activities such as irrigation, chemical application, harvesting, milking, breeding, or grading to ensure adherence to safety regulations or standards.
- Monitor and adjust irrigation systems to distribute water according to crop needs and to avoid wasting water.
- Monitor pasture or grazing land use to ensure that livestock are properly fed or that conservation methods, such as rotational grazing, are used.

PRECISION AGRICULTURE TECHNICIANS

Projected Openings: 33,500 // Median Hourly Wage: $20.73

Apply geospatial technologies, including geographic information systems (GIS) and Global Positioning System (GPS), to agricultural production or management activities, such as pestscouting, site-specific pesticide application, yield mapping, or variable-rate irrigation.

Tasks Relevant to Sustainable Water Projects:

- Apply precision agriculture information to specifically reduce the negative environmental impacts of farming practices.

FIRST-LINE SUPERVISORS OF AGRICULTURAL CROP AND HORTICULTURAL WORKERS

Projected Openings: 227,400* // Median Hourly Wage: $12.13

Directly supervise and coordinate activities of agricultural crop or horticultural workers.

Tasks Relevant to Sustainable Water Projects:

- Perform hardscape activities, including installation or repair of irrigation systems, resurfacing or grading of paths, rockwork, or erosion control.
- Confer with managers to evaluate weather or soil conditions, to develop plans or procedures, or to discuss issues such as changes in fertilizers, herbicides, or cultivating techniques.

AGRICULTURAL EQUIPMENT OPERATORS

Projected Openings: 13,600 // Median Hourly Wage: $20.48

Manually plant, cultivate, and harvest vegetables, fruits, nuts, horticultural specialties, and field crops.

Tasks Relevant to Sustainable Water Projects:

- Irrigate soil, using portable pipes or ditch systems, and maintain ditches or pipes and pumps.

FARMWORKERS AND LABORERS, CROP, NURSERY, AND GREENHOUSE

Projected Openings: 227,400* // Median Hourly Wage: $8.99

Drive and control farm equipment to till soil and to plant, cultivate, and harvest crops.

Tasks Relevant to Sustainable Water Projects:

- Maintain and repair irrigation and climate control systems.
- Set up and operate irrigation equipment.

FARM EQUIPMENT MECHANICS AND SERVICE TECHNICIANS

Projected Openings: 12,900 // Median Hourly Wage: $16.46

Diagnose, adjust, repair, or overhaul farm machinery and vehicles, such as tractors, harvesters, dairy equipment, and irrigation systems.

Tasks Relevant to Sustainable Water Projects:

- Install and repair agricultural irrigation, plumbing, and sprinkler systems.

* Projected job openings for Farmworkers and Laborers, Crop, Nursery, and Greenhouse workers and Agricultural Equipment Operators correspond to the more general occupational category of General Farm Worker.

and operating machinery. Workers in management positions typically perform duties that keep the farm in good operating condition and improve the efficiency of the farm or ranch. This includes hiring and supervising working; choosing and purchasing supplies such as seeds and fertilizers; monitoring lands; and maintaining on-farm facilities, records, and equipment. On a small farm, managers will oversee most or all of the operation, whereas on a large farm managers are often responsible for just a small portion of the total operation.

Workers in these occupations contribute to sustainable water management through their involvement in on-farm water management. In particular, tasks that involve installing, operating and maintaining irrigation systems in order to improve efficiency. In addition, greenhouse and nursery workers can work to grow and distribute drought tolerant plants that can help reduce urban irrigation and varieties suitable for green infrastructure projects. Greenhouse and nursery workers can also focus on plants that can be used for restoration projects that require re-vegetation as well as remediation projects utilizing phytoremediation techniques. Agricultural workers can also be involved in alternative water supply projects where recycled water is used as a source of water for agriculture.

Agricultural workers typically receive on-the-job training. A high school diploma is not usually required, and workers sometimes advance into more managerial and supervisory positions after some time. Proficiency in both English and Spanish can be helpful in advancing to these positions. Farmworkers have limited labor rights in most states and are notoriously exploited with wage theft, dangerous working conditions, and intimidation. The United Farm Workers union organizes for farmworkers' rights and is affiliated with the Change to Win Federation. The Farm Labor Organizing Committee is another labor union for farmworkers and is affiliated with AFL-CIO. The Irrigation Association offers a Certified Agricultural Irrigation Specialist (CAIS), which requires a written exam, agreement to follow the Code of Ethics established by the IA Certification Board, and 20 continuing education units per 2-year cycle to remain in good standing.

A major demographic transition is apparent among agricultural managers, as the growth of the occupation, -8%, is the lowest of all sustainable water occupations, yet the number of projected openings in among the highest. This is due to the high rate of people leaving the occupation and creating replacement positions. The majority (nearly 80%) of agricultural managers is self-employed and most have a high school diploma. Historically, growing up or working on a family farm was the most common way to learn the trade, however, a college degree (Associate's or Bachelor's) is becoming more important for management and irrigation specialist positions. Without a degree, prospective farmers and managers can participate in apprenticeships, though this can take longer than a degree program to learn some of the more complex aspects of farm management. Some farms offer their own apprenticeship programs, which can be paid or unpaid (BLS 2012).

The American Society of Farm Managers and Rural Appraisers offer accreditation for farm managers; this requires four years of experience and a bachelor's degree. They also offer courses in continuing education (American Society of Farm Managers and Rural Appraisers n.d.).

There are numerous college-level programs that offer training in agriculture and farm management. While there are new programs that focus on organic agriculture, there do not appear to be any that have a focus on agriculture water efficiency or improving on-farm water management, although courses within degree programs do address this issue. The University of Nebraska- Lincoln, for example, offers degrees in a range of agricultural topics, and offers courses, workshops, and training opportunities in on-farm water management and efficiency (University of Nebraska-Lincoln n.d.). The USDA maintains a database of education and training opportunities in sustainable farming (USDA n.d.). The State of Wisconsin now offers a Dairy Grazing Apprenticeship, and was established through the Sector Alliance for the Green Economy (SAGE) project. This apprenticeship includes training in on-farm water management and efficiency (Wisconsin's Sector Alliance for the Green Economy 2011).

Some states and municipalities have established licensing programs for irrigation contractors; these programs can provide higher wages as a skilled labor class. In Texas, for example, there are three different types of irrigation licenses: **Licensed irrigators, Licensed irrigation technicians**, and **Licensed irrigation inspectors** (Texas Commission on Environmental Quality 2012).

Landscaping Job Skills and Pathways

Grounds maintenance workers are responsible for maintaining the outdoor environment of houses, businesses, and parks. They maintain lawns, trim shrubbery and trees;

TABLE 17: LANDSCAPING OCCUPATIONS AND SUSTAINABLE WATER SKILLS

remove unwanted vegetation; plant new vegetation; and manage the watering system.

Workers in these occupations can work on jobs that fall into several sustainable water strategies. Improving outdoor irrigation through water efficient landscaping techniques can increase urban water conservation. Moreover, many green infrastructure projects require landscapers for installation and maintenance. The skills required for these roles could be transferred to restoration and remediation projects, although additional training might be necessary for workers to move into these kinds of projects. These workers can also be responsible for connecting irrigation systems to alternative supplies such as greywater.

This occupation does not require formal education and individuals can receive training on the job. After years of training and, in some cases, additional education, workers can advance to managerial positions or go on to start their own businesses.

LANDSCAPING AND GROUNDSKEEPING WORKERS

Projected Openings: 444,400 // Median Hourly Wage: $11.26

Landscape or maintain grounds of property using hand or power tools or equipment.

Tasks Relevant to Sustainable Water Projects:

- Follow planned landscaping designs to determine where to lay sod, sow grass, or plant flowers or foliage.
- Advise customers on plant selection or care.
- Use irrigation methods to adjust the amount of water consumption and to prevent waste.
- Maintain irrigation systems, including winterizing the systems and starting them up in spring.

FIRST-LINE SUPERVISORS/ MANAGERS OF LANDSCAPING, LAWN SERVICE, AND GROUNDSKEEPING WORKERS

Projected Openings: 60,100 // Median Hourly Wage: $20.22

Directly supervise and coordinate activities of workers engaged in landscaping or groundskeeping activities.

Tasks Relevant to Sustainable Water Projects:

- Direct activities of workers who perform duties such as landscaping, cultivating lawns, or pruning trees and shrubs.
- Train workers in tasks such as transplanting or pruning trees or shrubs, finishing cement, using equipment, or caring for turf.

The Professional Landscape Network (PLANET) is an international association serving lawn care professionals, landscape management, design/build/installation professionals, irrigation and water management and interior plantscapers. PLANET offers seven certifications in landscaping and grounds maintenance for workers at various experience levels.

The Professional Grounds Management Society offers certifications for Grounds Managers and Grounds Technicians. Becoming a Certified Grounds Manager requires a college degree and 4-6 years of experience, or eight years of experience without a degree. Certification as a Grounds Technician requires a high school diploma or GED, proof of employment, and two years of experience. PGMS also offers a certificate from their School of Grounds Management, a 24-credit program that can be completed in 2-4 years. Required courses include human resource management, business and financial management, and technical management. The cost is $25 for membership to the Society (Professional Grounds Management Society n.d.).

The Desert Botanical Garden in Phoenix, Arizona offers certification in desert landscaping. The six-month program consists of six modules with 4-5 classes each (approximately one class per week), and covers topics such as plant selection, sustainable water practices, and landscape design.

EPA's WaterSense program partners with training and certification programs offered by other organizations. For example, Sonoma Marin Saving Water Partnership offers certification as a Qualified Water Efficient Landscaper. Also, the California Landscape Contractors Association offers training and certification as a Certified Water Manager (California Landscape Contractors Association n.d.). Several other programs around the country offer certification in partnership with WaterSense.

The Irrigation Association offers several relevant certifications. All certifications require at least one year of experience, a written exam, and 20 units of continuing education per two-year cycle in order to

stay in good standing. Certified landscape and golf irrigation auditors, who gather irrigation water-use data and test landscape and golf irrigation systems, respectively, must also submit an independently completed audit, verified by an IA-certified professional in good standing. The certified irrigation designer, who establishes specifications and design drawings for irrigation projects and the certified irrigation contractor, who will install, maintain and repair irrigation systems, must have two additional years of experience beyond the minimum requirements. Certified landscape water managers evaluate, operate, manage, and improve landscape irrigation systems to achieve the highest level of water conservation possible. Individuals receiving this certification must already be an IA certified landscape or golf irrigation auditor in good standing and have three years of experience.

The Department of Labor registers four specialties associated with this occupation: Landscape Gardener, Landscape Technician, Landscape Management Technician, and Greenskeeper II.

Plumbing Skills and Pathways

These workers install and repair pipes that carry water, steam, air, or other liquids or gases to and in businesses, homes, and factories. This requires the ability to study blueprints and understand building codes. Plumbers, pipefitters, and steamfitters use many different materials and tools, and knowledge of these is important. Plumbers install plumbing fixtures and appliances, and can also be responsible for maintaining septic systems. The majority of workers in these occupations work as building equipment contractors.

