WATERSHED ACTION TOOLKIT CATALOG

VENTURA RIVER INSTREAM FLOW ENHANCEMENT & WATER RESILIENCE FRAMEWORK

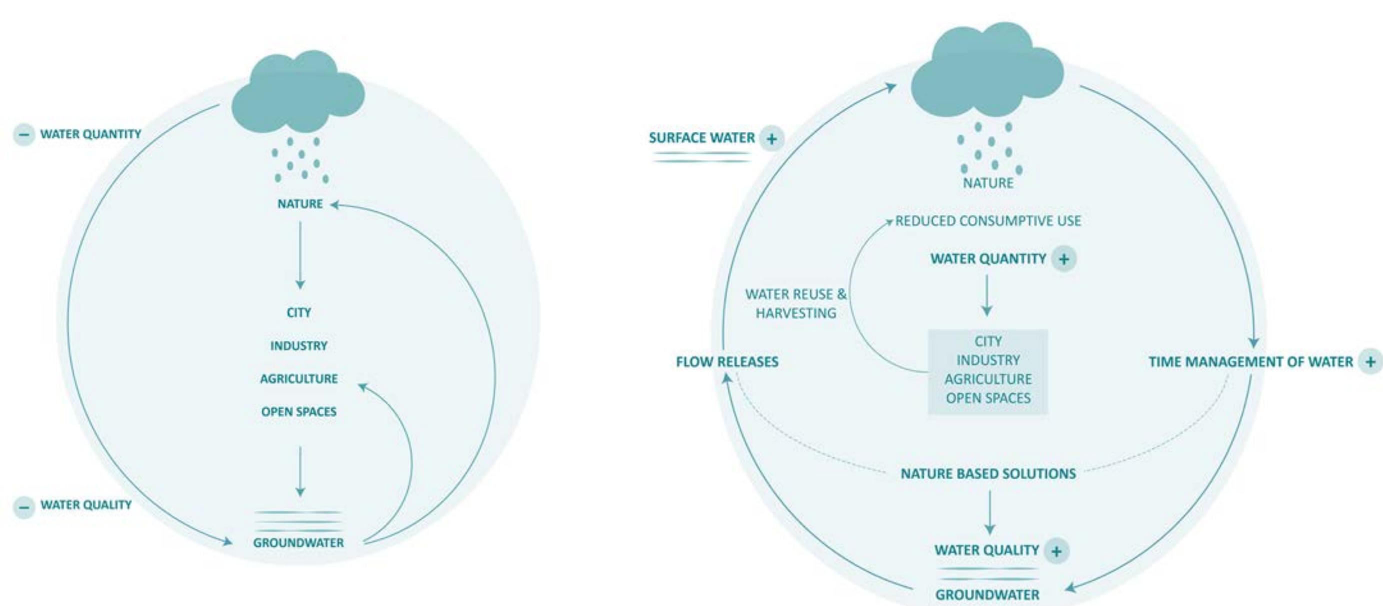
INTRODUCTION

VENTURA RIVER INSTREAM FLOW & WATER RESILIENCE FRAMEWORK

In 2019, Ventura River Watershed partners and collaborators came together to create a framework to enhance stream flow, defined by the Wildlife Conservation Board as "*a change in the amount, timing, and/or quality of water flowing down a stream, or a portion of a stream, to benefit fish and wildlife.*" This two year planning project, funded by WCB and administered and coordinated by the Ventura County Resource Conservation District, had over 32 stakeholders participate and over 24 planning projects from municipalities, water districts, groundwater agencies, commercial businesses, private and public schools, local and national organizations, as well as private landowners. A key deliverable is this document: The Ventura River Instream Flow & Water Resilience Framework. This Framework outlines actions to enhance stream flow while promoting water resilience for the health of the community and the Ventura watershed.

This framework and toolkit 'catalog' was created as an overview of actions which under current conditions may enhance stream flow through water quality or water quantity improvements. The implementation of the programmatic and physical tools listed in this document have multiple benefits for the Ventura River Watershed, contributing to enhanced stream flows and restored river habitats. The Watershed Action Toolkit Catalog was drafted by the VRIF Framework Committee, made up of stakeholders and community members.

This document aims to standardize, streamline, and improve transparency of environmental flow enhancement project types which intersect water and climate resilience. This framework will improve coordination and data sharing among management agencies, landowners and land stewards to promote diverse management goals and priorities.



EXTRACTIVE FRAMEWORK MODEL (DEHYDRATING, DEPENDENT)

RESILIENT FRAMEWORK MODEL (REHYDRATING, REGENERATIVE, COMMUNITY, REGIONAL, HABITAT)

Figure 1: (Left) An Extractive Framework Model is dehydrating and dependent, lowering both water quality and quantity within watersheds; (Right) A Resilient Framework Model is rehydrating and regenerative, increasing water quality and quantity while enhancing communities and habitat.

As illustrated by Figure 1, the VRIF Framework can easily add value to groundwater and surface water through harvesting, recovering, and restoring watershed cycles through cost effective solutions.

This framework works on small, aggregated actions that can help work with the water cycle to reach an intersection between water resilience and watershed health. Three founding principals are: 1) Everyone is a land, water, natural resource steward, 2) Most actions, including nature based solutions, are accessible to everyone, and 3) Problems are opportunity for abundance and multiple benefits.

The goal of the VRIF Framework is to reduce water resource competition while demonstrating a portfolio of streamflow enhancement voluntary actions to best steward the Ventura River Watershed water resources, that currently has the potential to impact the region's livelihood and remaining aquatic resources. The goal is met through the following objectives: 1) Work with landowners and land stewards identified in VRIF to demonstrate and voluntarily implement future forbearance and/or critical water quality projects to enhance stream flow, 2) Provide consistent metrics, communication and coordination for multiple voluntary streamflow enhancement projects to evaluate success as identified through the VRIF Framework.

The core values of this Framework were vetted in the first step of the process, and resulted in the same values as shared by the Ventura River Watershed Water Management Plan, and informed the principles and objectives. The VRIF Framework values are:

- Sufficient water supply
- Clean water
- Integrated flood management
- Healthy ecosystems
- Access to nature
- Responsible land and resource management
- Watershed coordination/collaboration

This framework was written to:

- Articulate goals and objectives
- Showcase projects/Watershed Action Toolkit Catalog
- Demonstrate opportunities and constraints analysis
- Evaluate and prioritize actions
- Provide instream flow and resilience recommendations
- Inform outreach, Ventura River Watershed Dashboard, Ventura River Watershed Instream Flow Inter-agency
- Guidance Document and template for land-stewards and other watershed frameworks

INTRODUCTION

VRIF: FRAMEWORK VALUES & A MODEL FOR WATERSHED RESILIENCE

This Watershed Action Toolkit Catalog is a key deliverable of The Ventura River Instream Flow & Water Resilience Framework. This document is a guide for different approaches that land stewards and land managers can use to create and enhance climate and water resiliency on their properties and throughout the watershed. The 25+ tools listed in this document are categorized by land-use type, however there is no prioritization as tools and approaches are situational (there is no one-size-fits-all approach to watershed resiliency).

This is an evergreen document that identifies a range of tools and approaches available to help enhance instream flow in the Ventura River Watershed. This document should serve as a model and template for other watershed frameworks. Many of the tools and approaches in this document can be used throughout the state of California and in other watersheds. The aim of this Watershed Action Toolkit Catalog is to provide a larger framework within which to understand the spatial and temporal impact of these tools on hydrological functions and systems.

As projects move forward to implementation, this document can be updated to reflect additional framework needs, new approaches and intersections of collaborators.

STREAMFLOW TOOLKIT BY LAND USE
VENTURA RIVER INSTREAM FLOW ENHANCEMENT & WATER RESILIENCE FRAMEWORK

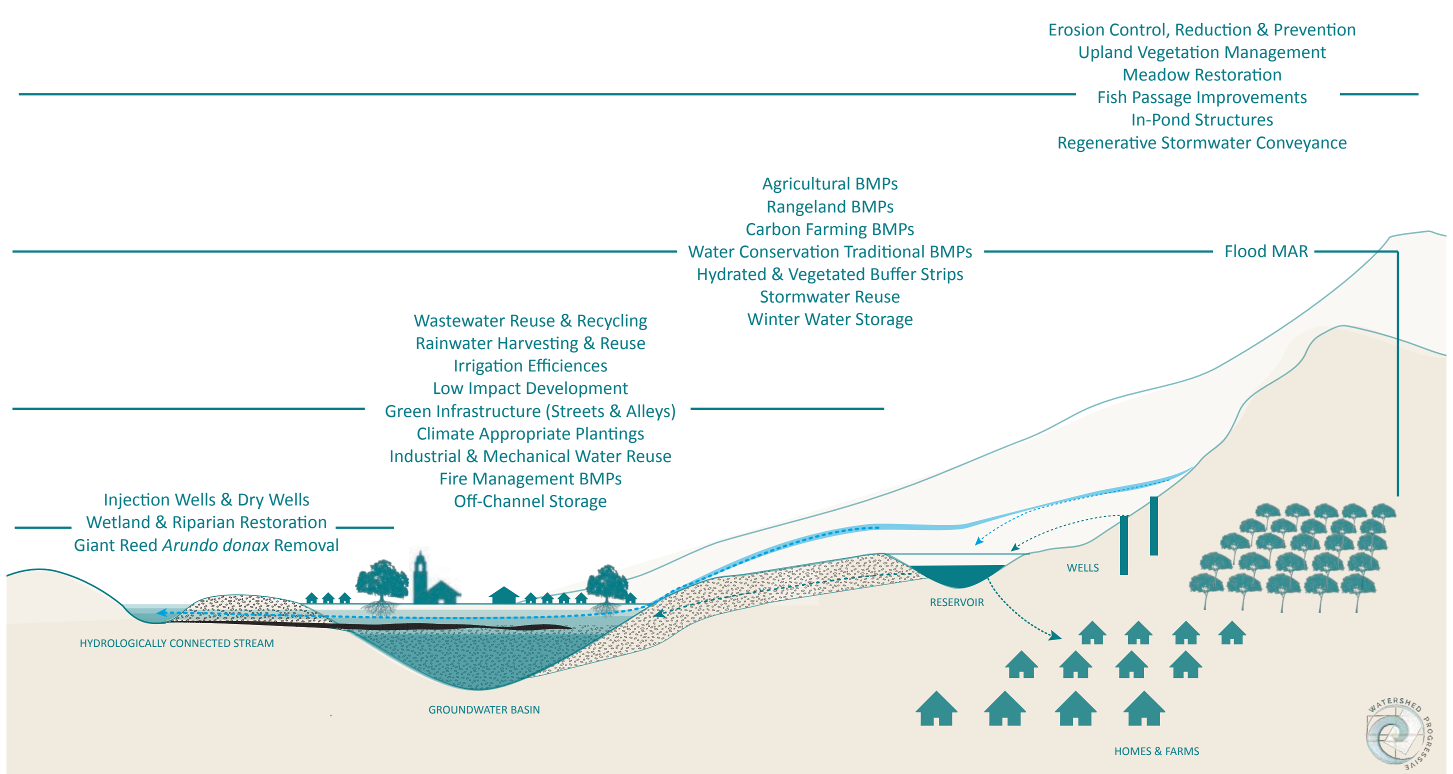


Figure 2: Streamflow toolkit by land-use shows what project types can be used throughout landscapes at a watershed scale to benefit and enhance stream flow for the Ventura River Instream Flow Enhancement and Water Resilience Framework.

VOLUNTARY ACTIONS

The Ventura County Resource Conservation District's Ventura River Instream Flow Planning Project (VRIF) Project Proponents are landowners with water rights who wish to engage in voluntary water conservation projects to enhance stream flow.

VRIF has led a highly-coordinated conservation planning effort ("the Framework") and produced this "Toolkit Catalog" of project-types, each of which reduces demand or increases water supply. This catalog identifies a range of 25+ programmatic tools and physical treatments which are a project-level build out or blueprint of a "Production Forbearance Program." Ongoing efforts have protected landowner confidentiality and data, while informing actionable steps for individuals to take to enhance stream flow.

VRIF has generated detailed plans for individual Project Proponents to take actions that add up to hundreds and potentially thousands of acre-feet annually. VRIF landowners have an overlapping and common interest to ensure that their conservation actions receive a form of "conservation credit" that can be accounted for within the Framework of variable supply and steady demand for local water. VRIF advocates for a pathway for watershed landowners to coordinate any number of voluntary water conservation actions specific to water rights established by diversion or pumping, that directly or indirectly enhance stream flow.

