



# Breaking the Barriers: Advancing Rainwater Harvesting Adoption in the United States

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## Executive Summary

Rainwater harvesting (RWH) offers a practical and sustainable response to multiple water challenges facing the United States, including water scarcity, stormwater management, and climate resilience. By capturing precipitation where it falls and putting it to beneficial use, rainwater harvesting can reduce pressure on centralized water infrastructure while simultaneously decreasing urban flooding and improving watershed health.

Despite these benefits, rainwater harvesting remains underutilized across much of the country. Adoption is slowed by fragmented regulations, limited technical data, uneven professional training, and persistent public misconceptions about the safety and value of harvested rainwater.

Rainwater harvesting transforms precipitation from a stormwater liability into a distributed water resource. When integrated into building design and urban infrastructure planning, these systems can supplement non-potable water supplies, reduce runoff, and strengthen community water resilience.

This white paper identifies key barriers to broader adoption, outlines priority areas for research and innovation, and proposes strategic actions that policymakers, researchers, and practitioners can take to expand the role of rainwater harvesting within modern water infrastructure.

## Key Takeaways and Strategic Implications

### **Rainwater harvesting is an underutilized water resource.**

Despite its long history and demonstrated benefits, rainwater harvesting remains underused in the United States due to fragmented regulations, limited technical data, and low public awareness.

### **Policy alignment, research, and workforce development are needed to expand adoption.**

Harmonized codes, national performance data, and expanded professional training can significantly reduce barriers to implementation.

## **Rainwater harvesting supports climate resilience and decentralized water infrastructure.**

By capturing precipitation at the point where it falls, rainwater harvesting can reduce stormwater runoff, supplement non-potable water supplies, and strengthen community water resilience.

### **1. Introduction**

Rainwater harvesting (RWH) is the practice of collecting, storing, and using precipitation that falls on rooftops or other constructed surfaces before it enters stormwater systems or infiltrates into the ground. Rainwater harvesting systems typically consist of storage cisterns, conveyance piping, filtration systems, pumps, and associated plumbing components designed to capture and distribute collected rainwater for beneficial use. These systems are also referred to as rainwater catchment systems or rainwater collection systems (ARCSEA/ASPE/ANSI Standards 63-2020 and 78-2023).

Rainwater harvesting has been used for centuries across many cultures, yet in the United States it remains underutilized compared to other water management strategies. As communities face increasing drought, aging infrastructure, urban flooding, and climate variability, interest in decentralized and distributed water systems is growing.

Rainwater harvesting represents one of the simplest and most accessible forms of distributed water infrastructure. When properly designed and integrated into building and site development, these systems can provide non-potable water supplies while reducing stormwater runoff and improving watershed performance.

However, significant barriers continue to limit widespread adoption across the United States. The challenges and opportunities associated with rainwater harvesting adoption can be understood through a three-layer framework that links barriers, enabling actions, and long-term system outcomes (Figure 1).

#### ***Figure 1. National Rainwater Harvesting Adoption Framework.***

Conceptual model illustrating the relationship between current adoption barriers, strategic policy and research actions, and the long-term transformation toward resilient and distributed water infrastructure.

#### **CURRENT BARRIERS**

##### **POLICY & REGULATION**

- Fragmented state regulations
- Unclear water rights
- Inconsistent plumbing codes

##### **TECHNICAL & PROFESSIONAL**

- Limited engineering guidance
- Lack of standardized performance data
- Low integration into building design

##### **ECONOMIC & MARKET**

- High upfront costs
- Few incentives or financing models
- Benefits not valued in cost analysis

## PUBLIC PERCEPTION

- Low awareness
- Seen as conservation rather than supply
- Misunderstood health concerns



## STRATEGIC ACTIONS

### POLICY ALIGNMENT

- Harmonize national codes and standards
- Clarify precipitation capture laws
- Integrate RWH into stormwater regulations
- Develop public works–specific guidance for rainwater harvesting integration
- Recognize rainwater harvesting as stormwater infrastructure with quantifiable credit
- Provide model maintenance and ownership frameworks for municipalities
- Expand training for municipal engineers and plan reviewers

### RESEARCH & DATA

- National performance monitoring
- Health and safety research
- Climate resilience modeling

### MARKET DEVELOPMENT

- Financial incentives
- Workforce training programs
- Design guidance for engineers & architects

### PUBLIC EDUCATION

- National awareness campaigns
- Demonstration projects
- Community resilience messaging



## FUTURE WATER SYSTEM

### RESILIENT COMMUNITIES

- Reduced stormwater flooding
- Local water supply diversification

### SUSTAINABLE INFRASTRUCTURE

- Reduced demand on centralized systems
- Lower infrastructure costs

### CLIMATE ADAPTATION

- Drought resilience
- Distributed water security

### WATER SYSTEM TRANSFORMATION

- Decentralized water infrastructure
- Integrated stormwater and rainwater systems

### *Sidebar: Rainwater Harvesting and Climate Resilience*

As climate variability increases, many communities across the United States are experiencing more intense rainfall events, longer drought periods, and growing pressure on aging water infrastructure. Rainwater harvesting provides a practical tool for climate adaptation by capturing precipitation at the point where it falls and storing it for later beneficial use.