TABLE 18 : PLUMBING OCCUPATIONS AND SUSTAINABLE WATER SKILLS

PIPELAYERS

Projected Openings: 28,800 // Median Hourly Wage: $17.26

Lay pipe for storm or sanitation sewers, drains, and water mains.

Tasks Relevant to Sustainable Water Projects:

- Install or repair sanitary or stormwater sewer structures or pipe systems.

PLUMBERS, PIPEFITTERS, AND STEAMFITTERS

Projected Openings: 228,800 // Median Hourly Wage: $22.96

Assemble, install, alter, and repair pipelines or pipe systems that carry water, steam, air, or other liquids or gases.

Tasks Relevant to Sustainable Water Projects:

- Install fixtures, appliances, or equipment designed to reduce water or energy consumption.
- Install or test greywater systems, such as recycling, treatment, or irrigation systems.
- Perform complex calculations and planning for special or very large jobs.
- Calculate costs or savings for water- or energy-efficient appliances or systems.
- Compile information on governmental incentive programs related to the installation of energy or water saving plumbing systems or devices.
- Install alternative water sources, such as rainwater harvesting systems or graywater reuse systems.
- Install green plumbing equipment, such as faucet flow restrictors, dual-flush or pressure-assisted flush toilets, or tankless hot water heaters.
- Perform domestic plumbing audits to identify ways in which customers might reduce consumption of water or energy.
- Recommend energy or water saving products, such as low-flow faucets or shower heads, water-saving toilets, or high-efficiency hot water heaters.

HELPERS—PIPELAYERS, PLUMBERS, PIPEFITTERS, AND STEAMFITTERS

Projected Openings: 41,700 // Median Hourly Wage: $12.99

Help plumbers, pipefitters, steamfitters, or pipelayers by performing duties requiring less skill.

Tasks Relevant to Sustainable Water Projects:

- Assist pipe fitters in the layout, assembly, and installation of piping for air, ammonia, gas, and water systems.

Workers in these occupations are most easily found in projects that improve urban water conservation and efficiency, installing plumbing fixtures and appliances that reduce water use. Plumbers will also have skills that can be applied to projects to install greywater systems or transfer new alternative water supplies, such as tail water or recycled water.

Most workers in this occupation learn the trade through a four- or five-year apprenticeship. These are offered by unions, colleges, and businesses and typically require applicants to be over the age of 18, able to pass a drug test, have a high school diploma, and be able to use computers and pass a basic math test. Most states and local jurisdictions require licensing of plumbers, which requires 2-5 years of experience and an exam (although specific requirements can vary). The Department of Labor registers nine apprenticeships associated with this occupation; relevant specialties include pipe fitter, pipefitting, and plumber.

Green Plumbers USA offers training and certification in sustainable water techniques. Candidates must be plumbers, mechanical contractors, or be in a recognized apprenticeship or training program. Individuals can receive green plumbing accreditation after completion of 32 hours of coursework in environmental and technical issues (Green Plumbers Training 2012). A business can be licensed as a green plumbing operation, at a cost of $400 per year. United Association of Journeymen and Apprentices of the Plumbing and Pipe Fitting Industry of the United States and Canada (UA) is the plumbers and pipefitters union. UA also offers apprenticeships, as well as certification in Green

TABLE 19 : REMEDIATION OCCUPATIONS AND SUSTAINABLE WATER SKILLS

BROWNFIELD REDEVELOPMENT SPECIALISTS AND SITE MANAGERS

Projected Openings: 249,400 // Median Hourly Wage: $47.85

Plan and direct cleanup and redevelopment of contaminated properties for reuse. Does not include properties sufficiently contaminated to qualify as Superfund sites.

Tasks Relevant to Sustainable Water Projects:

- Develop or implement plans for the sustainable regeneration of brownfield sites to ensure regeneration of a wider area by providing environmental protection or economic and social benefits.
- Design or implement measures to improve the water, air, and soil quality of military test sites, abandoned mine land, or other contaminated sites.
- Design or implement plans for surface or ground water remediation. Develop or implement plans for revegetation of brownfield sites.

ENVIRONMENTAL RESTORATION PLANNERS

Projected Openings: 43,200 // Median Hourly Wage: $30.25

Collaborate with field and biology staff to oversee the implementation of restoration projects and to develop new products. Process and synthesize complex scientific data into practical strategies for restoration, monitoring or management.

Tasks Relevant to Sustainable Water Projects:

- Conduct site assessments to certify a habitat or to ascertain environmental damage or restoration needs.
- Review existing environmental remediation designs.
- Supervise and provide technical guidance, training, or assistance to employees working in the field to restore habitats.

HAZARDOUS MATERIALS REMOVAL WORKERS

Projected Openings: 18,900 // Median Hourly Wage: $18.33

Identify, remove, pack, transport, or dispose of hazardous materials, including asbestos, lead-based paint, waste oil, fuel, transmission fluid, radioactive materials, contaminated soil, etc.

Tasks Relevant to Sustainable Water Projects:

- Apply bioremediation techniques to hazardous wastes to allow naturally occurring bacteria to break down toxic substances.

System Awareness, which is recognized by the United States Green Building Council (United Association 2011).

Remediation Skills and Pathways

Individuals in these occupations conduct work to remove pollution and hazardous materials from the environment and restore ecological conditions. Hazardous materials removal workers are responsible for identifying, removing, and disposing of hazardous materials. Restoration planners and redevelopment specialists oversee projects that remove pollution and hazardous material to improve environmental conditions. This work includes assessment of the conditions of the site and forming a plan for redevelopment and pollution management. Fifty-seven percent of workers in these occupations work for government agencies.

Workers in these occupations generally have a high school diploma; planners and managers will often have a bachelor's degree or more. Hazardous materials workers will often be trained on the job, and must have at least 40 hours of mandatory Occupational Safety and Health Administration (OSHA) training. This training can be offered in-house by the employer or at an OSHA-approved training center. Additional certifications may be required for specific contaminants. Employers commonly help workers fulfill these mandatory training requirements, either in-house or through sponsorship in another training program. These occupations typically require some background in environmental science and engineering. Proficiency in computers and computer software is typically required. Colleges and universities offer courses and degrees in environmental restoration and remediation.

Roofing Skills and Pathways

Workers in this occupation install and repair roofs. Workers typically work with materials such as shingles, asphalt, metal, bitumen, and insulation. Roofers must understand the uses and specifications of the building in order to account for insulation, vents, waterproofing, and weight load. Traditional roofing systems must also include stormwater management systems such as gutters. Roofing requires physical ability and balance, and workers operate in a range of weather conditions. Roofing has one of the highest rates of illness and injury, and safety precautions must be taken to prevent slipping, falling, and general construction injuries such as cuts and burns.

Roofing workers engaged in sustainable water management strategies are responsible for projects that improve stormwater management through the use of green roofs. Roofers installing green roof systems must install waterproof foundational layers, a drainage system, if necessary, and layers of soil and vegetation. Green roofers must ensure that the system is designed to absorb the expected runoff.

Most roofers learn on the job or through apprenticeship programs. Typical apprenticeship programs require a high school diploma, a minimum age, and physical ability. These apprenticeships are typically offered by unions and contractor associations. A background in mathematics, shop, mechanical drawing, and blueprint reading are helpful. Green Roofs for Healthy Cities (GRHC) offers accreditation as a Green Roof Professional. The exam required for accreditation costs $495; courses in preparation for the exam are in the hundreds of dollars, although they are not required to receive accreditation (Green Roofs Professional Accreditation Exam Guidebook n.d.).

Building Inspector Skills and Pathways

Construction and building inspectors monitor and inspect new buildings or repair work to ensure compliance with local, state, and federal regulations, codes, ordinances, and specifications. Inspectors must be up to date on existing regulations, codes, and ordinances. They will issue violations notices and stop-work orders when buildings or construction projects are out of compliance. Inspectors can be responsible for examining one or several aspects of building construction. For example, inspectors can be responsible for ensuring the electrical and plumbing systems are up to code, as well as ensuring the construction meets the design and contract specifications. Fifty-one percent of workers in this occupation work for government entities.

Workers in this occupation that are engaged in sustainable water strategies are typically working to improve stormwater management or utilize alternative supplies through ensuring proper application of building codes and regulations that address water and energy efficiency.

Inspectors typically have a high school diploma and substantial knowledge of construction trades. Training and courses in engineering or architecture are helpful, and bachelor's degrees are becoming more common. Most inspectors learn the details (such as recordkeeping and reporting) of their work on the job, but must independently learn the codes and standards.

TABLE 20: ROOFING OCCUPATIONS AND SUSTAINABLE WATER SKILLS

ROOFERS

Projected Openings: 52,500 // Median Hourly Wage: $16.96

Cover roofs of structures with shingles, slate, asphalt, aluminum, wood, and related materials.

Tasks Relevant to Sustainable Water Projects:

- Apply modular soil- and plant-containing grids over existing roof membranes to create green roofs.
- Install layers of vegetation-based green roofs, including protective membranes, drainage, aeration, water retention and filter layers, soil substrates, irrigation materials, and plants.

HELPERS—ROOFERS

Projected Openings: 4,600 // Median Hourly Wage: $11.18

Help roofers by performing duties of lesser skill.

Tasks Relevant to Sustainable Water Projects:

- Check to ensure that completed roofs are watertight.
- Provide assistance to skilled roofers installing and repairing roofs, flashings, and surfaces.

TABLE 21: BUILDING INSPECTORS AND SUSTAINABLE WATER SKILLS

CONSTRUCTION AND BUILDING INSPECTORS

Projected Openings: 48,600 // Median Hourly Wage: $25.57

Inspect structures using engineering skills to determine structural soundness and compliance with specifications, building codes, and other regulations.

Tasks Relevant to Sustainable Water Projects:

- Inspect bridges, dams, highways, buildings, wiring, plumbing, electrical circuits, sewers, heating systems, or foundations during and after construction for structural quality, general safety, or conformance to specifications and codes.
- Monitor installation of plumbing, wiring, equipment, or appliances to ensure that installation is performed properly and is in compliance with applicable regulations.
- Evaluate project details to ensure adherence to environmental regulations. Inspect facilities or installations to determine their environmental impact. Monitor construction activities to ensure that environmental regulations are not violated.

Some type of license or certification is usually required by the state or local jurisdiction, which can in turn require certification by industry associations like the International Code Council, International Association of Plumbing and Mechanical Officials, International Association of Electrical Inspectors, and National Fire Protection Association. Requirements for licensure or certification include a minimum level of experience and education, as well as an exam.

The US Green Building Council offers certification as a Homes Green Rater, who provides verification services on LEED for Homes projects. Candidates must be at least 18, pass an exam, have a minimum set of knowledge and skills, complete a mentorship, and complete some combination of online training or an in-person one or two-day workshop. Applicants must have a high school diploma or GED as well as three years minimum experience in the field of residential construction. The cost for the mandatory training varies, but starts at around $660, and the exam fee is $250 (U.S. Green Building Council 2011).