INTRODUCTION

VENTURA RIVER INSTREAM FLOW & WATER RESILIENCE FRAMEWORK

The following briefly highlights intersections of integrated resource management strategies, goals, and objectives within various existing regional planning efforts and that of the Ventura River Instream Flow & Water Resilience Framework.

Integrated Regional Water Management (IRWM)

- Agricultural water use efficiency
- Urban water use efficiency
- Flood risk management
- Regional/local conveyance
- System re-operation
- Water transfers
- Conjunctive management and groundwater
- Municipal recycled water
- Regional/local surface storage
- Drinking water treatment
- Groundwater and aquifer remediation
- Water quality
- Pollution prevention
- Urban stormwater runoff

United States Forest Service, Land Management Plan or "Forest Plan" (USFS)

- Reduce wildland fire risk
- Reduce invasive species impact
- Provide outdoor recreation opportunities
- Help meet energy resource needs
- Improve watershed conditions
- Data collection and monitoring
- Maintain environmental, social, and economic benefits of forests and grasslands

Casitas Municipal Water District, Urban Management Plan (UWMP)

- Agricultural, residential, and commercial water supply and risk management
- Conservation and drought resilience
- Climate change considerations
- Outreach and education

Ojai Basin Groundwater Management Agency, Management Plan (OBGMA)

- Understanding of basin hydrology – monitoring, data collection, modeling
- Protection and management of the basin – water exports, conjunctive use management and policy, establishing thresholds, water quality, well performance, subsidence, peak levels, soft allocation and springtime storage, and invasive species eradication
- Encourage supporting activities – water conservation, contour farming practice group, abandoned well inspection, artificial recharge
- Outreach and education

Upper Ventura River Groundwater Agency, Groundwater Sustainability Plan (GSP)

- Manage and monitor beneficial uses of groundwater extracted from Basin including municipal, residential, and agricultural supply
- Groundwater levels, storage, and quality
- Streamflow enhancement
- Manage, protect, and monitor critical riparian and aquatic habitat (i.e., steelhead)

Ventura River Watershed Council, Watershed Management Plan (VRWC)

- Sufficient Local Water Supplies- to allow continued independence from imported water and reliably support ecosystem and human (including urban and agricultural) needs in the watershed now and in the future, through wise water management.
- Clean Water- water of sufficient quality to meet regulatory requirements and safeguard public and ecosystem health.
- Integrated Flood Management- an integrated approach to flood management that improves flood protection, restores natural river processes, enhances floodplain ecosystems, increases water infiltration and storage, and balances sediment input and transport.
- Healthy Ecosystems- healthy aquatic and terrestrial ecosystem structures, functions, and processes that support a diversity of native habitats.
- Access to Nature- ample and appropriate opportunities for the public to enjoy the watershed's natural areas and open spaces associated with aquatic habitats, to provide educational opportunities, and to gain appreciation of the need to protect the watershed and its ecosystems.
- Responsible Land and Resource Management- land and resources managed in a manner that supports social and economic goals and is compatible with healthy ecosystem goals.
- Coordinated Watershed Planning- collaborates on developing an integrated watershed management plan to guide watershed priorities; facilitates communication between public, private, and nonprofit stakeholders; educates and engages stakeholders; provides a forum for collecting, sharing, and analyzing information about, and creatively and proactively responding to, watershed issues; and maximizes grant funding opportunities.

Cal Fire Resource Management Program (CalFire)

- Urban and community forestry
- Forest pest management
- Landowner assistance
- Environmental protection program
- Wildfire resilience
- Vegetation management
- Prescribed fire and fuels reduction
- Climate and energy
- Carbon sequestration
- Urban forestry
- Mapping, GIS, and data collection

Ventura County, Floodplain Management Ordinance (VC)

- Promote the public health, safety, and general welfare, and minimize public and private losses due to flood

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VENTURA RIVER INSTREAM FLOW ENHANCEMENT & WATER RESILIENCE FRAMEWORK
GOALS & OBJECTIVES

GOALS

VRIF Framework Goals & Organizational Objectives

	Sufficient Water Supply	Clean Water	Integrated Flood Management	Healthy Ecosystems	Access to Nature	Responsible Land & Resource Management	Watershed Coordination/ Collaboration	Related Framework Component *(see VRIF Framework Flowchart)*
Accountability for Watershed Instream Flow Actions				x		x	x	4, 5, 6
Adaptability to environment change	x			x		x	x	all
Clear, ransparent Pathways							x	2, 4, 5, 6
Conjunctive Use Timing	x	x	x	x		x	x	2, 5, 6
Counting additional actions community and watershed health benefits	x	x		x	x	x	x	all
Ease for building multiple agency relationships for Watershed Instream Flow Actions				x	x		x	all
Identification and Approach for Innovative Collaborations on project identification, monitoring and success sharing						x	x	all
Innovative Tool Sharing	x	x	x	x	x	x	x	2, 6
Support or Enhance GSA Actions for Sustainable Groundwater Management	x			x		x	x	2, 3, 5, 6
Multi-benefit identification for instream flow projects	x	x	x	x	x	x	x	4
Project Refinement, Collaborative Learning							x	2, 3, 5
Reduced risk of stranded assets	x	x	x				x	3, 4
Regulatory flexibility	x	x	x	x	x	x	x	3, 5, 6
Reliability of supply	x						x	2, 4, 5, 6
Resource sustainability/foundational stability							x	
Roadmap for collaboration for VRW instream flow mgmt.	x			x		x	x	4, 5, 6
Stakeholder based prioritization							x	2, 4, 6
Water Transactional standards	x			x			x	3, 4, 5
Water/Watershed budget	x	x	x	x		x	x	5
Water/Watershed Innovative stakeholder outreach						x	x	2, 4, 6
Water/Watershed queries/forecasting	x	x	x	x	x	x	x	5
Water/Watershed Project Interactive Database	x	x	x	x	x	x	x	52, 5, 6
Monitoring and Documentation of Project Benefits								
Reduce nutrient loading to streamflow and any groundwater connected to streamflow								

VENTURA RIVER INSTREAM FLOW ENHANCEMENT & WATER RESILIENCE FRAMEWORK
HEALTHY, RESILIENT COMMUNITIES

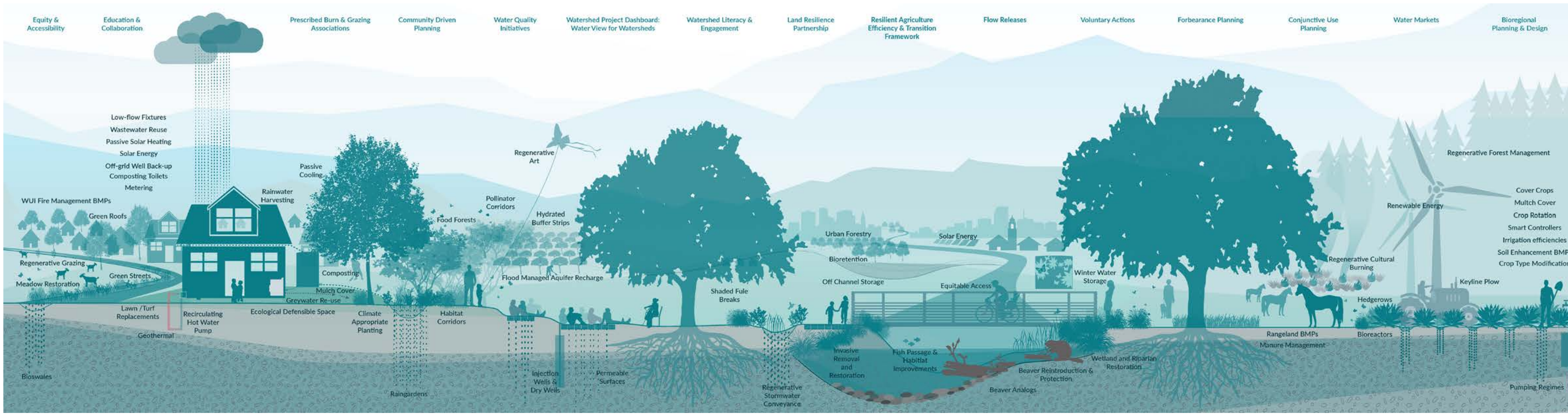

Figure 3: Integrated actions of the watershed action toolkit contribute to healhy, resilient communities.

FRAMEWORK PROCESS DIAGRAM
VENTURA RIVER INSTREAM FLOW ENHANCEMENT & WATER RESILIENCE FRAMEWORK

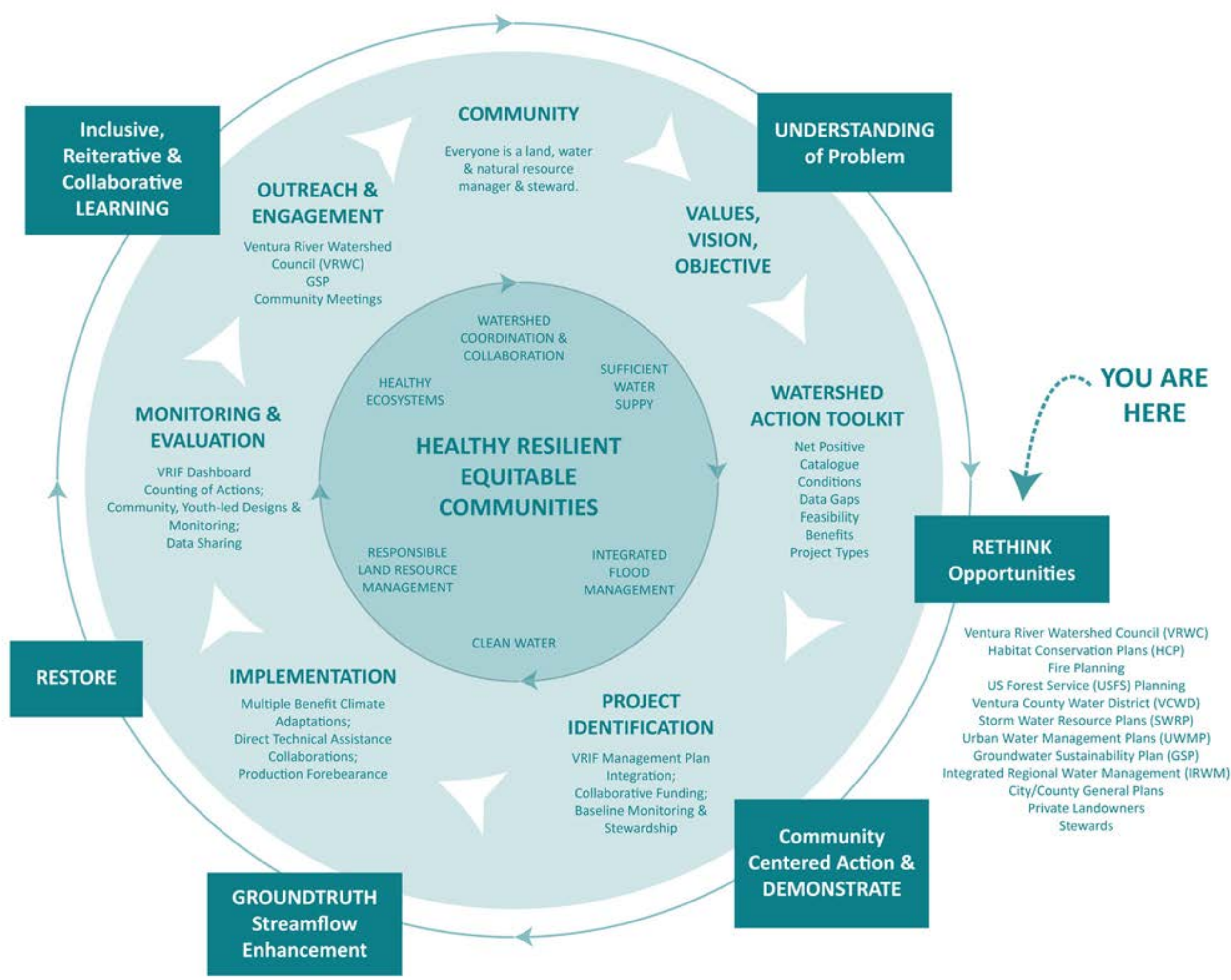

Figure 4: The stages of watershed resiliency for the Ventura River Watershed include understanding of a problem, rethinking opportunities, community centered action and demonstration, groundtruthing for streamflow enhancement, restoration, and inclusive, reiterative and collaborative learning.