These systems reduce stormwater runoff during heavy rainfall events while simultaneously providing supplemental water supplies during dry periods. By integrating rainwater harvesting into building design, urban planning, and stormwater management strategies, communities can strengthen local water security while reducing strain on centralized infrastructure.

## **2. Key Barriers to Adoption**

### **2.1 Regulatory and Policy Barriers**

Regulatory frameworks governing rainwater harvesting vary widely across states and municipalities. Some jurisdictions lack clear permitting guidelines or inspection protocols, while others maintain outdated water rights laws that historically treated precipitation as state-controlled resources.

This regulatory patchwork creates uncertainty for developers, engineers, and property owners. Inconsistent plumbing codes and varying interpretations of health and safety standards can also discourage adoption or increase project costs.

Greater policy alignment and model regulatory frameworks are needed to support safe and scalable implementation.

### **2.2 Technical and Infrastructure Barriers**

Although numerous successful rainwater harvesting systems exist, long-term performance data remains limited. Engineers and designers often lack access to comprehensive datasets documenting system performance across climates, building types, and use cases.

Expanded monitoring and standardized performance metrics would improve technical confidence and support broader adoption.

### **2.3 Financial and Market Barriers**

Upfront costs associated with rainwater harvesting systems can discourage adoption when financial incentives are limited. Traditional cost-benefit analyses often overlook broader economic benefits, including stormwater infrastructure savings, potable water reduction, and ecosystem services. Building owners and developers typically fund rainwater harvesting systems, while municipalities and utilities benefit from reduced runoff volumes, lower peak flows, deferred infrastructure expansion, and improved system resilience. Without mechanisms to capture and redistribute these shared benefits, adoption remains limited.

Incentive structures also remain inconsistent. Many jurisdictions lack meaningful financial incentives, stormwater fee credits, or financing mechanisms that reflect the infrastructure value of rainwater harvesting systems. Where incentives do exist, they are frequently framed around water conservation rather than water supply or stormwater performance, limiting their effectiveness.

## **2.4 Public Awareness Barriers**

Public understanding of rainwater harvesting remains inconsistent. Many communities view rainwater harvesting primarily as a conservation practice rather than a legitimate water supply resource.

Additionally, harvested rainwater is sometimes mistakenly perceived as a form of reused water requiring extensive treatment. In reality, rainwater collected directly from rooftops represents a high-quality source water that can safely serve many potable and non-potable uses when properly managed.

Improving public education and outreach can help shift perceptions and increase acceptance of rainwater harvesting systems.

## **2.5 Institutional and Professional Barriers**

Rainwater harvesting is not yet standard practice in many engineering and architectural workflows. Limited professional training and unfamiliarity with decentralized water systems often prevent integration during early project planning stages.

## **2.6 Public Works and Municipal Implementation Barriers**

Municipal public works and health departments play a central role in shaping the adoption of rainwater harvesting systems, as they are often responsible for stormwater management, infrastructure protection, and long-term system oversight.

Public works departments are typically oriented toward centralized infrastructure models and may view decentralized systems as operational risks. Rainwater harvesting systems are sometimes evaluated using potable water or traditional stormwater criteria that do not align with their intended non-potable or distributed function. This risk-averse approach can result in overly conservative design requirements, extended permitting timelines, or project denial.

Additionally, rainwater harvesting often falls between established regulatory categories. In many jurisdictions, it is unclear whether stored rainwater is regulated as plumbing infrastructure, stormwater infrastructure, or a private onsite system. This ambiguity can trigger conflicting requirements across departments and discourage project proponents.

Concerns regarding long-term maintenance and system ownership further complicate municipal acceptance. Public works agencies may be hesitant to approve systems if future responsibility for

inspection, maintenance, or liability is uncertain. Without clear frameworks defining private versus public responsibility, rainwater harvesting systems are frequently excluded from municipal projects or constrained to pilot applications.

### 3. Analysis of Critical Challenges

Rainwater harvesting adoption in the United States is limited not by technology but by systemic gaps between research, policy, and implementation.

Water governance occurs across federal, state, and local jurisdictions, often resulting in fragmented regulations. Existing infrastructure systems also prioritize centralized treatment and rapid stormwater removal rather than local capture and reuse. Additionally, national datasets documenting rainwater harvesting performance remain limited. Unlike centralized water infrastructure, decentralized systems are rarely monitored through coordinated reporting programs.

Addressing these challenges will require coordinated research, policy alignment, and expanded professional capacity. Below is an example of expanding local water resources through cascading use showing rainwater is the entry point to a larger distributed water system.