Buildings receiving EPA's WaterSense label must be inspected by a trained and approved water efficiency inspector and certified by an EPA licensed certification provider. An organization seeking to provide this service must have a staff member attend a training session conducted by EPA or a WaterSense new homes program administrator. Organizations that certify landscape irrigation professionals may also apply for the WaterSense label (EPA 2012k).

Water Treatment Skills and Pathways

Water and liquid waste treatment plant and system operators manage machines that transport and treat water and wastewater. Operators are typically responsible for monitoring system operations, taking samples, managing chemical applications, and recording monitoring and operational data. Job duties typically depend on the size of the plant; in small systems, only one operator will be needed to operate the whole system, but large systems will have more specialized operators and more systems controlled by computers. Seventy-eight percent of workers in this occupation work for the government.

Workers in this occupation typically work for traditional, centralized systems. However, some workers can be engaged in sustainable water projects within these systems. For example, workers will be needed to operate facilities providing alternative supplies such as greywater or utilizing aquifer storage and recovery. It is unclear what skills are required for these new tasks.

Workers in this occupation typically begin their careers in lower level positions in the plant, gaining the experience they need to become operators. These workers typically need to have a high school diploma, and be skilled in mechanics and mathematics. An associate's degree or certificate is helpful. Certificates and degrees are offered by community colleges, technical schools, and trade associations. Workers are trained on the job, and so certification or degree programs can reduce the amount of time needed for training. The EPA has compiled fact sheets describing training programs, internships and mentoring programs that help new operators enter the water and wastewater industries (EPA 2012i).

Operators must receive a license from the state in which they operate, and may need to apply again when moving to a different state. Licensing requires a minimum amount of experience and training, as well as some coursework and an exam. These licenses are usually tiered to reflect the operator's training and experience.

Apprenticeships are offered by some state agencies as well as community and technical colleges. The State of Wisconsin, for example, now offers a wastewater system plant operator apprenticeship program, and was established through the Sector Alliance for the Green Economy (SAGE) project (State of Wisconsin Department of Workforce Development 2011). There are four recognized apprenticeship specialties: Clarifying-Plant Operator; Wastewater-Treatment-Plant Operator; Waste-Treatment Operator; Water-Treatment-Plant Operator.

Construction Skills and Pathways

Construction laborers perform a mix of physical tasks on a variety of types of construction sites. These tasks can include cleaning and preparing the site and the land for construction; loading and unloading materials; and building temporary structures such as scaffolding. Laborers work with a variety of materials, machinery, and tools, and it is important that workers are familiar with the proper use and handing of this equipment. Some of the more complicated tasks can require training and experience, however, many can be learned quickly on the job. Some construction laborers specialize in a particular task. Computer skills are becoming more important as the work becomes more mechanized.

Workers in this occupation can be engaged in sustainable water projects in any category, as most require some form of general construction. For example, construction laborers will prepare sites for environmental restoration and remediation projects and help install

TABLE 22: WATER TREATMENT PLANT OPERATORS AND SUSTAINABLE WATER SKILLS

WATER AND LIQUID WASTE TREATMENT PLANT AND SYSTEM OPERATORS

Projected Openings: 41,500 // Median Hourly Wage: $20.09

Operate or control an entire process or system of machines, often through the use of control boards, to transfer or treat water or liquid waste.

Tasks Relevant to Sustainable Water Projects:

- Implement ecological treatment techniques and water reuse systems.

improved indoor water use or storm-water management components of new building construction.

Most construction laborers gain experience through on-the-job training, but apprenticeships are available. While a high school education is helpful, it is not required. Trade or vocational schools, association training class, and community colleges have programs to help construction laborers gain experience.

Unions and contractor associations sponsor apprenticeships; generally, these only require participants to be over the age of 18. There are recognized apprenticeship specialties associated with this occupation; programs that train Construction Craft Laborers are relevant to jobs in sustainable water strategies. The Northwest Laborers-Employers Training Trust Fund, for example, provides a 6,000 apprenticeship program for construction workers (Northwest Laborers-Employers Training Trust Fund 2012).

Specialized certification is only required when certain tasks are performed. For example, hazardous material removal, scaffold building, and welding can all require specialized certification or licensing. Many colleges and organizations offer certification in green building construction; LEED Green Associates (U.S. Green Building Council 2012) is probably the most well-known, although other green building programs exist.[13] Optional certifications can help workers advance to more specialized or managerial positions.

For managerial positions, individuals typically need a high school diploma and several years of experience. New managers typically start out as assistants before beginning to work independently. As the complexity of construction projects increases, a bachelor's degree, associate's degree, or certification is becoming increasingly important.

The American Institute of Constructors awards the Associate Constructor (AC) and Certified Professional Constructor (CPC) designations. AC certification is for new workers in the construction industry who are completing a four-year bachelor's degree program or have worked in the industry for at least four years. The Certified Professional Constructor certificate requires at least eight years of experience, plus at least two of these years in a position with overall responsibility for delivery of a project or a substantial portion of a project (AIC 2012).

The Construction Management Association of America awards the Certified Construction Manager (CCM),

TABLE 23: CONSTRUCTION OCCUPATIONS AND SUSTAINABLE WATER SKILLS

FIRST-LINE SUPERVISORS/ MANAGERS OF CONSTRUCTION TRADES AND EXTRACTION WORKERS

Projected Openings: 259,700 // Median Hourly Wage: $28.44

Directly supervise and coordinate activities of construction or extraction workers.

Tasks Relevant to Sustainable Water Projects:

- Coordinate work activities with other construction project activities.
- Estimate material or worker requirements to complete jobs.
- Order or requisition materials or supplies.

CONSTRUCTION LABORERS

Projected Openings: 292,400 // Median Hourly Wage: $14.30

Perform tasks involving physical labor at construction sites.

Tasks Relevant to Sustainable Water Projects:

- Perform site activities required of green certified construction practices, such as implementing waste management procedures, identifying materials for reuse, or installing erosion or sedimentation control mechanisms.
- Install sewer, water, or storm drain pipes, using pipe-laying machinery or laser guidance equipment.

[13] *For example, the Green Advantage® Certification (http://www.greenbuilding.com/training/what-green-advantage%C2%AE-certification) and the National Association of Home Builders' Certified Green Professional (http://www.nahb.org/category.aspx?sectionID=1174)*

which is accredited by the American National Standards Institute (ANSI). To be certified, individuals must meet minimum functional requirements (such as experience in project management and contract administration) have a minimum of 48 months of experience, plus a degree or additional experience beyond the minimum. Individuals must submit an application and pass an exam, at a cost of $550-$575 (CMAA 2012).

Associated Builders and Contractors, Inc. offers green contractor certification for businesses (not individuals, although there are requirements for a minimum number of workers with experience in green construction. Certification requires meeting minimum, plus a $475 application fee (Associate Builders and Contractors 2012).

Conclusions

This section explores the job quality, workforce, growth, and pathways to employment in sustainable water occupations. The analysis is coarse as it does not account for regional differences that may vary greatly. The number of job openings in a related occupation can be shaped by local factors related to water management, like new local investments in water efficiency, and factors unrelated to water management, like slow growth in another industry.

Many of the occupations involved in sustainable water projects are projected to have high demand in the overall economy. Of the 136 occupations identified in sustainable water strategies, 37 are projected in the overall economy to have more than 100,000 job openings by 2020. Workers trained to advance water sustainability in these occupations will likely experience high demand and have the competitive edge of holding green skills. The high number of workers that will move into these occupations also means that there may be a growing demand for occupational training, creating an opportunity to train a new generation with the green skills that will make their sector more sustainable.

Twenty-seven sustainable water occupations have more than 100,000 job openings projected for 2020 in the overall economy and have relatively accessible education and experience requirements consistent with Job Zones 1 through 3. Half of these sustainable water occupations have median wages above the national median wage ($16.50) and would provide an income sufficient to cover the basic expenses of one adult with one child in at least 70% of the regions in the country.

The median wages of more than one-third of these sustainable water occupations may not currently provide enough income to support a modest living in most regions in the US. Ten of the occupations with 100,000 projected job openings and more accessible training requirements currently have median wages that would not cover the basic expenses of one adult with one child in 75% of regions in the US. The growing opportunities in these occupations may not fully address poverty and inequality unless efforts are made to improve job quality. An additional ten occupations have similar projected openings and require advanced degrees.

The gender and racial makeup of the current workforce in growing sustainable water occupations suggests that efforts will have to be made to achieve equity in these fields. In the occupations with high numbers of projected job openings that do not require university degrees, African American and Latino workers disproportionately make up the workforce in occupations with the lowest median wages, while white workers disproportionately make up those in the highest paid occupations. Women workers are only found in percentages above the national average in occupations that are clerical in nature. Roles in management or more physical occupations like electricians and carpenters have extremely low participation by women. Addressing barriers that may exist and implementing strategies for ensuring equal access to these professions should be a part of green water jobs policies and programs.

Our review of the career pathways to eleven occupations requiring unique water-related skills reveals a challenging lack of relevant data. No centralized information source exists to review certification standards and relevant training programs across the country. A diverse range of public and educational institutions, union apprenticeships, private associations, and community-based programs are training and certifying workers for these occupations, but we were not able to determine the degree to which many of the existing programs are covering the skills unique to sustainable water projects.