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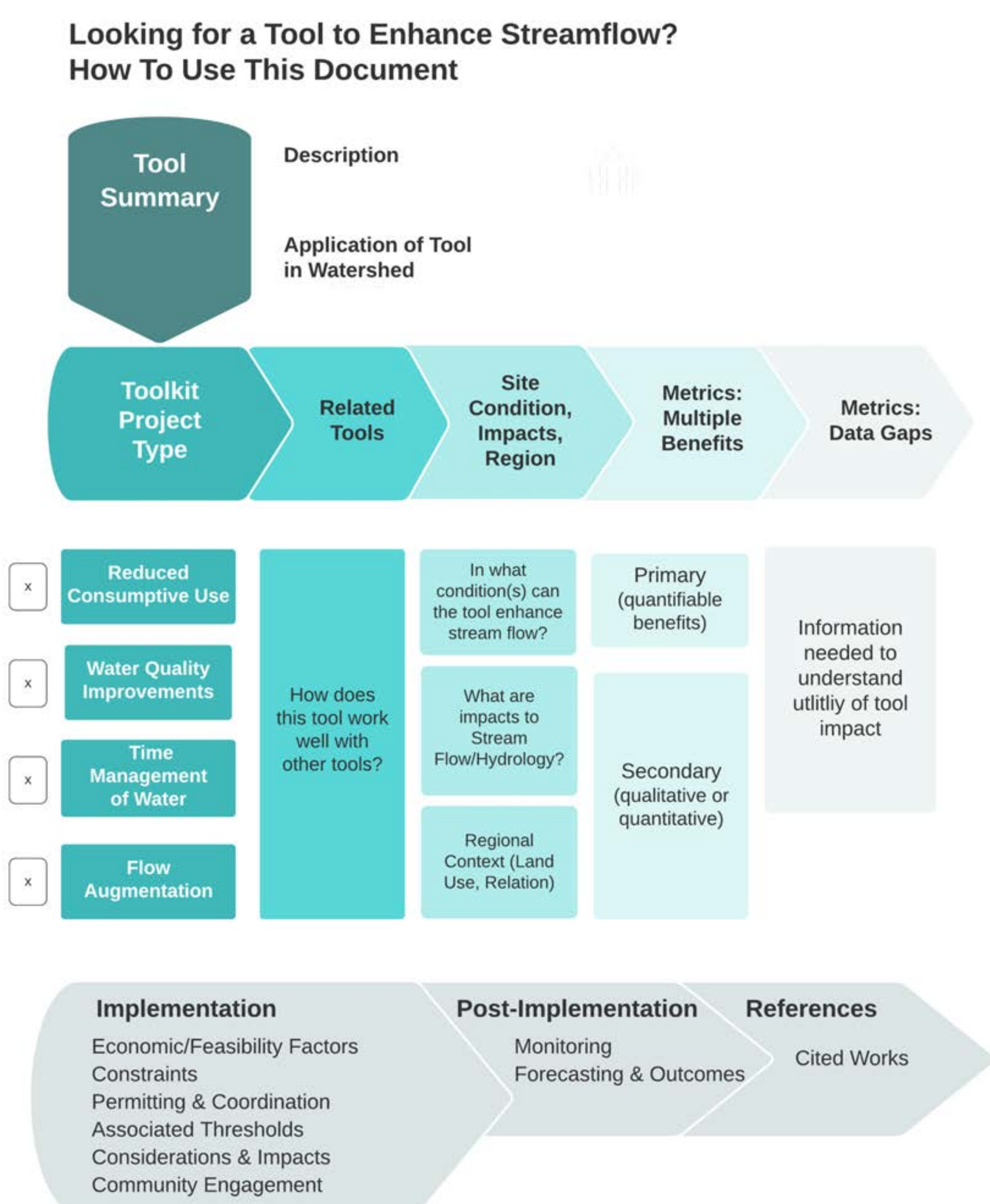
WHY USE THIS DOCUMENT?

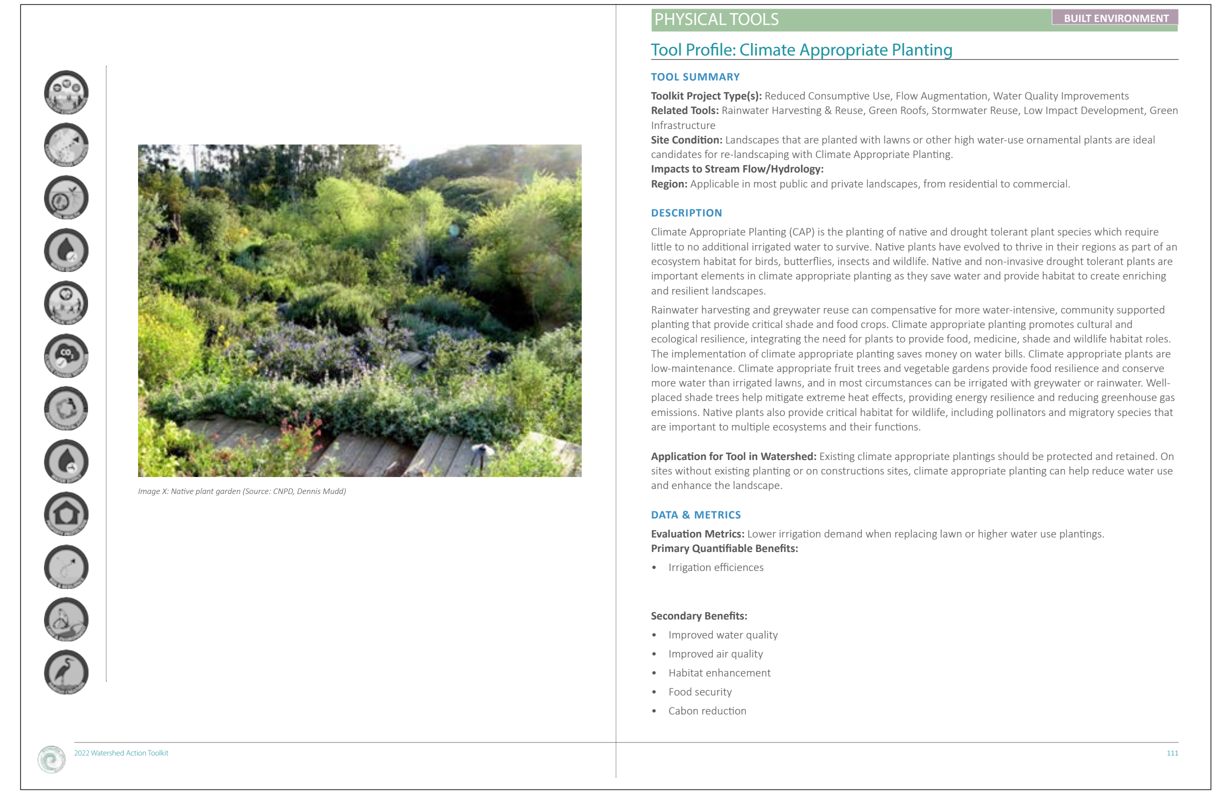
OVERVIEW

Streamflow enhancement tools are already used in many different projects throughout the Ventura River Watershed. With careful planning and implementation, many of these multiple value- and benefit-tools can also lead to streamflow enhancement whether singularly, or in aggregate at the neighborhood or community scale. To better understand what tools are applicable to enhance streamflow in the Ventura River Watershed, this Watershed Action Toolkit Catalog was drafted by the VRIF Framework Committee. (*Reference Acronyms Glossary at the end of this Introduction*.)

To best understand how these tools work together in the template, please note the figure below on how to use the template, as well as the following "How to Read this Document" section.



HOW TO READ THIS DOCUMENT



PHYSICAL TOOLS — BUILT ENVIRONMENT

Tool Profile: Climate Appropriate Planting

TOOL SUMMARY

Toolkit Project Type(s): Reduced Consumptive Use, Flow Augmentation, Water Quality Improvements
Related Tools: Rainwater Harvesting & Reuse, Green Roofs, Stormwater Reuse, Low Impact Development, Green Infrastructure
Site Condition: Landscapes that are planted with lawns or other high water-use ornamental plants are ideal candidates for re-landscaping with Climate Appropriate Planting.
Impacts to Stream Flow/Hydrology:
Region: Applicable in most public and private landscapes, from residential to commercial.

DESCRIPTION

Climate Appropriate Planting (CAP) is the planting of native and drought tolerant plant species which require little to no additional irrigated water to survive. Native plants have evolved to thrive in their regions as part of an ecosystem habitat for birds, butterflies, insects and wildlife. Native and non-invasive drought tolerant plants are important elements in climate appropriate planting as they save water and provide habitat to create enriching and resilient landscapes.

Rainwater harvesting and greywater reuse can compensative for more water-intensive, community supported planting that provide critical shade and food crops. Climate appropriate planting promotes cultural and ecological resilience, integrating the need for plants to provide food, medicine, shade and wildlife habitat roles. The implementation of climate appropriate planting saves money on water bills. Climate appropriate plants are low-maintenance. Climate appropriate fruit trees and vegetable gardens provide food resilience and conserve more water than irrigated lawns, and in most circumstances can be irrigated with greywater or rainwater. Well-placed shade trees help mitigate extreme heat effects, providing energy resilience and reducing greenhouse gas emissions. Native plants also provide critical habitat for wildlife, including pollinators and migratory species that are important to multiple ecosystems and their functions.

Application for Tool in Watershed: Existing climate appropriate plantings should be protected and retained. On sites without existing planting or on constructions sites, climate appropriate planting can help reduce water use and enhance the landscape.

DATA & METRICS

Evaluation Metrics: Lower irrigation demand when replacing lawn or higher water use plantings.
Primary Quantifiable Benefits:

- Irrigation efficiences

Secondary Benefits:

- Improved water quality
- Improved air quality
- Habitat enhancement
- Food security
- Cabon reduction

Image X: Native plant garden (Source: CNPD, Dennis Mudd)

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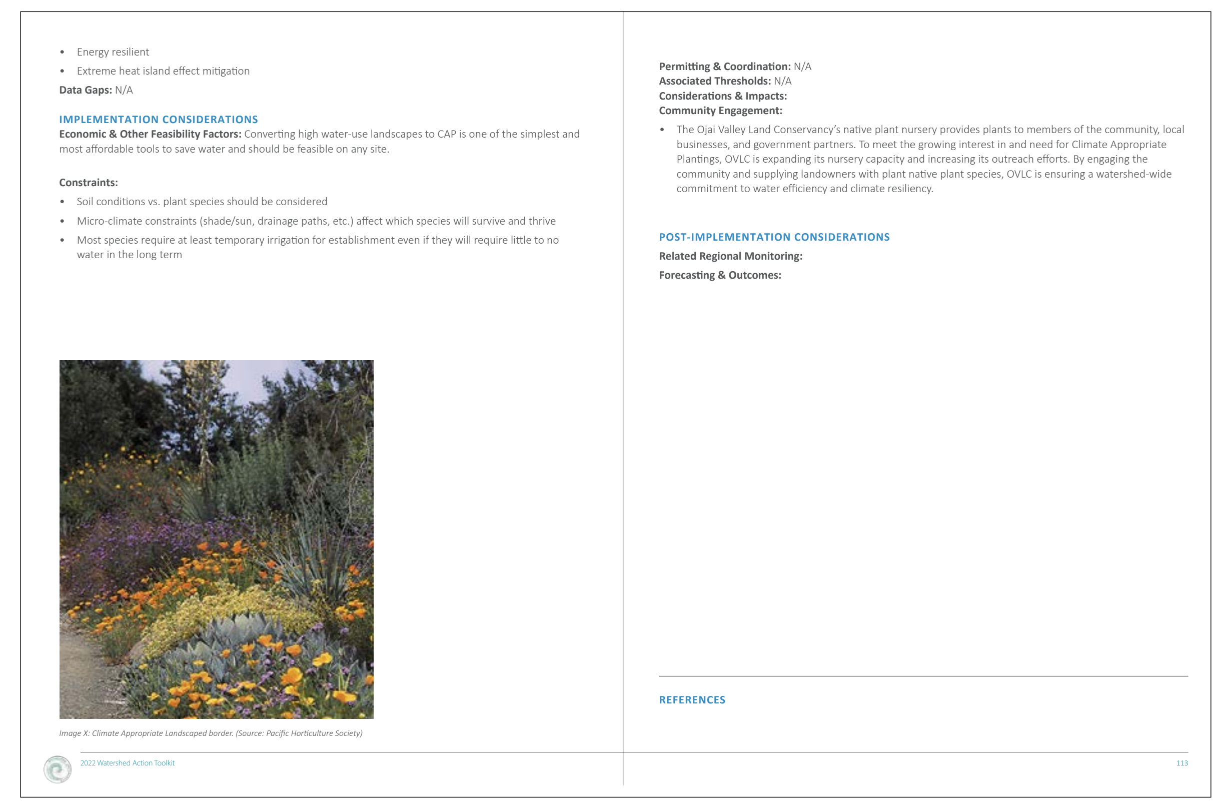

- Energy resilient
- Extreme heat island effect mitigation

Data Gaps: N/A

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors: Converting high water-use landscapes to CAP is one of the simplest and most affordable tools to save water and should be feasible on any site.