### 4. Distributed Water Infrastructure Context

Rainwater harvesting can serve as the entry point to broader distributed water systems.

#### **Distributed Water Infrastructure Ladder**

- Level 1 – Rainwater Harvesting
- Level 2 – Stormwater Harvesting
- Level 3 – Greywater Reuse
- Level 4 – Advanced Water Reuse

This ladder illustrates how rainwater harvesting functions as the first step in a broader decentralized water infrastructure system. Rainwater harvesting can serve as the first step in a broader transition toward decentralized water infrastructure systems that include stormwater capture, building reuse, and advanced water recycling (Figure 2).

#### ***Figure 2. Distributed Water Infrastructure Ladder.***

Illustration of how rainwater harvesting forms the foundational layer of distributed water systems, which can expand to include stormwater capture, greywater reuse, and advanced water recycling to build resilient local water supplies.

#### **LEVEL 1 – RAINWATER HARVESTING**

Capture precipitation directly from rooftops before it enters stormwater systems.

Uses:

- Potable water
- Irrigation
- Toilet flushing
- Cooling towers

- Laundry
- Highest water quality / simplest systems



**LEVEL 2 – STORMWATER HARVESTING**

Capture runoff from developed landscapes and built environments.

Uses:

- Landscape irrigation
- Urban agriculture
- groundwater recharge
- non-potable municipal uses

Requires filtration and sediment control



**LEVEL 3 – GREYWATER REUSE**

Reuse lightly used water from buildings such as sinks, showers, and laundry.

Uses:

- irrigation
- toilet flushing
- cooling water

Requires treatment and system management



**LEVEL 4 – ADVANCED WATER REUSE**

Treatment of wastewater for high-quality non-potable or potable reuse.

Uses:

- industrial processes
- groundwater recharge
- indirect potable reuse

Highest treatment complexity

Result: A resilient distributed Water System taking rainwater harvesting from a niche practice to the first step in a distributed water infrastructure system.

While the distributed water infrastructure ladder illustrates how alternative water sources can expand local supply options, another important concept involves matching water quality with appropriate uses. Many water applications within buildings and landscapes do not require potable-quality water. Aligning water quality with appropriate uses can significantly reduce demand on centralized drinking water systems.

**Figure 3. Water Supply Pyramid: Matching Water Quality to Water Use.**

Conceptual model illustrating how different water uses require different levels of treatment. Rainwater and other alternative water sources can supply many non-potable uses, reducing demand on potable water infrastructure.

**WATER SUPPLY PYRAMID**  
**Water Quality Matching Pyramid**



POTABLE WATER USES  
 Drinking  
 Cooking  
 Food preparation  
 Medical uses  
 Highest treatment  
 Smallest demand  
 Rainwater can supply these uses



BUILDING NON-POTABLE USES  
 Toilet flushing  
 Laundry  
 Cooling towers  
 Mechanical systems  
 Rainwater & treated greywater  
 can supply these uses



LANDSCAPE & URBAN ENVIRONMENT USES  
 Irrigation  
 Urban agriculture  
 Tree canopy watering  
 Street cleaning  
 Stormwater & rainwater sources  
 can supply these uses



ECOLOGICAL & RECHARGE FUNCTIONS  
 Aquifer recharge  
 Wetlands  
 Soil moisture systems  
 Green infrastructure  
 Lowest treatment / largest volume uses

## 5. Research and Innovation Agenda

Research Area	Key Questions
Performance Monitoring	How do systems perform across climates and building types?
Water Quality	What treatment strategies ensure safe reuse?
Economic Modeling	What long-term benefits result from adoption?
Policy Harmonization	What regulatory frameworks support national adoption?

Research Area	Key Questions
Climate Resilience	How can rainwater harvesting reduce flood risk and drought vulnerability?
Public Perception	What communication strategies increase adoption?

## 6. Recommendations for Policy and Practice

### Policy Alignment

- Harmonize plumbing codes and water reuse standards
- Clarify precipitation capture rights
- Integrate rainwater harvesting into stormwater regulations

### Market Development

- Establish financial incentives and rebate programs
- Expand workforce training and certification

### Research Infrastructure

- Develop national monitoring databases
- Support demonstration projects

## 7. Future Research Agenda

Future research should prioritize interdisciplinary collaboration to develop standardized monitoring systems, economic valuation models, and scalable policy frameworks that support widespread rainwater harvesting adoption.

Priority research areas include:

- national monitoring programs
- expanded water quality research
- economic valuation of decentralized systems
- policy alignment strategies
- behavioral research on adoption

## 8. Conclusion

Rainwater harvesting represents a powerful yet underutilized strategy for building resilient water systems. By capturing precipitation where it falls, communities can supplement water supplies, reduce stormwater runoff, and improve watershed health.

With coordinated research, supportive policies, and expanded professional training, rainwater harvesting can evolve from a niche sustainability practice into a foundational component of distributed water infrastructure.