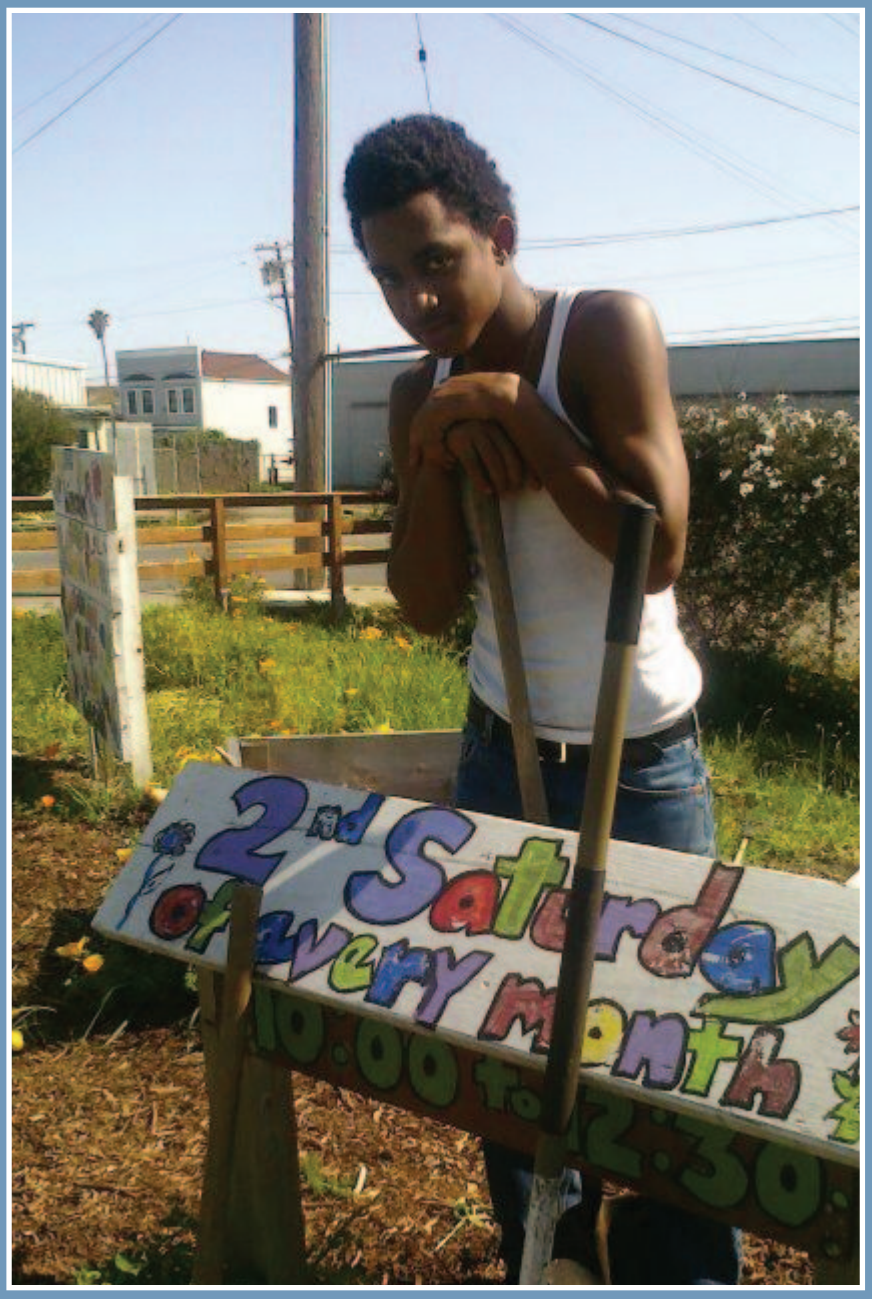
In several of the occupations the strong training and certification infrastructure suggests to us that there may be a clearer and more reliable pathway for disadvantaged communities. More in-depth research should assess the training and certification programs for disadvantaged communities to enter into careers as Plant Operators, Plumbers, Building Inspectors, and Brownfields Specialists. However, it must be acknowledged that

Source: Loretta Quach/Amigos de los Rios

certification in a particular field does not necessarily guarantee employment. The certification must be recognized by employers, and few certifications in sustainable water strategies exist, let alone have achieved wide recognition. In addition, language, cost, timing, and geographic availability of certification programs could pose barriers for workers who want to access these programs.

Other occupations are critical to achieving water sustainability, and have high projected job openings, but the jobs created may be of poor quality. Farmworkers and landscaping workers have low median wages, low union representation, and weak or fragmented certification systems – conditions that may prevent jobs created in these occupations from addressing poverty and economic inequality.

A key area for further research is the occupational "lattices" that allow workers to move from one occupation to another using transferrable skills. Information and analysis on this will facilitate training that prepares workers so that they have multiple options for employment and lateral movement.



Source: Doria Robinson/Urban Tilth

V PROGRAMS LINKING DISADVANTAGED COMMUNITIES TO SUSTAINABLE WATER JOBS

What does it take to ensure that members of disadvantaged communities have opportunities to enter into careers related to water sustainability? The previous section describes a range of training, certification, apprenticeship and other programs that are resources to workers attempting to find a pathway into key opportunities in sustainable water jobs. This section draws on case studies of green job programs that explicitly work with disadvantaged communities, and highlights some of their challenges and successes. For these interviews, we identified workforce programs that specialize in training community members who face barriers to securing quality employment. Training programs were identified from professional networks, internet searches, media, and published information sources. We conducted structured phone interviews with program managers and directors from nine organizations, obtaining permission to record and publish information shared (See Appendix D for list of organizations interviewed). In addition to phone interviews, we held a more in-depth two-day forum with multiple semi-structured discussions of related topics. The convening allowed for cross discussion about program challenges, provided an opportunity to learn from each other's experiences, and reaffirmed the purpose of connecting workforce development and sustainable water strategies.

Programs

Our research examined 38 organizations with water-related job training programs although only nine organizations work directly with disadvantaged communities. These organizations train participants in a variety of fields, including restoration, brownfield remediation, and stormwater management. They also offer specialized trainings and certifications in operating heavy machinery, hazardous material, Occupational Safety and Health Administration (OSHA), and CPR. A majority of these programs serve at-risk youth, ages 18-24, while some serve immigrant communities, formerly incarcerated individuals, and low-income community members. Many programs also offer supplemental supportive programs, such as life skills workshops, English language classes, and high-school diploma courses. Some have the capacity to hold year-long programs, whereas others offer shorter programs multiple times a year. Even with the differences in capacity, region, and range of services offered to communities, these workforce programs share many of the same challenges, opportunities, and visions for their environment and communities.

Challenges

There are a limited number of programs that link disadvantaged communities to the sustainable water sector. Compared to energy efficiency training programs across the country, water-related programs are meager. The sustainable water training programs we identified generally serve local areas with relatively low number of participants. Many programs have only been in existence for a few years, and have yet to establish a reputation with employers, funders and communities. Some have even faced challenges in establishing a program to serve disadvantaged community members because they had difficulty identifying and connecting with the community. Programs' have acknowledged the need to build capacity in supportive services and program evaluation to better track their outcomes.

Inadequate funding is the biggest challenge vocalized by the training programs interviewed. Many depend largely on grants for their funding which makes organizations vulnerable to changing priorities of funders and the level of support they provide. Without consistent funding, they are unable to carry out needed components like soft skills training and program evaluation. Another predicament that some of these organizations face is covering project costs up-front and getting reimbursed after completion. Limited resources coupled with lack of access to affordable credit or capital on-hand can constrain their ability to provide programs.

An additional setback for many programs is the inability to finance operation and maintenance, especially when clients expect programs to be responsible for maintaining projects. For the most part, project funding accounts for the design and installation phases of a project, but does not include the maintenance, which is still needed in order for many projects to work effectively.

For individual case studies on six organizations working with disadvantaged communities to access sustainable water job opportunities, see www.pacinst.org/reports/sustainable_water_jobs.

Organizations also report difficulty in effectively assisting program participants in overcoming challenges that can prevent them from succeeding in the workforce. To better train and prepare participants for a professional setting, many of the job training programs provide a more hands-on approach and offer supportive services such as life skills training and English language classes in addition to job training. Some of the challenges reported include: access to reliable transportation, childcare, and public safety issues that limit participants' mobility.

While programs customize their curriculum to fit the needs of their trainees, program curricula at times do not match the skillset needed for participants to pass certifications. Alternatively, some organizations develop program-specific certifications that are well-aligned with their training but are not known outside of the program's immediate local area or network. Certifications with limited recognition or familiar to only a subsection of the market create challenges for graduates who are leveraging their training in a competitive market.

Job placement is also a major challenge, with multiple underlying reasons. Some training program managers have observed a low demand in the occupations they have targeted, and need to be able to better adjust their program to employment trends. Moreover, these employment trends can be difficult to identify at all. Training providers stated the need for stronger relationships with employers, which could provide important input and networking for organizations as well as their program graduates. For some, employers' pre-conceived notions of people of color, young adults, individuals with a past conviction, and other stigmatized groups create additional barriers to employment.

A weakness for many of the programs is evaluation and research. The lack of information and understanding of water-related occupations was consistent among programs. Interviewees were aware of the local job context, but often unfamiliar of the larger market trends. Data on job types, projections, and wages are also insufficient for analyzing occupations in the industry for program managers, researchers, and practitioners. Another component to evaluating success is measuring the program's outcomes. Robust program evaluation is rare since most providers have not gathered information on program participants during and after the training, and have not set up an evaluation system.

Many of the challenges these workforce development programs experience are common to non-profit organizations and are more systemic than to be attributed to each individual organization. And for many of the challenges that came up, there were also organizations that had found a strategy to overcome it.

Promising Practices

Thinking beyond organizations' own resources and limitations have allowed programs to overcome some of their challenges. Examining the broader policies and trends that affect the community and local economy can lead to creative strategies for workforce programs. These innovative and promising practices include engaging in planning processes and collaborating with local partners in a way that builds their capacity and long-term strategy.

Engaging in Policy and Planning

Engaging in policy and planning can benefit workforce programs immensely by increasing investment in sustainable projects and related labor demand, creating new funding sources for programs, and discovering opportunities to contract with public agencies, among others. As cities are becoming more aware of the need for sustainable water practices, they are actively pursuing policies that will involve green infrastructure improvements such as low impact development projects. Engaging in the local policy planning processes, like general plan updates and flood management plans can expand public commitments to support sustainable water projects like river restoration, green infrastructure, or urban water efficiency. Sustainable South Bronx, for example, couples advocacy for community access to green space with training for residents to work on a wide range of green projects. The organization joined with residents opposing the construction of a new jail, a plan that was ultimately transformed into a greenway where residents trained by Sustainable South Bronx were employed to carry out restoration work (Milner 2012). Workforce development programs that are well informed about nearby developments and new city infrastructure initiatives have a greater opportunity to be involved, and being engaged in policy ensures that programs are aligned with building codes, procurement policies, and other regulations, keeping programs competitive.

"High-road Strategies" has become a term describing a range of innovative agreements between communities, public agencies, unions, and others interested in ensuring that publicly funded projects provide desired long-term environmental, economic, and social benefits (Hays 2012). Low wages and low-quality jobs are prevalent in disadvantaged communities, often despite

the numerous projects that have been funded with public dollars and justified by the jobs they would generate. A Community Benefits Agreement (CBA) is one example of a project agreement between a developer and community coalition that can bring in local jobs to a community or other community needs. We have not found examples of a CBA focused on a sustainable water project, but projects that CBA's have focused on exhibit many similar characteristics to some sustainable water projects.

Building Relationships

Fostering strong relationships with businesses, government agencies, and contractors is a key practice to connecting program participants to jobs, as these are potential employers and sources of referrals. An innovative way that Portland-based Verde has built relationships in the community is through its hybrid business/non-profit model. By providing landscaping services to the City of Portland, non-profits, general contractors, and landscape contractors, Verde has cultivated relationships with the community and potential employers for its current employees. This model not only creates sustainable funding for the organization's operations, but it allows for the non-profit to learn about business and employer needs.

Setting up networking events and being active in the community can also create opportunities for training providers and participants to build relationships with employers. Organizations that have a long standing commitment with the community can advocate for the program and build awareness of the program's purpose, as well as open the dialogue to firms in the water sector about the opportunities needed for disadvantaged communities. These types of opportunities expose programs to potential employers and partners. It also serves as a model for minorities and women who have the desire to pursue their own business.