Constraints:

- Soil conditions vs. plant species should be considered
- Micro-climate constraints (shade/sun, drainage paths, etc.) affect which species will survive and thrive
- Most species require at least temporary irrigation for establishment even if they will require little to no water in the long term

Image X: Climate Appropriate Landscaped border. (Source: Pacific Horticulture Society)

Permitting & Coordination: N/A
Associated Thresholds: N/A
Considerations & Impacts:
Community Engagement:

- The Ojai Valley Land Conservancy's native plant nursery provides plants to members of the community, local businesses, and government partners. To meet the growing interest in and need for Climate Appropriate Plantings, OVLC is expanding its nursery capacity and increasing its outreach efforts. By engaging the community and supplying landowners with plant native plant species, OVLC is ensuring a watershed-wide commitment to water efficiency and climate resiliency.

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring:

Forecasting & Outcomes:

REFERENCES

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HOW TO READ THIS DOCUMENT

Tools: Treatment or approach, which under certain conditions can enhance streamflow through either quality or quantity of ecological important stream flows. These tools can be used singularly or in aggregate to diversify a portfolio and gain multiple benefits.

TOOL SUMMARY

Toolkit Project Type(s):

- Reduced Consumptive Use: Tools and strategies to reduce non-beneficial uses of water (such as unproductive evaporation from sprinkler spray). Reductions in consumptive use create 'new supplies' of water that are available for other uses. (*Definition via Pacific Institute*)
- Water Quality Improvements: Tools and projects that enhance water quality, reduce and prevent the contamination of rivers and streams, and restore water for beneficial uses.
- Time Management of Water: Using storage or conjunctive use to "bank" or detain water.
- Flow Augmentation (Direct or Infiltration): The direct release of water stored in a reservoir or other impoundments to increase natural flow or water quality of a stream.

Related Tools: Brief description of how this tool relates to, and interacts with other entries.
Site Condition: Current site/environmental conditions where tool will be used or implemented.
Impacts to Stream Flow/Hydrology: Impacts of the tool group(s) on stream flow quality and quantity.
Region: Geographical location of tool in watershed.

DESCRIPTION

Description: What the tool is, how it's applied within a watershed, and associated environmental impact (positive and negative).
Application for Tool in Watershed: Ways to quantify or qualify benefits of tool use within watershed.

DATA & METRICS

Evaluation Metrics: Quantifiable method for evaluating benefits.
Primary Quantifiable Benefits: Top one to three multiple benefits associated with tool implementation.
Secondary Benefits: Remainder of multiple benefits associated with implementation. May be qualitative or quantitative.
Data Gaps: Information needed to enhance knowledge of tool benefits and impacts.

IMPLEMENTATION CONSIDERATIONS

Economic & other Feasibility Factors: Economic Feasibility discussion includes discussion of cost leaders, where appropriate. This section also reviews issues of scale and costs (economic or otherwise) vs benefits, as appropriate.
Constraints: Factors that affect the tool's viability for implementation.
Permitting & Coordination: Individuals, organizations, groups and processes involved or needed to implement tool.
Associated Thresholds: Thresholds of significance for the subject tool. This includes minimum thresholds developed under the Groundwater Sustainability Plan to avoid undesirable results. (*Definition via groundwaterexchange.org*). For example, minimum flows required to allow for fish passage.
Considerations & Impacts: Key factors to consider scaling, planning or implementing this tool. Related impacts of implementing this tool from realized community or watershed values, multiple benefits, or aggregated single metrics that can enhance stream flow quality or quantity.
Community Engagement: Community outreach methods, organizations and programs which can assist in scaling, funding, planning, implementing and/or monitoring of the tool.

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring: Current or past regional monitoring efforts that can inform effectiveness of tool on streamflow enhancement and other watershed and community values, benefits.
Forecasting & Outcomes: Key applied targets or climatic factors forecasted to modify the tool or approach in the future.

REFERENCES

References: Related cited works.

THE MULTIPLE PROJECT BENEFITS

MULTIPLE BENEFIT APPROACH

The Multiple Benefit approach finds alignment of common values that build collaboration, streamline projects, and reduce costs. (*Reference Pacific Institute's Multiple Benefit Checklist Guidance Document for more information.*)

The tools within this toolkit achieve multiple beneits of water conservation, reuse, and best management practices that include: increased instream flows, fire resilience, habitat creation, energy resilience, carbon reduction, equitable communities, extreme heat reduction, groundwater recharge, flood mitigation, improved water quantity and quality, food security, beauty and aesthetics, and energy resilience.

This toolkit demonstrates the multiple opportunities for building community and climate resilience through programmatic and phsyical tools approaches. Listed below are the primary multiple benefit categories achieved through the holistic integration and implementation of the tools within this toolkit.

Healthy Communities: Healthy, resilient communities include healthy ecosystems, watersheds, people and economies. Tools that localize water and land resources contribute to food security, groundwater recharge, carbon reduction and help protect against extreme effects of climate change. The integration of multiple tools supports holistic, healthy communities.

Climate Change Resilience: Stormwater BMPs, rainwater harvesting, and greywater reuse systems support trees and plants that provide shade and counteract the urban heat island effect. Regenerative Stormwater Conveyance approaches, Climate Appropriate Plantings and Low Impact Design tools help capture and slow stormwater, mitigating flood. Fire BMPs protect communities and landscapes from wildfire.

Soil Health: Rainwater harvesting, mulch, carbon farming and greywater reuse are treatments that build soil by adding humidity, carbon, and nutrients. Healthy soils contribute to healthier plants and landscapes, and can help prevent or slow wildfire. Healthier soils are more absorbant and can hold more moisture which helps reduce runoff as well. Erosion reduction prevents extreme flooding.

Improved Water Quality: Rainwater harvesting and stormwater best management practices reduce the volume of runoff entering creeks and rivers. Stormwater BMPs and Climate Appropriate Plantings clean and cool water. All of these impacts are building blocks for healthy waterways and improve both wildlife habitat and drinking water quality.

Public Health: Healthy landscapes contribute to overall air quality improvements and water quality improvements, which benefit public health. Green spaces provide recreational areas for families and children, benefitting both physical and mental health.

Climate Change Mitigation: Strategies like rainwater and stormwater harvesting and greywater reuse that localize our water supplies help to reduce the energy we use to pump and treat water, which in turn reduces the carbon footprint of water. Trees irrigated with reused greywater and rainwater reduce cooling energy needs. Finally, trees, shrubs and crops irrigated with rainwater support healthy soil high in organic matter. Healthy soil, trees and shrubs all absorb carbon from the atmosphere.

Environmental Justice: food security Greywater reuse is a strategy used to irrigate fruit and nut trees and food-producing shrubs like blackberries, contributing to food security and localizing food supplies. Rainwater harvesting can support irrigation of all food crops, adding diversity ro local food production.

Water Supply: Rain tanks serve as both a primary or secondary source of potable water. Rainwater tanks are safe and reliable sources of water through drought and disaster. Tools that recharge groundwater like greywater reuse, stormwater gardens and Climate Appropriate Plantings ensure robust groundwater supplies that can help through severe drought. Fire BMPs enhance soil health and protect water quality. Groundwater recharge: when we slow water in stormwater gardens and through rainwater harvesting, it has a chance to sink into the ground and recharge groundwater supplies rather than rushing down storm drains and rivers to the ocean.

Property Protection: Fire BMPs, stormwater BMPs, Low Impact Design, rainwater harvesting, greywater reuse and climate appropriate landscapes provide protection from extreme effects of wildfire and flooding. Well-hydrated landscapes slow the spread of wildlife.

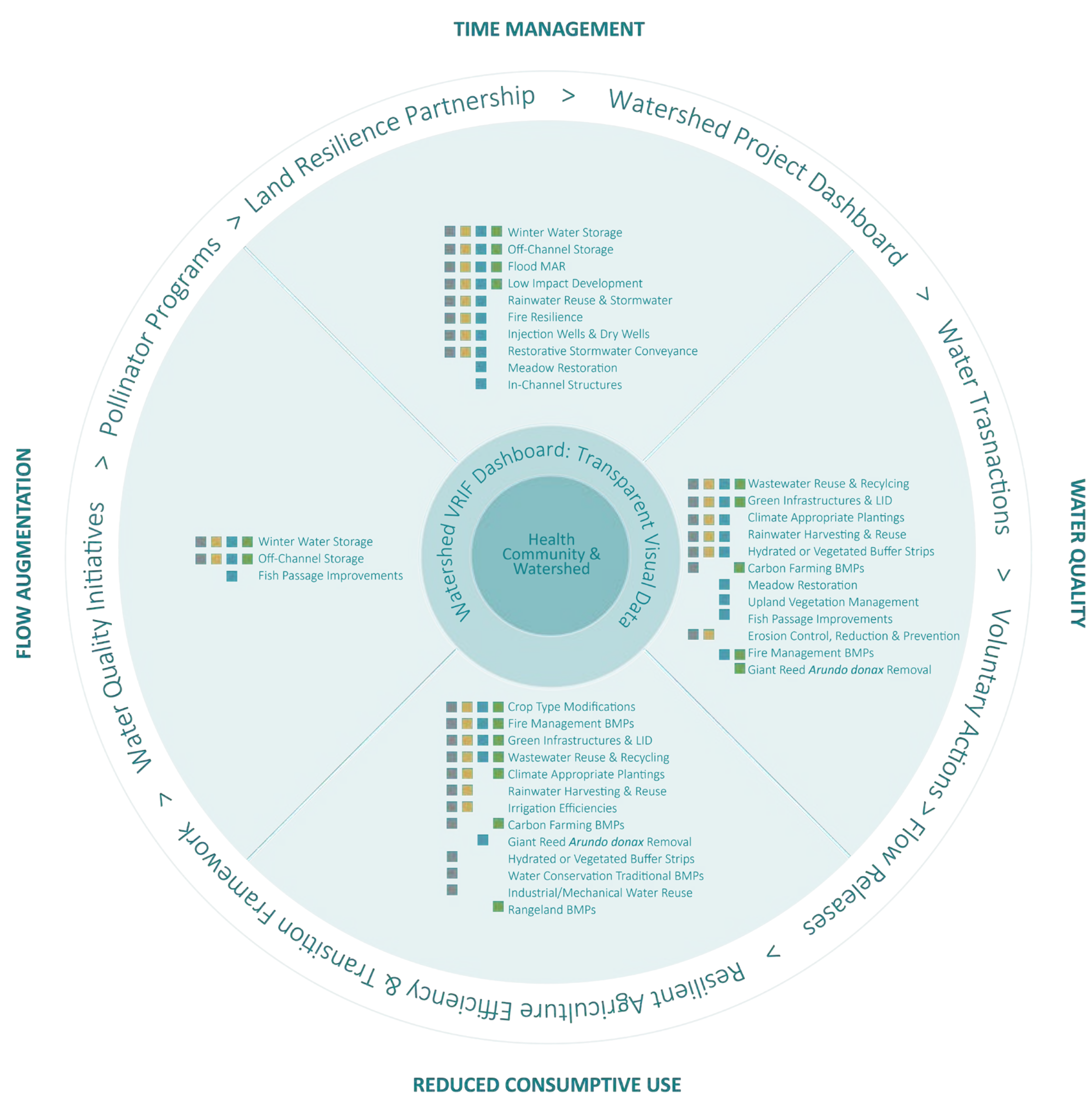
Risk & Resilience: Greywater and rainwater irrigated landscapes are well hydrated and resist fire well to help mitigate wildlife. Many native plants, part of climate appropriate planting strategies, are well adapted to fire. Mulch and carbon farming help to build soil by adding humidity, carbon, and nutrients. Energy resilience: In California, a minimum of 20% of the state's energy is used to move water and treat wastewater. Hyper-localized alternative water supplies from rainwater, greywater, and stormwater, combined with reduced consumptive use BMPs, decrease energyconsumption from transporting and treating water throughout the state.

Land & Environment: Stormwater gardens, greywater and rainwater irrigated trees, shrubs and climate appropriate plantings provide significant patches of habitat for birds, insects and wildlife. These same tools recharge groundwater, which increases instream flows, supporting robust habitat for aquatic species including macroinvertebrates, fish, birds and the rest of our ecological family.