Program Design

Relatively new and inexperienced in workforce development of disadvantaged communities or in the water sector, many of these programs are taking on unchartered territory. Therefore some of these programs find programmatic gaps in addressing their participants' needs. To address the educational, health, and social needs of its participants, ¡YouthWorks! of Santa Fe has integrated supportive services by working closely with its strong community-based partnerships. This approach allows the program to incorporate environmental education, a job skill services and a 36-hour GED curriculum to its program.

Providers agree that program design should respond to the expected labor demand for occupations that fit the population served. Program staff with limited time for researching labor markets stated they find Bureau of Labor Statistics and the O*NET OnLine database to be the most useful.[14] These regularly updated databases provide information on the projected openings, wages, training, skills, and other aspects of most occupations.

Programs report greater employment success for participants when training is oriented to a certification that is national and industry-endorsed. Limitless Vistas, for example, trained a cohort to become Water and Waste Water Plant Operators, and had one participant get recruited and hired in another state after he passed the standard certification.

Funding

As mentioned, securing adequate and consistent funding is a common challenge for non-profit organizations, especially for programs that are highly dependent on grant funding. To help overcome this challenge, Verde established a business from its landscape services to ensure that trainees are not only trained, but are paid for contract landscape projects. Feasibility studies and business plans were created for each of Verde's social enterprises. It includes a sales strategy for the next few years, projecting significant growth for the landscape industry with the goal of financing at least 85% of annual operating expenses from earned income. With this model in place, Verde has a stable operations plan for its program and can focus its operations on training and projects.

Another practice that has solidified funding for organizations is contracting with institutional players, such as utilities, cities, and other government agencies. This approach has been demonstrated successfully by ¡YouthWorks!, who has a multiple-year contract with the City of Santa Fe for its green collar job training programs. Its strong partnership with the City of Santa Fe has made green jobs training a priority for the city, using the training as an investment in youth as well as an environmental, workforce and economic development tool. Contracts to provide maintenance of a landscaping or other or project can also provide a stable source of income and work experience for training organizations.

These evolving and promising practices present a holistic and innovative approach to linking disadvantaged workers to opportunities in sustainable water fields. As programs mature and adapt, they will have a better understanding of the industry environment,

[14] *http://www.onetonline.org/*

Source: US Department of Agriculture

VI CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The United States faces a complex set of water challenges that can only be addressed with a greater commitment to invest in sustainable solutions. Failing to rise to this challenge will leave crumbling infrastructure, contaminated waterways, and water shortages that threaten public health, economic growth, and ecosystems in myriad ways. Sustainable approaches take advantage of the potential for decentralized facilities; efficient technologies; flexible public, private, and community-based institutions; innovative economics; and human capital. These solutions can be grouped into five major strategies: Urban Water Conservation and Efficiency, Stormwater Management, Restoration and Remediation, Alternative Water Sources, and Agricultural Water Efficiency and Quality.

The types of jobs involved in implementing sustainable water strategies cover a broad range of occupations. We identified 136 occupations involved in the work of achieving more sustainable water outcomes in agriculture, urban residential and commercials settings, restoration and remediation, alternative water sources, and stormwater management.

The quantity of employment created by sustainable water practices is substantial. The data available points to 10-15 jobs per $1 million invested in alternative water supplies; 5-20 in stormwater management; 12-22 in urban conservation and efficiency; 14.6 in agricultural efficiency and quality; and 10-72 jobs per $1 million invested in restoration and remediation. The view that environmental conservation produces net job losses is not supported by any of the data on sustainable water projects.

The potential for job creation through implementation of sustainable water strategies has been largely ignored by policymakers, scholars, and practitioners, with the efforts on green jobs mostly limited to energy efficiency and renewable energy activities. This has left a gap in understanding and action on these opportunities.

A lack of economic data and information from sustainable water projects makes identifying the occupations involved, the quantity of jobs, and the potential opportunities for disadvantaged communities difficult. The fragmentation of the institutions governing water management makes it difficult to identify the "water sector" and understand the financing and policy shaping it.

Federal mandates that require water improvements and promote green strategies – such as the recent stormwater guidelines and green reserve programs in State Revolving Funds – make labor demand more predictable and allow for more effective planning of green jobs programs.

Many of the occupations involved in sustainable water projects are also projected to have high demand in the overall economy. Thirty-seven sustainable water occupations are projected in the overall economy to have more than 100,000 job openings by 2020. Workers trained to advance water sustainability in these occupations will likely experience high demand and have the competitive edge of holding green skills. The high number of workers that will move into these occupations also means that there may be a growing demand for occupational training, creating an opportunity to train a new generation with the green skills that will make their sector more sustainable.

Numerous sustainable water occupations are accessible to workers without advanced degrees. Twenty-seven out of the 37 occupations with 100,000 job openings by 2020 generally require on-the-job training, with some requiring previous experience and associates degrees or technical training, but not graduate degrees. This translates to a more feasible pathway to employment for adults without formal education beyond high school.

While data is limited, the existing training and education programs preparing workers with the skills needed in sustainable water fields appear nascent and small-scale. Conventional educational and job-training resources like community colleges and union apprenticeships are only beginning to integrate green water occupational skills. And the link to disadvantaged communities is even more tenuous. We identified fewer than a dozen independent non-profits that are piloting innovative approaches to serve disadvantaged communities with job training and certification combined with supportive services.

Existing programs linking disadvantaged communities to sustainable water opportunities appear to face multiple challenges in designing and implementing programs,

meeting the scale of need, and placing program graduates. Programs have difficulty matching training to actual labor demand for particular occupations and skills. Certifications and licensing related to sustainable water occupations too often are accepted in too small a geographic area or too narrow an industry to provide workers and employers with the needed level of confidence in their value.

Existing training programs have also developed promising strategies for connecting disadvantaged communities to sustainable water jobs. Hybrid models that both train and hire workers through coordinated business and non-profit branches have found greater success placing graduates and maintaining stable funding. Organizations with contracts to provide operations and maintenance for public and private entities have also found a more stable source of funding and practical work experience for participants. However, training programs are unlikely to achieve substantial economic improvements for disadvantaged communities unless coupled with policy that increases and targets demand for new workers.

Top Source: Irrigation Association
Bottom Source: EPA

Recommendations

Data Collection and Research

- State agencies managing state revolving funds and other state and federal funding programs should require grantees and loan recipients to submit information on job types and numbers using a template aligned with standard occupational codes.
- Models for financing the ongoing operations and maintenance of sustainable water projects must be developed, piloted, and refined to ensure desired environmental and economic outcomes are sustained. This research should start with the lessons of leading local efforts, such as stormwater in Portland and Philadelphia.
- Workforce development and training organizations must increase their capacity to track and evaluate job placement and other program outcomes to strengthen the feedback loop that will improve programming and broader understanding of best practices.
- Economic research projecting job generation of sustainable water projects should incorporate data on the occupations and types of firms specific to these projects, as they in some cases are significantly different from those involved in conventional water project industries.

Policy and Planning

- The jobs created by sustainable water strategies should be considered, as new mandates for promoting these strategies are put forward in policy proposals. The jobs created must be recognized as a co-benefit and planned for such that there is an integrated approach to workforce training and placement.
- Water utilities, state water agencies, planning departments and other public entities funding and managing sustainable water projects should implement "high-road" strategies that consider job quality, training, and targeted hiring as an integral component of project design and implementation. This should include local hiring and minority hiring requirements and incentives that increase contracting and hiring with individuals from local and disadvantaged communities.
- Considering the strong interdependence between water and energy use, policy and workforce efforts to take advantage of the win-win solutions at this nexus should be strengthened.
- Better planning for and investment in financing the ongoing operations and maintenance of sustainable water projects is needed to ensure that the maximum environmental and employment benefits are realized.

Community Programs and Partnerships

- Unions, community-based organizations, and environmental advocates should join together in envisioning and promoting policies and funding programs that incorporate high-road work opportunities into sustainable water projects.
- Workforce development and training organizations must build stronger partnerships with unions and employers to ensure training is well-aligned with emerging occupations and skill sets, and increase placement rates for program participants.
- Training programs seeking to improve access of disadvantaged communities to sustainable water jobs should focus on occupations that are projected to have high labor demand in the overall economy. Data on the labor demand generated by sustainable water projects alone is not robust enough to justify training workers for these jobs unless their training will also prepare them to qualify for conventional occupations in demand.
- Partnerships between industry associations, labor unions, and training programs are needed to develop, deliver, and evaluate and update standardized training and certification that reflects actual skills needed and is accessible to disadvantaged communities. This should include the creation of a centralized, up-to-date clearinghouse of training curricula and certification standards.

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APPENDICES

Appendix A. Methods for Occupational Data Analysis

The ARRA data used for this analysis is from the National Cumulative dataset (2009-2012) from the Recipient Reported data, which was obtained from the Recovery.gov database. We filtered the data using the Catalog of Federal Domestic Assistance (CFDA) field, to only include projects categorized as one of the following federal programs:

- Recovery Act of 2009: Capital Improvement and Maintenance (10.687)
- Construction Grants for Wastewater Treatment Works (66.418)
- Water Quality Management Planning (66.454)
- Capitalization Grants for Clean Water State Revolving Funds (66.458)
- Capitalization Grants for Drinking Water State Revolving Fund (66.468)

739 projects in the database were supported by the five above program. We reviewed these to identify projects that fit squarely in one of our categories of sustainable water strategies and for which occupational data was provided. Unfortunately, only 41 projects met these criteria. We used the information provided on these projects to identify the occupations involved, but not the numbers of jobs.

We also attempted to use occupational data on projects funded through State Revolving Fund and TMDL programs, key sources of funding for a range of sustainable water projects. However, we found no states or agencies that routinely track job outcomes related to their projects funded under these programs.

Additional information on sustainable water occupations was gathered through focus groups and interviews with practitioners. From October 12th to 14th, 2012, Pacific Institute hosted 16 representatives from community organizations, labor unions, trade associations, and foundations with expertise in the employment aspects of sustainable water management. Focused discussions were held and participants reviewed and commented on lists of occupations associated with each sustainable water strategy.

Drawing from the occupational data sources, we compiled a list of all occupations documented in projects falling within each of the five sustainable water strategies. We defined occupations using the Standard Occupational Classification (SOC) code, the official system of federal agencies for classifying workers into occupational categories and the additional codes created by the National Center for O*NET Development.

APPENDIX B: DATA SOURCES FOR JOB QUALITY AND WORKFORCE ANALYSIS

COLUMN NAME	SOURCE
title	*ONET DB4 database*
number of workers (overall economy)	*HOUSEHOLD DATA ANNUAL AVERAGES 11. Employed Persons By Detailed Occupation, Sex, Race, And Hispanic Or Latino Ethnicity*
projected growth 2010-2020, percent	*BLS 2012 Table 1.7 Occupational employment and job openings data, projected 2010-20, and worker characteristics, 2010*
job openings due to growth and replacements	*BLS 2012 Table 1.7 Occupational employment and job openings data, projected 2010-20, and worker characteristics, 2010*
training & education job zone	*ONET DB4 database*
entry level hourly wage (10th percentile)	*BLS 2011 Occupational Employment and Wage Estimates, column H_PCT10*
median hourly wage	*BLS 2011 Occupational Employment and Wage Estimates, column H_MEDIAN*
percentage women	*BLS HOUSEHOLD DATA ANNUAL AVERAGES 11. Employed persons by detailed occupation, sex, race, and Hispanic or Latino ethnicity*
race and ethnicity	*BLS HOUSEHOLD DATA ANNUAL AVERAGES 11. Employed persons by detailed occupation, sex, race, and Hispanic or Latino ethnicity*
represented by unions - percent	*BLS HOUSEHOLD DATA ANNUAL AVERAGES 42. Union affiliation of employed wage and salary workers by occupation*

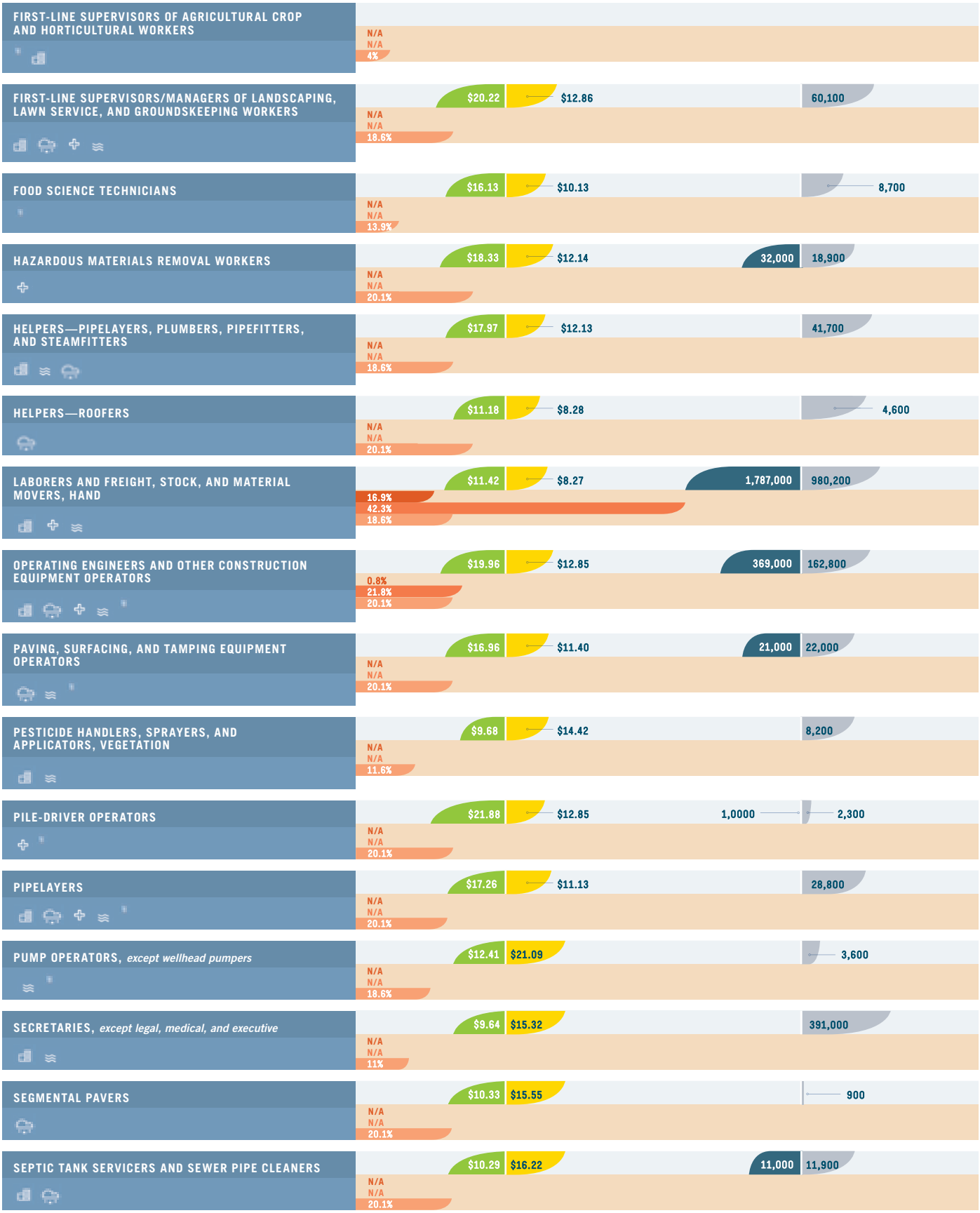
APPENDIX C: SUSTAINABLE WATER OCCUPATIONS (including those with fewer than 100,000 projected job openings)

Jobs Requiring Little or No Education and Training (Zone 1)


LANDSCAPING AND GROUNDSKEEPING WORKERS
$11.26
$8.23
444,400
N/A
N/A
11.6%
METER READERS, utilities
$17.02
$10.39
28,000
12,700
N/A
N/A
11%
OFFICE CLERKS, general
$13.07
$8.53
1,061,000
1,011,500
85.4%
34%
11%
RECEPTIONISTS AND INFORMATION CLERKS
$12.35
$8.60
1,259,000
565,600
92.1%
32.2%
11%
REFUSE AND RECYCLABLE MATERIAL COLLECTORS
$15.52
$8.92
92,000
69,700
7.7%
47.8%
18.6%
SHIPPING, RECEIVING, AND TRAFFIC CLERKS
$13.84
$9.25
559,000
177,400
28.5%
42.2%
11%
STOCK CLERKS AND ORDER FILLERS
$10.52
$8.07
1,503,000
465,000
34.8%
37.7%
11%
TRUCK DRIVERS, LIGHT OR DELIVERY SERVICES
$13.98
$8.67
295,900
N/A
N/A
18.6%

(Zone 2)


AGRICULTURAL EQUIPMENT OPERATORS
$12.13
$8.43
N/A
N/A
4%
AGRICULTURAL TECHNICIANS
$16.13
8,700
N/A
N/A
13.9%
BIOLOGICAL TECHNICIANS
$18.98
$11.99
21,000
37,900
N/A
N/A
13.9%
BOOKKEEPING, ACCOUNTING, AND AUDITING CLERKS
$16.13
$10.13
1,300,000
467,800
89.9%
20.2%
11%
CARPENTERS
$19.24
$11.96
1,330,000
408,300
1.9%
33.6%
20.1%
CONSTRUCTION LABORERS
$14.30
$9.05
1,253,000
292,400
2.1%
52%
20.1%
DREDGE OPERATORS
$16.12
$10.41
900
N/A
N/A
18.6%
EARTH DRILLERS, except oil and gas
$19.33
$13.07
23,000
6,200
N/A
N/A
20.1%
EXCAVATING AND LOADING MACHINE AND DRAGLINE OPERATORS
$17.97
$12.13
28,900
N/A
N/A
18.6%


FIRST-LINE SUPERVISORS OF AGRICULTURAL CROP AND HORTICULTURAL WORKERS
N/A
N/A
4%
FIRST-LINE SUPERVISORS/MANAGERS OF LANDSCAPING, LAWN SERVICE, AND GROUNDSKEEPING WORKERS
$20.22
$12.86
60,100
N/A
N/A
18.6%
FOOD SCIENCE TECHNICIANS
$16.13
$10.13
8,700
N/A
N/A
13.9%
HAZARDOUS MATERIALS REMOVAL WORKERS
$18.33
$12.14
32,000
18,900
N/A
N/A
20.1%
HELPERS—PIPELAYERS, PLUMBERS, PIPEFITTERS, AND STEAMFITTERS
$17.97
$12.13
41,700
N/A
N/A
18.6%
HELPERS—ROOFERS
$11.18
$8.28
4,600
N/A
N/A
20.1%
LABORERS AND FREIGHT, STOCK, AND MATERIAL MOVERS, HAND
$11.42
$8.27
1,787,000
980,200
16.9%
42.3%
18.6%
OPERATING ENGINEERS AND OTHER CONSTRUCTION EQUIPMENT OPERATORS
$19.96
$12.85
369,000
162,800
0.8%
21.8%
20.1%
PAVING, SURFACING, AND TAMPING EQUIPMENT OPERATORS
$16.96
$11.40
21,000
22,000
N/A
N/A
20.1%
PESTICIDE HANDLERS, SPRAYERS, AND APPLICATORS, VEGETATION
$9.68
$14.42
8,200
N/A
N/A
11.6%
PILE-DRIVER OPERATORS
$21.88
$12.85
1,0000
2,300
N/A
N/A
20.1%
PIPELAYERS
$17.26
$11.13
28,800
N/A
N/A
20.1%
PUMP OPERATORS, except wellhead pumpers
$12.41
$21.09
3,600
N/A
N/A
18.6%
SECRETARIES, except legal, medical, and executive
$9.64
$15.32
391,000
N/A
N/A
11%
SEGMENTAL PAVERS
$10.33
$15.55
900
N/A
N/A
20.1%
SEPTIC TANK SERVICERS AND SEWER PIPE CLEANERS
$10.29
$16.22
11,000
11,900
N/A
N/A
20.1%

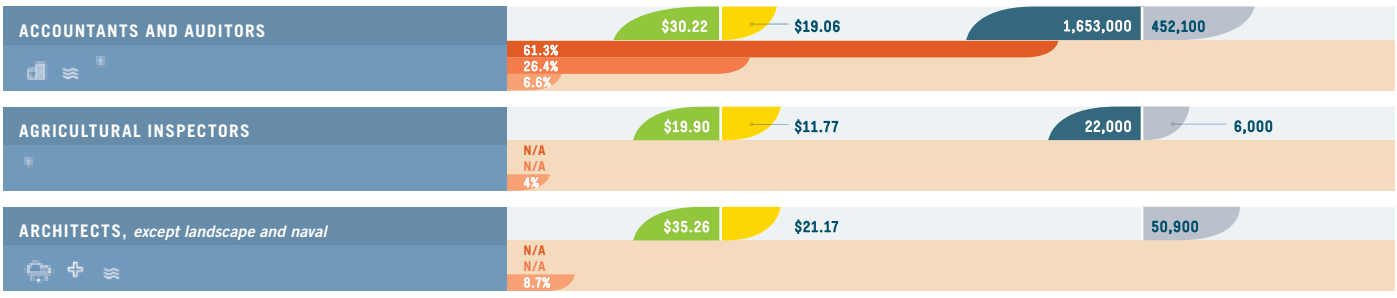

TREE TRIMMERS AND PRUNERS
$9.56
$15.06
18,000
N/A
N/A
11%
TRUCK DRIVERS, heavy and tractor-trailer
$17.26
$11.13
649,400
N/A
N/A
20.1%
WATER AND LIQUID WASTE TREATMENT PLANT AND SYSTEM OPERATORS
$20.09
$12.21
41,500
N/A
N/A
15%