Habitat Creation: Stormwater gardens, greywater and rainwater irrigated trees, shrubs and climate appropriate plantings provide significant patches of habitat for birds, insects and other wildlife .These same tools recharge groundwater, which increases instream flows, supporting robust habitat for aquatic species, fish, birds and others.

TOOLKIT BY PROJECT TYPE & LAND USE

TOOLKIT BY PROJECT TYPE & LAND USE
VENTURA RIVER INSTREAM FLOW ENHANCEMENT & WATER RESILIENCE FRAMEWORK



Associated Land Use Regions:

- Built Environment
- Wildland Urban-Interface (WUI)
- Wetland & Riparian Habitat
- Landscape

Project Types:

- Time Management
- Water Quality
- Flow Augmentation
- Reduced Consumptive Use

Figure 5: Intersection of Tools by Project Type and Land Use shows how multiple tools work across multiple land-uses for benefits to impact and enhance stream flow for the Ventura River Instream Flow Enhancement and Water Resilience Framework

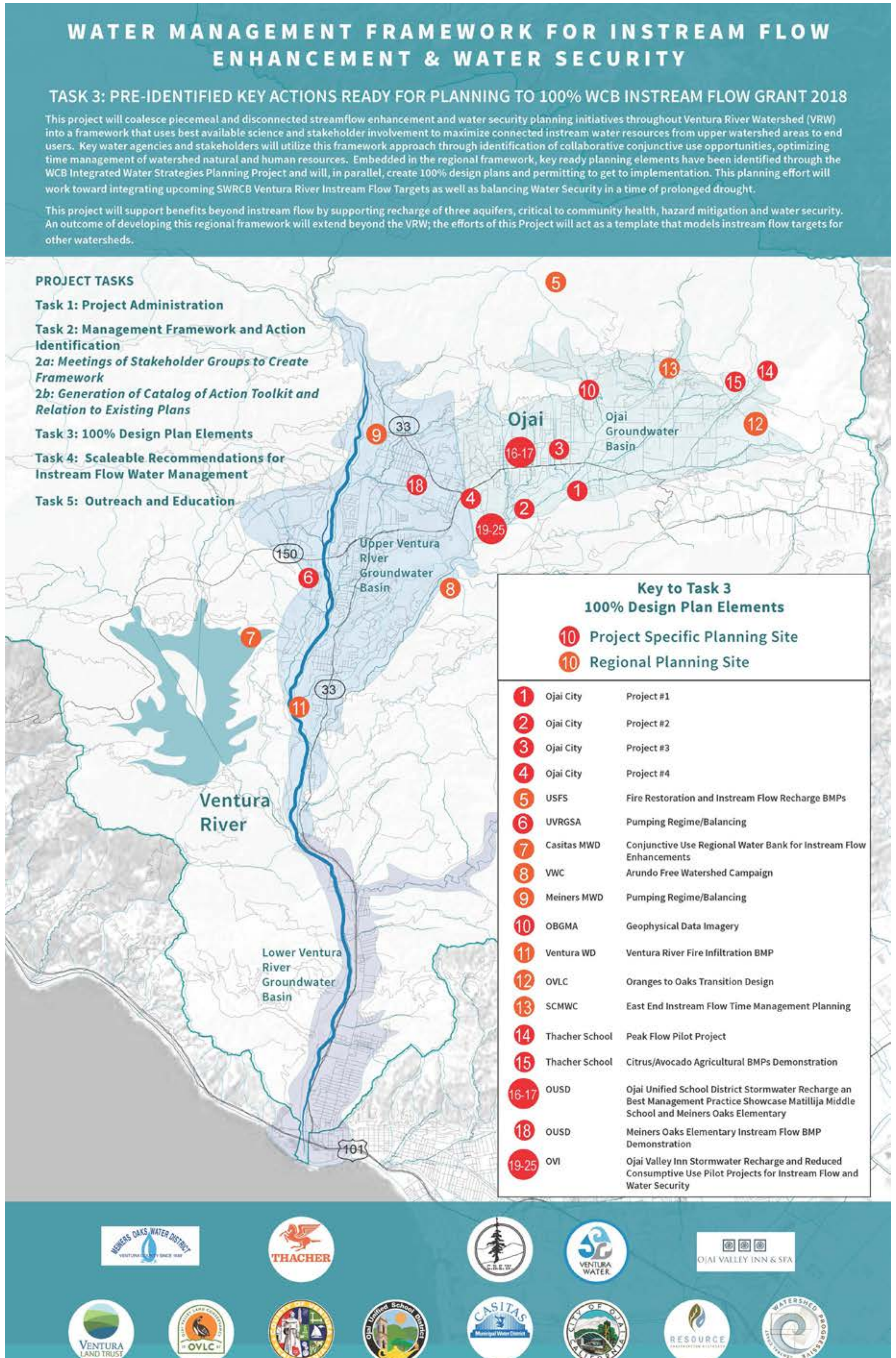
WATERSHED ACTION TOOLKIT

PROGRAMMATIC TOOLS

- Water Transactions
- Water Banking
- Water Markets
- Conjunctive Use Planning
- Forbearance Planning
- Voluntary Actions
- Flow Releases
- Resilient Agriculture Efficiency & Transition Framework
- Land Resilience Partnership
- Prescribed Burn & Grazing Associations
- Watershed Project Dashboard: Water View for Watersheds
- Watershed Literacy & Engagement
- Water Quality Initiatives

PHYSICAL TOOLS

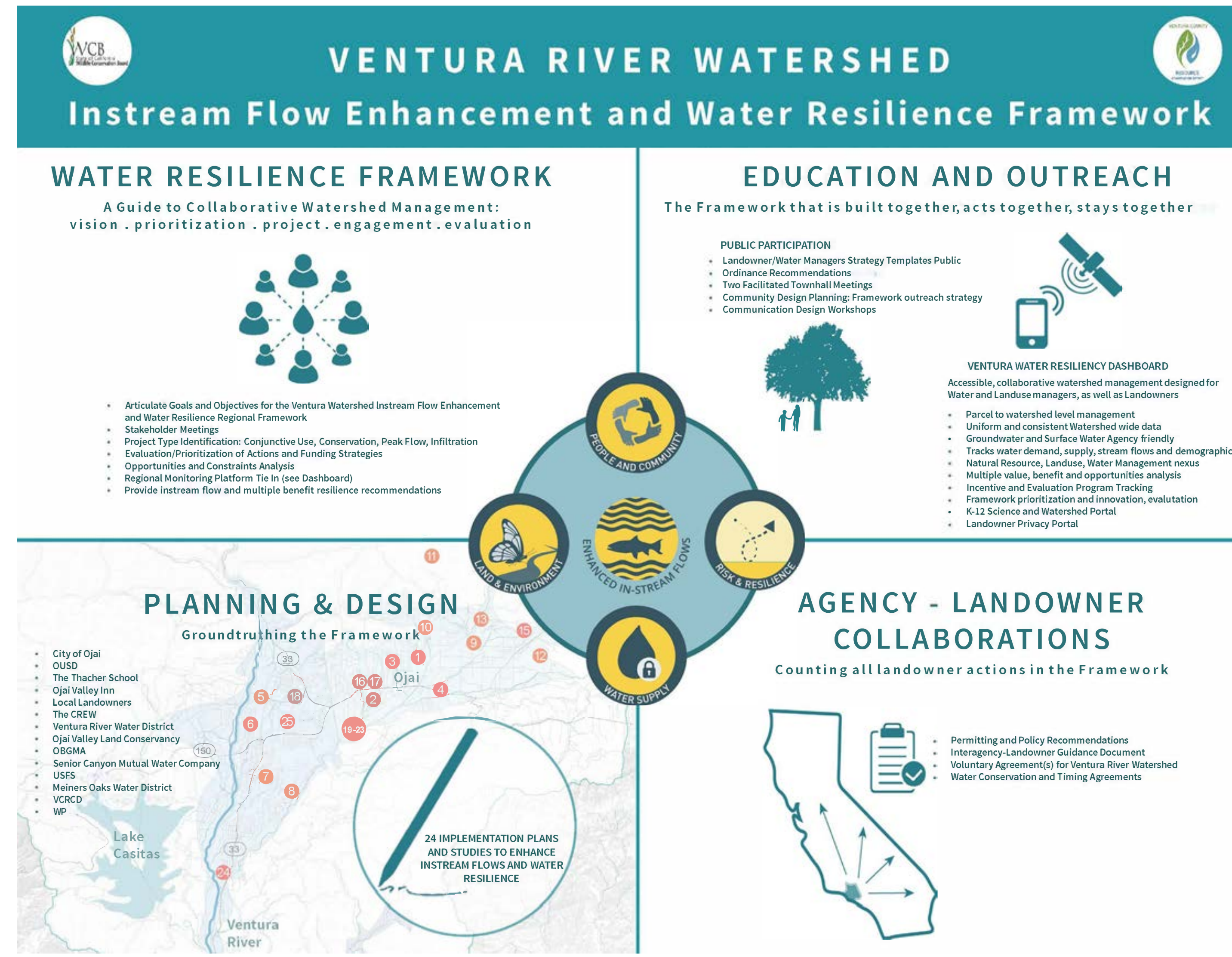
- Wastewater Reuse & Recycling
- Low Impact Development (LID)
- Green Infrastructures (Streets & Alleys)
- Stormwater Reuse
- Climate Appropriate Plantings (CAP)
- Rainwater Harvesting & Reuse
- Green Roofs
- Fire Management BMPs
- Hydrated or Vegetated Buffer Strips
- Fire Resilience Landscaping & Home Hardening
- Industrial & Mechanical Water Reuse
- Irrigation Efficiencies
- Water Conservation Traditional BMPs
- Injection Wells & Dry Wells
- Erosion Control, Reduction & Prevention
- Traditional Ecological Knowledge (TEK) & Cultural Burning
- Upland Vegetation Management
- Meadow Restoration
- Carbon Farming BMPs
- Rangeland BMPs
- Winter Water Storage (Storage & Forbearance)
- Off-Channel Storage
- Flood Managed Aquifer Recharge (FloodMAR)
- Agricultural BMPs
- Crop Type Modification
- Wetland & Riparian Restoration
- Vegetation Management
- Riparian Invasive (Vegetative) Species Removal
- Giant Reed Arundo donax Removal
- Fish Passage Improvements
- In-Channel Pond Structures
- Regenerative Stormwater Conveyance (RSC)



TOOLKIT IN VRIF 2019 PLANNING PROJECTS

VRIF PLANNING FRAMEWORK

The VRIF Planning Framework aims to not only create a framework for streamflow enhancement, yet also to create planning documents to inform and provide shovel readiness on the VRIF Action Toolkit. The map (left) illustrates planning projects from a wide variety of partnerships throughout the watershed testing and utilizing tools in a condition that may enhance stream flow. These planning projects are critical to work together on concepts that can scale to a watershed scale, as well as to other regions of California. Please see Table (on the following pages 12-13) for an intersection and wide array of the tools that are being activated in the wide array of the VRIF 2019 Planning Projects.



TOOLKIT IN VRIF 2019 PLANNING PROJECTS

VENTURA RIVER INSTREAM FLOW ENHANCEMENT & WATER RESILIENCE FRAMEWORK WATERSHED ACTION TOOLKIT

PROJECTS

TOOLS

	#1. City of Ojai	#2. City of Ojai Neighborhood Recharge Downtown South	#3. City of Ojai Signal Street Recharge Project	#4. City of Ojai Land Resilience Partnership	#7. Ventura River Water District Land Resilience Partnership	#8. OVLC Giant Reed Arundo donax Free Watershed	#9. Landowner Orchard BMPs	#10. Baseline Monitoring OBGMA	#11. Fire Restoration BMPs USFS	#12 Oranges to Natives	#13. East End Instream Flow Time Management	#14. Winter Water Storage Pilot Project
Wastewater Reuse & Recycling	x	x		x	x							
Low Impact Development	x	x	x	x	x				x			
Green Infrastructure (Streets & Alleys)	x	x		x								
Stormwater Reuse			x									
Climate Appropriate Gardens	x	x	x	x	x							
Rainwater Reuse	x	x		x	x				x			
Green Roofs	x	x		x	x							
Fire Management BMPs	x	x		x	x				x			
Hydrated & Vegetated Buffer Strips	x	x	x	x	x				x			
Traditional Ecological Knowledge	x	x		x	x				x			
Fire Resilience Landscaping & Home Hardening	x	x		x	x							
Industrial & Mechanical Water Reuse	x	x		x	x							
Irrigation Efficiencies	x	x	x	x	x		x					
Water Conservation Traditional BMPs	x	x		x	x							
Injection Wells & Dry Wells			x									
Erosion Control	x	x		x	x				x			
Upland Vegetation Management	x	x	x	x	x				x	x		
Meadow Restoration												
Carbon Farming BMPs	x	x	x	x	x		x					
Rangeland BMPs												
Winter Water Storage (Storage & Forbearance)									x		x	x
Off-Channel Storage									x			
Flood Managed Aquifer Recharge												
Agricultural BMPs							x					
Crop Type Modification							?			x		
Wetland & Riparian Restoration						x			x			
Riparian Invasive Species Removal									x			
Giant Reed Arundo donax Removal						x						
Fish Passage Improvements												
In-pond Structures									x			
Regenerative Stormwater Conveyance	x	x		x	x				x			
Water Transactions												
Water Banking												
Water Markets												
Conjunctive Use Planning											x	
Forbearance Programs					x						x	x
Flow Releases												
Resilient Agriculture Efficiency & Transition Framework												
Land Resilience Partnership				x	x							
Prescribed Burn & Grazing Associations												
Watershed Project Dashboard: Water View for Watersheds	x	x	x	x	x	x	x	x	x	x	x	x
Watershed Literacy & Engagement				x								
Water Quality Initiatives				x	x	x						

TOOLKIT IN VRIF 2019 PLANNING PROJECTS

VENTURA RIVER INSTREAM FLOW ENHANCEMENT & WATER RESILIENCE FRAMEWORK WATERSHED ACTION TOOLKIT

PROJECTS

TOOLS

	#15. Orchard BMP Laboratory	#16. School Stormwater LID	#17. School Rainwater Project	#18. Elementary School Stormwater BMPs	#19. Ojai Valley Inn Golf Course Redesign	#20. Ojai Valley Inn Central Landscape Redesign	#21. Ojai Valley Inn Water Reuse	#22. Invasive Tree REmoval and Oak Woodland Health Habitat Plan	#23. Ojai Valley Inn Stormwater Detention/ Retention	#24. River Parkway Project Feasibility	#25. Pumping Regime/ Balancing for Instream Flow and Water Quality
Wastewater Reuse & Recycling					x	x	x			x	
Low Impact Development		x	x	x	x	x			x	x	
Green Infrastructure (Streets & Alleys)				x		x			x	x	
Stormwater Reuse		x		x			x		x		
Climate Appropriate Gardens		x	x	x	x	x				x	
Rainwater Reuse		x	x	x			x		x	x	
Green Roofs				x						x	
Fire Management BMPs	x			x		x			x	x	
Hydrated & Vegetated Buffer Strips	x	x		x	x	x		x		x	
Traditional Ecological Knowledge	x				x	x				x	
Fire Resilience Landscaping & Home Hardening		x								x	
Industrial & Mechanical Water Reuse							x			x	
Irrigation Efficiencies	x	x		x	x					x	
Water Conservation Traditional BMPs				x						x	
Injection Wells & Dry Wells									x	x	
Erosion Control	x			x	x				x	x	
Upland Vegetation Management	x				x					x	
Meadow Restoration		x						x	x	x	
Carbon Farming BMPs	x	x		x	x	x				x	
Rangeland BMPs										x	
Winter Water Storage (Storage & Forbearance)							x		x	x	
Off-Channel Storage										x	
Flood Managed Aquifer Recharge									?	x	
Agricultural BMPs	x										
Crop Type Modification	x										
Wetland & Riparian Restoration								x	x	x	
Riparian Invasive Species Removal								x		x	
Giant Reed Arundo donax Removal								x		x	
Fish Passage Improvements											
In-pond Structures											
Regenerative Stormwater Conveyance									x	x	
Water Transactions							x				
Water Banking											
Water Markets											
Conjunctive Use Planning					x	x	x		x	x	x
Forbearance Programs	x	x									
Flow Releases									?	?	
Resilient Agriculture Efficiency & Transition Framework											
Land Resilience Partnership										?	
Prescribed Burn & Grazing Associations								?			
Watershed Project Dashboard: Water View for Watersheds	x	x	x	x	x	x	x	x	x	x	?

Fig. 6a, 6b: Before and After Rendering of Giant Reed Arundo donax Removal and Restoration, San Antonio Creek
Tool Type: Giant Reed Arundo donax Removal

Fig. 7: Rendering of Stormwater Planted Bioswale, Ojai Valley Inn
Tool Type: Stormwater Reuse

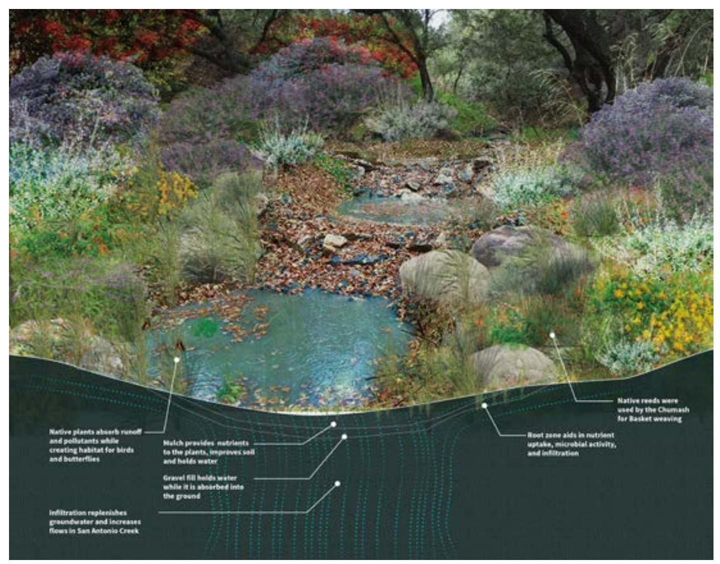


Fig. 8: Rendering of Stormwater Check-dams, Ojai Valley Inn
Tool Type: Stormwater Reuse

Fig. 9: Rendering of Meadow Restoration, Ojai Valley Inn
Tool Type: Meadow Restoration

Fig. 10: Rendering of Planted Rain Garden, Ojai Valley Inn
Tool Type: Rainwater Harvesting and Reuse

TOOLKIT PROJECT EXAMPLES

Figure 11: Native Plant Garden
Tool Type: Climate Appropriate Plantings

Figure 12: Rainwater Tank
Tool Type: Rainwater Harvesting and Reuse

Fig. 13: Green Roof at the Thacher School in Ojai
Tool Type: Green Roofs

Fig. 14: Mulch groundcover
Tool Type: Irrigation Efficiencies

Fig. 15: Bioswale in Parking Lot Median
Tool Type: Stormwater Reuse; Low Impact Development