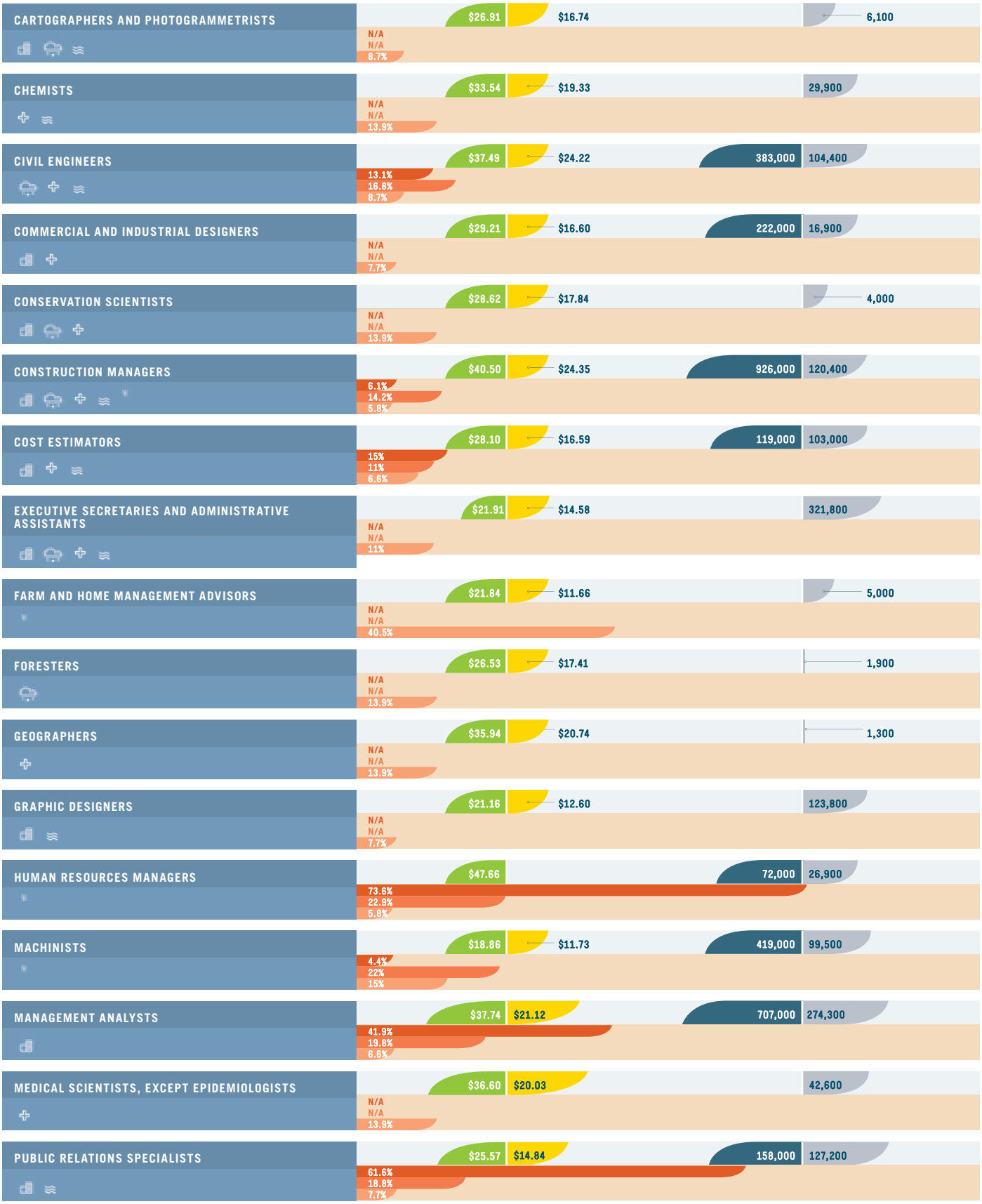
(Zone 3)


BROWNFIELD REDEVELOPMENT SPECIALISTS AND SITE MANAGERS
N/A
N/A
5.8%
BUSINESS OPERATIONS SPECIALISTS, All Other
$30.09
$16.48
281,000
327,200
66.9%
25.4%
6.6%
CAPTAINS, MATES, AND PILOTS OF WATER VESSELS
$30.73
$14.82
20,700
N/A
N/A
18.6%
CEMENT MASONS AND CONCRETE FINISHERS
$17.11
$11.15
72,900
N/A
N/A
20.1%
CONSTRUCTION AND BUILDING INSPECTORS
$25.57
$15.42
75,000
48,600
4.7%
16.8%
20.1%
ELECTRICIANS
$23.71
$14.61
682,000
289,200
1.5%
22.5%
20.1%
ENVIRONMENTAL RESTORATION PLANNERS
N/A
N/A
13.9%
ENVIRONMENTAL SCIENCE AND PROTECTION TECHNICIANS, including health
$20.32
$12.85
19,500
N/A
N/A
13.9%
FARM EQUIPMENT MECHANICS
$16.46
$10.67
12,900
N/A
N/A
18%
FARMERS, RANCHERS, and other agricultural managers
$31.09
$15.38
978,000
234,500
23%
5.8%
5.8%
FIRST-LINE SUPERVISORS/MANAGERS OF CONSTRUCTION TRADES AND EXTRACTION WORKERS
$28.44
$17.72
259,700
N/A
N/A
20.1%
FIRST-LINE SUPERVISORS/MANAGERS OF OFFICE AND ADMINISTRATIVE SUPPORT WORKERS
$23.47
$14.56
584,400
N/A
N/A
11%


GENERAL AND OPERATIONS MANAGERS
$45.74
$22.87
978,000
410,100
30.4%
16.9%
5.8%
HOME APPLIANCE REPAIRERS
$17.04
$9.63
43,000
11,900
N/A
N/A
18%
MAINTENANCE AND REPAIR WORKERS, general
$16.84
$10.01
422,000
379,100
3.2%
31.5%
18%
MILLING AND PLANING MACHINE SETTERS, OPERATORS, AND TENDERS, METAL AND PLASTIC
$17.37
$10.72
4,000
4,700
N/A
N/A
15%
OCCUPATIONAL HEALTH AND SAFETY TECHNICIANS
$22.13
$13.23
5,100
N/A
N/A
14.7%
PLUMBERS, PIPEFITTERS, AND STEAMFITTERS
$22.96
$13.61
228,800
N/A
N/A
20.1%
PRECISION AGRICULTURE TECHNICIANS
N/A
N/A
13.9%
RECREATION WORKERS
$10.64
$8.07
118,600
N/A
N/A
7.6%
REINFORCING IRON AND REBAR WORKERS
$18.27
$11.87
7,000
13,200
N/A
N/A
20.1%
ROOFERS
$16.96
$10.79
222,000
52,500
1.1%
53%
20.1%
SURVEYING AND MAPPING TECHNICIANS
$18.92
$11.74
62,600
20,000
12.2%
13.6%
8.7%
TANK CAR, TRUCK, AND SHIP LOADERS
$19.16
$11.21
3,000
3,300
N/A
N/A
18.6%
WELDERS, CUTTERS, SOLDERERS, AND BRAZERS
$17.27
$11.78
140,700
N/A
N/A
15%

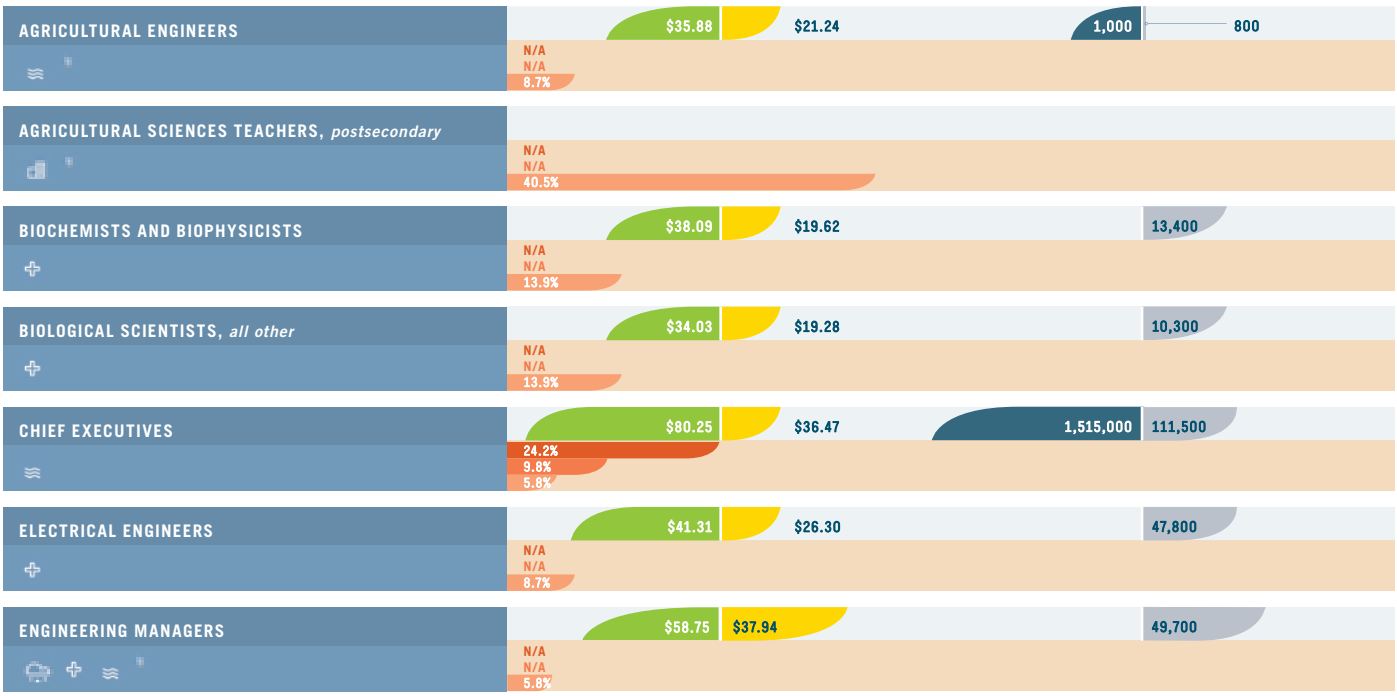
(Zone 4)


ACCOUNTANTS AND AUDITORS
$30.22
$19.06
1,653,000
452,100
61.3%
26.4%
6.6%
AGRICULTURAL INSPECTORS
$19.90
$11.77
22,000
6,000
N/A
N/A
4%
ARCHITECTS, except landscape and naval
$35.26
$21.17
50,900
N/A
N/A
8.7%