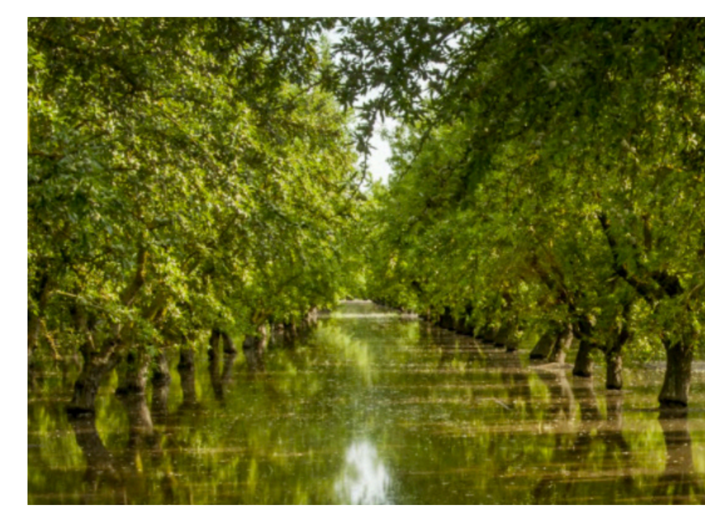


Fig. 16: FloodMAR
Tool Type: Flood Managed Aquifer Recharge

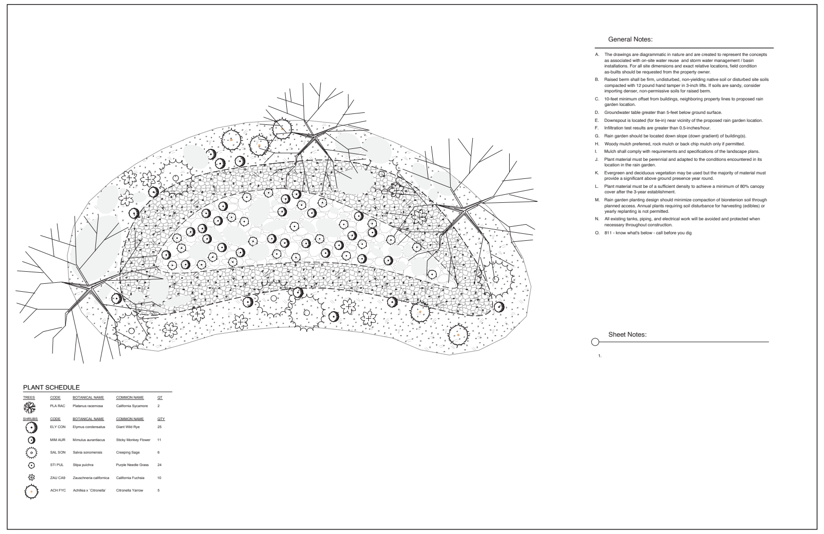


Fig. 17: Design Template for Rain Garden Planting
Tool Type: Rainwater Reuse

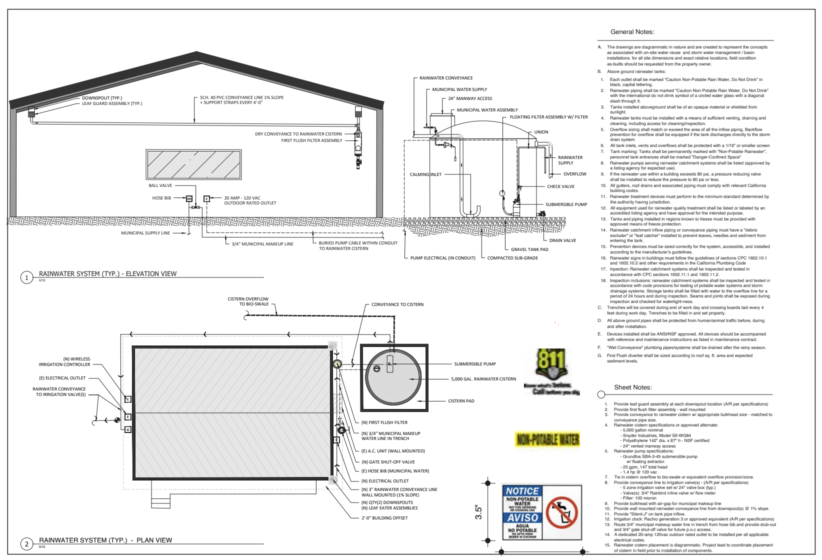


Fig. 18: Design Template for Rainwater Harvesting
Tool Type: Rainwater Reuse

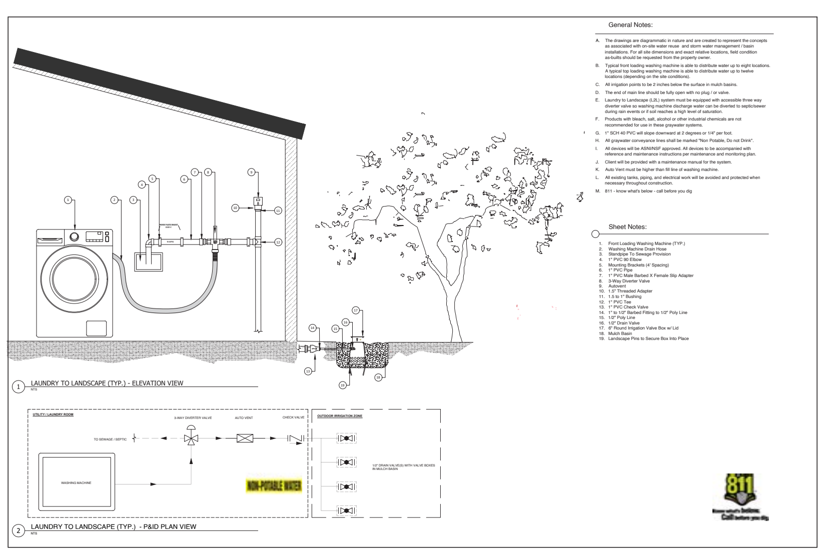


Fig. 19: Design Template for Laundry to Landscape
Tool Type: Wastewater Reuse

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PROGRAMMATIC TOOLS

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PHSYICAL TOOLS

GLOSSARY OF TERMS

- **Acre Foot:** The amount of water needed to cover an acre of land one foot deep.
- **Best Management Practices (BMPs)**: A combination of practices determined to be most effective and practicable means of preventing or reducing non-point source pollution for water quality goals.
- **Bioretention**:Structural stormwater control practices that biofilter and retain runoff using specific vegetation, mulch, bioretention soils media, and aggregate rock. Treatment occurs through filtration, biological uptake of pollutants, adsorption, ion exchange, infiltration and in some cases evapotranspiration.
- **Agricultural BMPs:** This refers to a collection of best management practices intended to maximize irrigation efficiency and reduce evaporation in agricultural settings. Some examples of agricultural BMPs are irrigation schedule timing, efficient irrigation emitter heads, and mulch treatment.
- **Carbon Farming BMPs:** Practices such as prescribed grazing, riparian restoration, and compost application, that are known to improve the rate at which CO2 is removed from the atmosphere and converted into plant material and soil organic matter.
- **Climate Appropriate Plantings:** Climate Appropriate Planting refers to planting native and drought tolerant species which need low or no additional irrigated water to survive.
- **Crop Type Modification:** This strategy includes utilizing crop type selections best suited to reduce water demand and, in some cases, improve water quality runoff.
- **Erosion Control, Reduction & Prevention:** This strategy refers to construction and maintenance practices that are intended to prevent erosion of topsoil and stream banks.
- **Fire Management BMPs:** Best management practices for fire resilience including fire breaks, vegetated buffer strips, and soil stabilization techniques that can reduce the risks associated with fire.
- **Fish Passage Improvements:** Projects that facilitate upstream and downstream movement of aquatic fish species within the watershed throughout a range of flow conditions.
- **Flood Managed Aquifer Recharge (Flood-MAR):** An integrated and voluntary resource management strategy that uses flood water resulting from, or in anticipation of, rainfall or snow melt for managed aquifer recharge (MAR) on agriculture lands and working landscapes, including but not limited to refuges, floodplains, and flood bypasses.
- **Flow Regime:** The changing quantity and timing of water flows throughout the course of a year.
- **Flow Releases:** Managed flow releases address environmental impacts in areas downstream of dams by scheduling releases from the dam to meet restoration objectives.
- **Green Infrastructures - Streets & Alleyways:** Green infrastructure refers to a variety of best management practices intended to mitigate the negative watershed-related environmental impacts of urban development. Interventions include bioswales, curb cuts, and pervious pavement.
- **Green Roofs:** Also known as a 'living roof', a roof of a building that is partially or completely covered with vegetation.
- **Hydrated or Vegetated Buffer Strip:** Vegetated buffers between urban development or agricultural areas and waterways that serve to improve bank stabilization, water quality, flood control, and wildlife habitat.
- **Hydrograph:** A graph that plots water flow against time.
- **In-Pond Structures:** Restoration strategy that promotes ponds in stream channels to provide wildlife habitat, increases infiltration to groundwater reserves, and prevents erosion.
- **Industrial & Mechanical Reuse:** In warm climates where air conditioning is used, condensate can be captured and reused to offset municipal water sources.
- **Injection Wells & Dry Wells:** A device that places fluid deep underground into porous rock formations such as sandstone or limestone, or into or below the shallow soil layer. The fluid may be water, wastewater, brine, or water mixed with industrial chemical waste.
- **Irrigation Dose Timing:** Changes to the timing and quantity of water delivered in an irrigation system to maximize efficiency and reduce water demand.
- **Low Impact Development (LID):** Systems and practices that use or mimic natural processes that result in the infiltration, evapotranspiration or use of stormwater in order to protect water quality and associated aquatic and wildlife habitat.
- **Meadow Restoration:** Meadows play an important role in mountain ecosystems; serving to slow, spread, and sink stormwater. Restoration activities include beaver dam analogues, channel restoration, rangeland management, and vegetation management.
- **Off-Channel Storage:**
- **Rainwater Harvesting & Reuse:** Rainwater includes precipitation collected from rooftops and other collection surfaces above and below ground. Rain tanks are used to harvest, store and reuse rainwater for landscape irrigation or non-potable indoor uses such as toilet flushing.
- **Rangeland BMPs:** Best management practices for rangeland stewardship and maintenance are intended to minimize negative environmental impacts. These include the use of rotational grazing and stormwater BMPS.
- **Regenerative Stormwater Conveyance:** Regenerative Stormwater Conveyance (RSC) uses boulder check dams to form step pools within eroding drainage channels to slow, sink, spread, and filter stormwater.
- **Riparian Invasive Species Removal:** Native riparian plants and trees are to be planted throughout the drainage channel to restore the area to its natural plant pallet, reduce evapotranspiration, provide wildlife habitat, stabilize soils to minimize erosion, create pathways for water infiltration through root channels, and increasing water quality with oxygenation, sediment filtration, and contamination removal.
- **Storage & Forbearance:** Habitat restoration approach where a water user diverts and stores water quantities exceeding their water right allocation in wet season months while diverting less than their allotted amount during dry season months.
- **Stormwater Reuse:** The collection, accumulation, treatment, or purification, and storage of stormwater for its eventual use.
- **Traditional Ecological Knowledge (TEK):** Also called by other names including Indigenous Knowledge or Native Science, refers to the evolving knowledge acquired by indigenous and local peoples over hundreds or thousands of years through direct contact with the environment.
- **Upland Vegetation Management:** Includes the removal of non-native species and replacement of those plants with native species in upland regions that serve as stream headwaters. Restoring native vegetation can reduce environmental water demand and leave more flow instream.
- **Water Banking:** The practice of forgoing water deliveries during certain periods, and 'banking' either the right to use the forgone water in the future, or saving it for someone else to use in exchange for a fee or delivery in kind.
- **Water Conservation Traditional BMPs:** Water conservation BMPs like water audits are some of the lowest hanging fruits which we can harvest and in turn greatly benefit from, as audits help us understand and put into perspective our own unique water use.
- **Water Transactions:** Incentive-based approaches that are agreements between a water user and another party to make water available for some other purpose.
- **Water Year:** Categorization of annual precipitation relative to average annual precipitation.
- **Wastewater Reuse & Recycling:** Reclaimed water from a variety of sources that is treated and reused for beneficial purposes such as agriculture and irrigation, potable water supplies, groundwater replenishment, industrial processes, and environmental restoration. Water reuse can provide alternatives to existing water supplies.
- **Wetland & Riparian Restoration:** Wetland and riparian restoration is the process of restoring wetland and riparian areas to a state that allows them to fulfill their natural ecological function. In practice, wetland and riparian restoration includes removal of invasive species, reestablishment of native plant communities, and other actions that reduce the human impact on wetland and riparian areas.

ACRONYMS

- **AFY**: Acre-feet per Year
- **BLM**: Bureau of Land Management
- **BMPs**: Best Management Practices
- **CASQA:** California Stormwater Quality Association
- **CDFW:** California Department of Fish and Wildlife
- **CEQA:** California Environmental Quality Act
- **CFS**: Cubic Feet per Second
- **CWA:** Clean Water Act
- **DWR:** Department of Water Resources
- **Flood MAR**: Flood Managed Aquifer Recharge
- **GHG:** Green House Gases
- **GIS**: Geographic Information System Mapping
- **GSP:** Groundwater Sustainability Plans
- **IRWM**: Integrated Regional Water Management
- **IWS-TQ:** Integrated Water Strategies Toolkit Quantification
- **LID**: Low Impact Development
- **MWELO:** Model Water Efficient Landscape Ordinance
- **NOAA:** National Oceanis and Atmospheric Administration
- **NPDES:** National Pollutant Discharge Elimination System
- **NRCS:** National Resources Conservation Services
- **OBGMA:** Ojai Basin Groundwater Management Agency
- **OVLC**: Ojai Valley Land Conservancy
- **PAD:** Passage Assessment Database
- **PBA**: Prescribed Burn Association
- **RWQCB**: Regional Water Quality Control Board
- **SDWA:** Safe Drinking Water Act
- **SGMA**: Sustainable Groundwater Management Act
- **SWRCB:** State Water Resources Control Board
- **TEK**: Traditional Ecological Knowledge
- **TSD**: Total Dissolved Solids
- **TMDL:** Total Maximum Daily Load
- **USACE:** United States Army Corps of Engineers
- **USDA:** United States Department of Agriculture
- **USFS:** United States Forest Service
- **VCRCD:** Ventura Resource Conservation District
- **VRW:** Ventura River Watershed
- **VRWC:** Ventura River Watershed Council
- **VRWD:** Ventura River Water District
- **VRIF:** Ventura River Instream Flow
- **VMP:** Vegetation Management Program
- **WPDG**: Wetland Program Development Grant
- **WUI**: Wildland Urban Interface

Framework Participants & Reviewers:

Thank you to participants and reviewers including:

- Ventura County Resource Conservation District
- Ventura River Watershed Council
- Watershed Coalitions of Ventura County
- Watershed Protection District
- City of Ojai
- Ojai Unified School District
- Casitas Municipal Water District
- Ventura River Water District
- Meiners Oak Water District
- Senior Canyon Mutual Water District
- Ventura City
- Ojai Valley Land Conservancy
- United States Forest Service
- Ojai Basin Groundwater Management Agency
- Upper Ventura River GSA
- Julie Tumamait-Stenslie
- Jonathan Katz
- The Thacher School
- Ojai Valley Inn
- The CREW
- Watershed Progressive
- Eagle Aerial
- Flip Labs
- Hicks Law
- Trout Unlimited
- Northstar
- South Coast Habitat Restoration
- Stillwater Sciences
- Tom Ash
- and additional Public and Commercial stakeholder Input

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SECTION I.

1. Water Transactions

    a. Water Banking
    b. Water Markets
    c. Conjunctive Use Planning
    d. Forbearance Programs

Image 1: Recharge Pond at Kern Water Bank (Source: Maven's Notebook)

Tool Profile: Water Banking & Transactions

TOOL SUMMARY

Toolkit Project Type(s): Time Management of Water
Related Tools: Conjunctive Use
Site Condition:
Impacts to Stream Flow/Hydrology:

Region:

DESCRIPTION

Water Banking and transactions are voluntary, market-based tools that can facilitate water transactions between willing sellers and buyers. Water banking is used to improve water supply reliability by capturing low cost water for underground storage during wet periods and recovering this water for later use during dry periods or emergencies. Water transactions are incentive based approaches including agreements between water users and other parties to make water available for various uses such as instream flow.

Application for Tool in Watershed:

DATA & METRICS

Evaluation Metrics:
Primary Quantifiable Benefits: Enhanced Stream Flows
Secondary Benefits:
Data Gaps:

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors:

- Construction and operating costs

Constraints:

- Requires groundwater basins to have access to available surface water, the means to transport it and a management framework to account for what goes in and comes out.
- Aquifers must have accessible, unconfined storage at a relatively shallow depth, and be easy to fill and draw from.

Permitting & Coordination: Successful groundwater banking requires adequate data collection, monitoring and modeling in order to size an aquifer, estimate its groundwater banking capacity, verify movement of water once in the ground and assess costs and benefits of the project.

- Sustainable Groundwater Management Act of 2014
- Coordination with Sustainable Conservation and agricultural areas.

Associated Thresholds:

Considerations & Impacts:

- Reliable water supply that offers security during drought and dry periods
- Cost-effective way to save water for dry years.
- Reduces demand for imported water.
- Benefits groundwater levels and provides wildlife habitat.
- Provides sustainable water supplies for local agricultural use.
- Can be integrated into other water storage projects and reservoirs for statewide benefits.