CARTOGRAPHERS AND PHOTOGRAMMETRISTS
$26.91
$16.74
6,100
N/A
N/A
8.7%
CHEMISTS
$33.54
$19.33
29,900
N/A
N/A
13.9%
CIVIL ENGINEERS
$37.49
$24.22
383,000
104,400
13.1%
16.8%
8.7%
COMMERCIAL AND INDUSTRIAL DESIGNERS
$29.21
$16.60
222,000
16,900
N/A
N/A
7.7%
CONSERVATION SCIENTISTS
$28.62
$17.84
4,000
N/A
N/A
13.9%
CONSTRUCTION MANAGERS
$40.50
$24.35
926,000
120,400
6.1%
14.2%
5.8%
COST ESTIMATORS
$28.10
$16.59
119,000
103,000
15%
11%
6.6%
EXECUTIVE SECRETARIES AND ADMINISTRATIVE ASSISTANTS
$21.91
$14.58
321,800
N/A
N/A
11%
FARM AND HOME MANAGEMENT ADVISORS
$21.84
$11.66
5,000
N/A
N/A
40.5%
FORESTERS
$26.53
$17.41
1,900
N/A
N/A
13.9%
GEOGRAPHERS
$35.94
$20.74
1,300
N/A
N/A
13.9%
GRAPHIC DESIGNERS
$21.16
$12.60
123,800
N/A
N/A
7.7%
HUMAN RESOURCES MANAGERS
$47.66
72,000
26,900
73.6%
22.9%
5.8%
MACHINISTS
$18.86
$11.73
419,000
99,500
4.4%
22%
15%
MANAGEMENT ANALYSTS
$37.74
$21.12
707,000
274,300
41.9%
19.8%
6.6%
MEDICAL SCIENTISTS, EXCEPT EPIDEMIOLOGISTS
$36.60
$20.03
42,600
N/A
N/A
13.9%
PUBLIC RELATIONS SPECIALISTS
$25.57
$14.84
158,000
127,200
61.6%
18.8%
7.7%

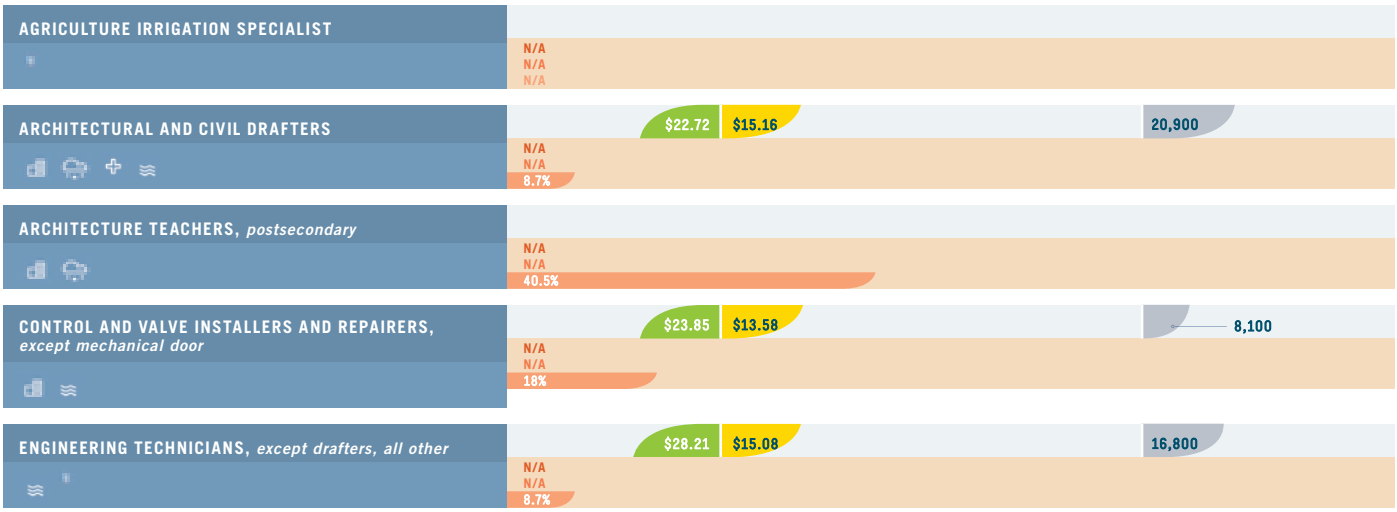

PURCHASING AGENTS AND BUYERS, farm products
$26.86
$15.53
3,200
N/A
N/A
6.6%
PURCHASING AGENTS, except wholesale, retail, and farm products
$27.68
$17.13
259,000
91,200
54%
17.5%
6.6%
SALES REPRESENTATIVES, WHOLESALE AND MANUFACTURING, TECHNICAL AND SCIENTIFIC PRODUCTS
$35.94
$18.52
159,700
N/A
N/A
3.4%
SOCIAL AND COMMUNITY SERVICE MANAGERS
$28.20
$16.83
329,000
64,800
71.3%
20.8%
5.8%
SOIL CONSERVATIONISTS
N/A
N/A
13.9%
SURVEYING TECHNICIANS
N/A
N/A
8.7%
SURVEYORS
$26.73
$15.01
24,200
N/A
N/A
8.7%
URBAN AND REGIONAL PLANNERS
$30.82
$19.73
26,000
16,800
N/A
N/A
13.9%
VOCATIONAL EDUCATION TEACHERS POSTSECONDARY
$23.46
$13.03
N/A
N/A
40.5%

(Zone 5)


AGRICULTURAL ENGINEERS
$35.88
$21.24
1,000
800
N/A
N/A
8.7%
AGRICULTURAL SCIENCES TEACHERS, postsecondary
N/A
N/A
40.5%
BIOCHEMISTS AND BIOPHYSICISTS
$38.09
$19.62
13,400
N/A
N/A
13.9%
BIOLOGICAL SCIENTISTS, all other
$34.03
$19.28
10,300
N/A
N/A
13.9%
CHIEF EXECUTIVES
$80.25
$36.47
1,515,000
111,500
24.2%
9.8%
5.8%
ELECTRICAL ENGINEERS
$41.31
$26.30
47,800
N/A
N/A
8.7%
ENGINEERING MANAGERS
$58.75
$37.94
49,700
N/A
N/A
5.8%


ENVIRONMENTAL ENGINEERS
$38.01
$23.54
45,000
22,600
N/A
N/A
8.7%
ENVIRONMENTAL SCIENCE AND PROTECTION TECHNICIANS, *including health*
$30.25
$18.31
43,200
N/A
N/A
13.9%
GEOLOGISTS
N/A
N/A
13.9%
HYDROLOGISTS
$36.39
$23.50
3,600
N/A
N/A
13.9%
INDUSTRIAL ECOLOGISTS
N/A
N/A
13.9%
LANDSCAPE ARCHITECTS
$30.40
$18.08
7,800
N/A
N/A
8.7%
MATERIALS ENGINEERS
$40.65
$25.05
32,000
8,100
N/A
0%
8.7%
NATURAL SCIENCES MANAGERS
$55.18
$30.86
16,000
33,500
N/A
N/A
5.8%
SOIL AND PLANT SCIENTISTS
$28.34
$17.28
8,600
N/A
N/A
13.9%
SOIL SCIENTISTS
N/A
N/A
13.9%
ZOOLOGISTS AND WILDLIFE BIOLOGISTS
$27.60
$17.46
5,900
N/A
N/A
13.9%

(Zone 6)


AGRICULTURE IRRIGATION SPECIALIST
N/A
N/A
N/A
ARCHITECTURAL AND CIVIL DRAFTERS
$22.72
$15.16
20,900
N/A
N/A
8.7%
ARCHITECTURE TEACHERS, *postsecondary*
N/A
N/A
40.5%
CONTROL AND VALVE INSTALLERS AND REPAIRERS, *except mechanical door*
$23.85
$13.58
8,100
N/A
N/A
18%
ENGINEERING TECHNICIANS, *except drafters, all other*
$28.21
$15.08
16,800
N/A
N/A
8.7%


FARM LABOR CONTRACTORS
$14.02
$8.55
100
N/A
N/A
4%
FARMWORKERS AND LABORERS, CROP, NURSERY, AND GREENHOUSE
$8.99
$8.19
N/A
N/A
4%
FIRST-LINE SUPERVISORS OF ANIMAL HUSBANDRY AND ANIMAL CARE WORKERS
N/A
N/A
4%
FIRST-LINE SUPERVISORS/MANAGERS OF FARMING, FISHING, AND FORESTRY WORKERS
$20.48
$11.67
13,600
N/A
N/A
4%
FOREST AND CONSERVATION TECHNICIANS
$16.78
$11.99
15,400
N/A
N/A
13.9%
IRRIGATION DESIGNER
N/A
N/A
N/A
OFFICE AND ADMINISTRATIVE SUPPORT WORKERS, all other
$14.96
513,000
98,500
74.8%
30.8%
11%
TEAM ASSEMBLERS
$13.22
$8.67
241,000
N/A
N/A
15%
TRAINING AND DEVELOPMENT MANAGERS
$44.10
$25.24
38,000
11,600
N/A
N/A
5.8%
TRAINING AND DEVELOPMENT SPECIALISTS
$26.51
$15.27
130,000
98,300
57.2%
26.5%
6.6%

APPENDIX D: PROGRAMS REVIEWED IN CASE STUDIES ON LINKING DISADVANTAGED COMMUNITIES TO SUSTAINABLE WATER JOBS

NAME OF ORGANIZATION	NAME OF PROGRAM(S)	RELEVANT SERVICES OFFERED	GEOGRAPHIC FOCUS	WATER FOCUS	POPULATION TARGETED
State University of New York College of Environmental Science And Forestry	*Green Train Landscaping & Urban Ecology: Workforce Training Program*	*Offers courses and certifications*	*Syracuse, NY*	*Stormwater*	*Un/underemployed residents in the Syracuse area*
Sustainable South Bronx	*Bronx Environmental Stewardship Training Academy*	*Courses and certifications*	*NYC*	*Environmental remediation and restoration; Stormwater*	*Low-income NYC residents*
Limitless Vistas, Inc.		*Training*	*Louisiana*	*W&WW, Brownfield development, urban farming, wetland restoration*	*Disconnected youth*
Generation Water	*Generation Water Program*	*Entry-level opportunities, workforce development, educational programs, classroom training and on-the-job paid experience*	*Los Angeles*	*Conservation*	*Youth and young adults 18-24 years of age*
Verde	*Verde Landscape*	*Job training focused on landscape and stormwater management*	*Portland, OR*	*Environmental Restoration and stormwater management*	*Low-income residents*
Youthworks	*City of Santa Fe River Restoration Crew*	*Job training focused on environmental restoration*	*Santa Fe, NM*	*Environmental restoration*	*At risk youth*
Amigos de los Rios	*Green Jobs Corps*	*Job training focused on environmental restoration*	*Los Angeles, CA*	*Environmental Restoration*	*Youth from disadvantaged backgrounds*
Chesapeake Conservation Corps		*Service-learning opportunities and green job training for young people through environmental and energy conservation projects*	*Maryland*	*conservation and efficiency, restoration, other*	*Young adults ages 18-25*
Green Team Program	*Groundwork Portland*	*Training program on environmental and social justice issues, brown fields, redevelopment, job skills, environmental career, watershed restoration and stewardship*	*Portland, OR*	*Environmental restoration*	*Youth from disadvantaged backgrounds*

For individual case studies on six organizations working with disadvantaged communities to access sustainable water job opportunities, see www.pacinst.org/reports/sustainable_water_jobs.

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