Community Engagement:

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring:

Forecasting & Outcomes:

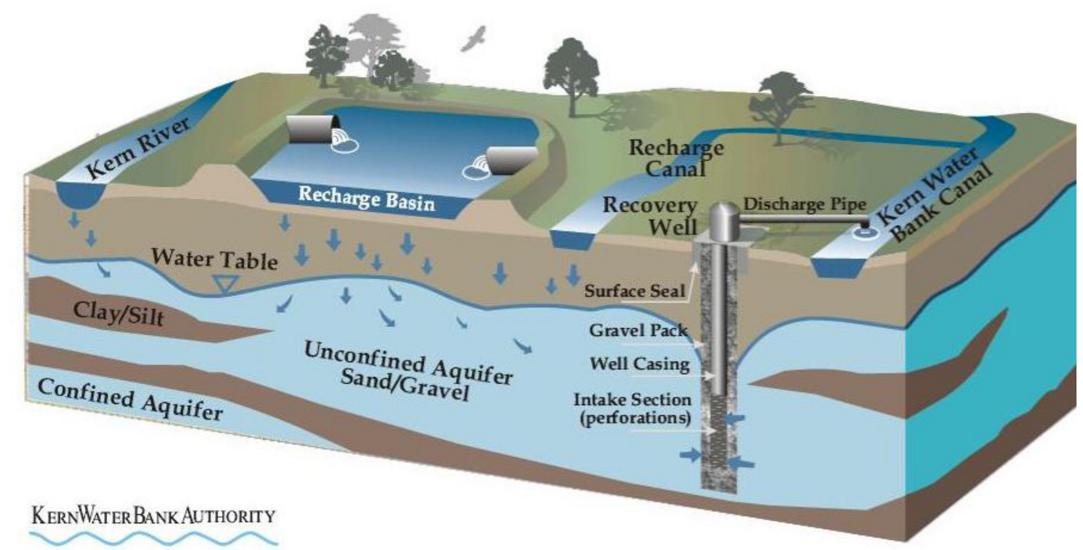

Figure 1: Groundwater banking diagram. (Source: Kern Water Bank Authority)

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Image 1: Ventura River (Source: Ojai Valley Land Conservancy)

Tool Profile: Water Markets

TOOL SUMMARY

Toolkit Project Type(s):

Related Tools:

Site Condition:

Impacts to Stream Flow/Hydrology:

Region:

DESCRIPTION

Application for Tool in Watershed:

DATA & METRICS

Evaluation Metrics:

Primary Quantifiable Benefits:

Secondary Benefits:

Data Gaps:

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors:

Constraints vs. Benefits:

Permitting & Coordination:

Associated Thresholds:

Considerations & Impacts:

Community Engagement:

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring:

Forecasting & Outcomes:

Image 1: Kern Water Bank (Source: WaterEducation.org)

Tool Profile: Conjunctive Use Planning

TOOL SUMMARY

Toolkit Project Type(s): Time Management of Water

Related Tools: Water Banking, Water Transactions

Site Condition:

Impacts to Stream Flow/Hydrology:

Region:

DESCRIPTION

In its passive form, also called in-lieu conjunctive use, surface water is used in wet years and groundwater is used in dry years. In active conjunctive use, surface water is directly injected into aquifers and wells to be used as needed as part of groundwater banking. Or, groundwater water is stocked in pond or basins and then allowed to percolate naturally into aquifers.

Such practices enable water purveyors to buy and reserve water to be used at a later date. It also gives them the flexibility to mix and match water resources based on demand and in spite of California's widely varying hydrological landscape. Storing groundwater below ground through conjunctive use is also seen as a way to lessen its evaporation and avoid building reservoirs and dams. Additionally, some water users are paid to use more expensive surface supplies instead of pumping groundwater, a practice known as in-lieu recharge.

There are several criteria experts say is key to successful conjunctive use implementation including:

- Sourcing an adequate supply of groundwater, ensuring a safe yield
- Protecting water quality
- Analyzing the economic costs
- Determining water rights
- Assessing the geological condition of aquifers

Currently, Southern California and the southern San Joaquin Valley are two centers of conjunctive use in the state. This also helps southern California lessen its dependence on the already heavily used Colorado River and Sacramento-San Joaquin Delta. In Southern California basins, about 21.5 million acre-feet of additional conjunctive use potential is available, according to the Association of Ground Water Agencies.

Application for Tool in Watershed:

DATA & METRICS

Evaluation Metrics :
Primary Quantifiable Benefits:

- Enhanced water quantity

Secondary Benefits:

- Improved local water supply
- Reduced groundwater overdraft
- Flood protection
- Enhanced water quality

Data Gaps:

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors: There are several criteria experts say is key to successful conjunctive use implementation including *(WaterEducation.org)*:

- Sourcing an adequate supply of groundwater
- Ensuring a safe yield
- Protecting water quality
- Analyzing the economic costs
- Determining water rights
- Assessing the geological condition of aquifers

Constraints vs. Benefits:
Permitting & Coordination: This programmatic tool is supported by the following regional watershed management plan(s):

- * Ventura County IRWMP

Associated Thresholds:
Considerations & Impacts:
Community Engagement:

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring:
Forecasting & Outcomes:

REFERENCES

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Image 1: Example of off-stream storage in 3,500 gallon tanks. (Source: WaterBoards.ca.gov)

Tool Profile: Forbearance Programs

TOOL SUMMARY

Toolkit Project Type(s): Time Management of Water, Reduced Consumptive Use, Flow Augmentation

Related Tools: Winter Water Storage, Water Banking & Transactions, Water Markets, Conjunctive Use Planning, Voluntary Actions, Water Quality Initiatives, Off-Channel storage

Site Condition: N/A

Impacts to Stream Flow/Hydrology: Enhanced streamflows through reduced consumptive use practices.

Region: Ventura County

DESCRIPTION

The Ventura County Resource Conservation District's Ventura River Instream Flow Planning Project (VRIF) Project Proponents are landowners with water rights who wish to engage in voluntary water conservation projects to enhance stream flow.

VRIF has led a highly-coordinated conservation planning effort ("the Framework") and produced this "Toolkit Catalog" of project-types, each of which reduces demand or increases water supply. The "Toolkit Catalog" identifies a range of 25+ programmatic tools and physical treatments which are a project-level build out or blueprint of a "Production Forbearance Program." Ongoing efforts have protected landowner confidentiality and data, while informing actionable steps for individuals to take to enhance stream flow.

VRIF has generated detailed plans for individual Project Proponents to take actions that add up to hundreds and potentially thousands of acre-feet annually. VRIF landowners have an overlapping and common interest to ensure that their conservation actions receive a form of "conservation credit" that can be accounted for within the Framework of variable supply and steady demand for local water. VRIF advocates for a pathway for watershed landowners to coordinate any number of voluntary water conservation actions specific to water rights established by diversion or pumping, that directly or indirectly enhance stream flow.

Landowners need assurance that their voluntary flow contributions today will be properly accounted for and protected from future regulatory reductions before others are appropriately reduced. For VRIF landowner efforts to be successful, multiple simultaneous regulatory and adjudicatory processes must account for these voluntary efforts. First adopters of voluntary water conservation measures should not later be penalized. It is this "leap" between individual actions and the overall potential of these contributions in the aggregate to enhance flow that the VRIF project has sought to address. VRIF landowners are first movers and will shift the dynamic from contention to solution.

The VRIF projects present a direct pathway for a 100% voluntary conservation solution to enhance stream flow above baseline conditions. These VRIF projects will immediately contribute to "unimpaired flow" and "enhance streamflow" and "contribute to groundwater recharge" and "improve baseline conditions" and/or "increase the net conservation benefit."

Production forbearance of water from an existing groundwater well or surface diversion does not encompass conservation actions and projects that do not implicate water rights. Actions such as arundo removal or stormwater capture/infiltration create "new water" that are not forbearance actions, yet still deserve additional consideration within the VRIF Framework.

Application for Tool in Watershed:

DATA & METRICS

Evaluation Metrics: VRIF landowners have an overlapping and common interest to ensure that their conservation actions receive a form of "conservation credit" that can be accounted for within the Framework of variable supply and steady demand for local water.

Primary Quantifiable Benefits:

- Enhanced water quality
- Enhanced water quantity

Secondary Benefits:

- Enhanced wildlife habitat
- Soil health
- Flood mitigation
- Extreme heat mitigation

Data Gaps:

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors:

Constraints vs. Benefits:

Permitting & Coordination:

Associated Thresholds:

Considerations & Impacts:

Community Engagement:

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring:

Forecasting & Outcomes:

REFERENCES

SECTION 2.

2. Flow Releases

Figure 1: Matilija Dam in Ojai, CA. (Source: Claudin Hellmuth/E&E News)

Tool Profile : Flow Releases

TOOL SUMMARY

Toolkit Project Type(s): Time Management of Water
Related Tools: Water Transactions, Water Banking, Conjunctive Use
Site Condition: Dammed waterways; Adequate flow to balance restoration objectives and human water needs.
Impacts to Stream Flow/Hydrology: While complete dam removal would minimize ecosystem impacts, this is not always feasible in the near term. With managed flow releases, instream flow volume and water quality are enhanced through stream hydrograph, sediment, and water temperature management.

Hydrograph management involves flow releases that allow for an appropriate annual volume of water in a manner that mimics the natural stream hydrograph that existed prior to dam construction. Flow volumes are maintained at a level that can support endemic species at all stages of development. Sediment management is accomplished by monitoring the geomorphological response to peak flows. Once monitoring has established the flow rate necessary to mobilize gravel particles of a certain size, the geomorphological impacts of certain flow release volumes can be established, and flows can be managed such that the natural functions of peak flows on geomorphology are maintained. Similarly, flow volumes can be tied to water temperatures which are important signals in the life cycles of endemic species–particularly for spawning salmonids. As part of an adaptive management approach, sediment and water temperature management serve to improve water quality.

Modifies the stream hydrograph of areas downstream from dams in order to reestablish the natural streamflow pattern that native species have adapted to.

Region: Dams within Ventura River Watershed.

DESCRIPTION

Over millions of years the plants and animals that make their home in river ecosystems have adapted to natural variations in instream flow. The expansion of the human environment has modified these natural patterns and significantly impacted sensitive habitats. Managed flow releases address these impacts in areas downstream of dams by scheduling releases from the dam to meet restoration objectives. Objectives are met by increasing the annual quantity of water released for instream flow. The timing releases mimic the flow patterns that existed prior to dam construction. In many cases, releases are timed so that there is enough water for fish at the right times of year-for both juvenile and adult biological needs. Flow regimes and release schedules are developed based on a variety of factors including water year classification and the hydrograph components necessary to meet restoration objectives. Depending on the local conditions that affect streamflow classifications (such as the source of the stream as snow melt, groundwater, or ephemeral rain), there may be distinct flow signatures. Knowledge of flow signatures that existed prior to dam construction are used to inform flow release schedules. Functional flow metrics, such as the start of wet season and dry season base-flow magnitude, are used to link important aspects of hydrology to ecological response. As part of an adaptive management approach and using scientific knowledge of functional flow metrics, flow releases can help mitigate the negative impacts of dams while maintaining the supply of water needed for human uses.

Application for Tool in Watershed: Bard Reservoir, Lake Eleanor, Lake Sherwood, Las Llajas, Matilija Dam, Runkle Debris Basin, Santa Felicia Dam, Senior Canyon, and Sinaloa Lake.

DATA & METRICS

Evaluation Metrics:

- Instream flow volume
- Sediment transport volume
- Spawning habitat area

Primary Quantifiable Benefits:

- Water temperature

Secondary Benefits:

Data Gaps:

- Existing flow volumes (environmental flows framework)
- Studies to establish water temperature objectives that are tied to ecological response
- Studies to establish flow volumes associated with geomorphological response

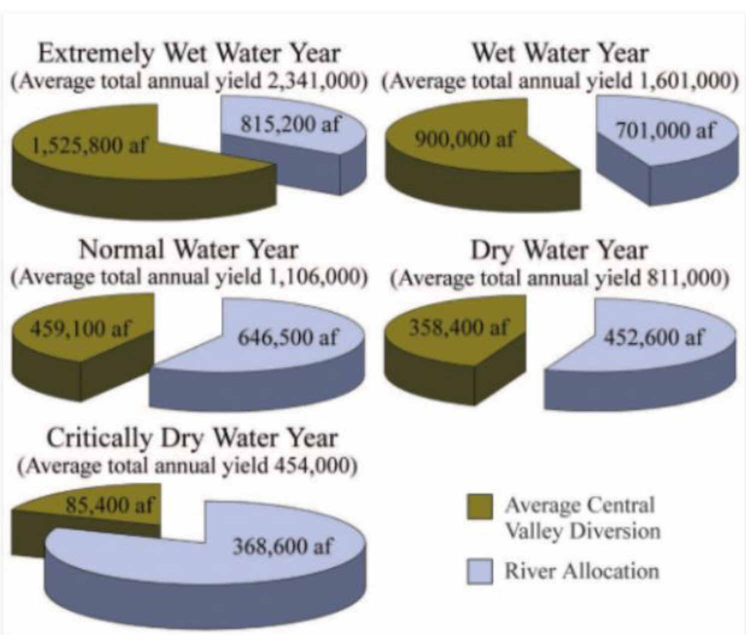

Figure 2 (Source: Trinity River Restoration Program)

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors:

- Requires enough water available to meet restoration objectives and human needs including diversion for municipal use, dam safety, hydro-power, agriculture, and recreation.
- With an increase in annual flow, downstream infrastructure like bridges and surrounding development could be affected and may need to be moved or enhanced.

Constraints:

- Competing objectives including dam safety flow releases, which are based in part on precipitation.

Permitting & Coordination:

- Need to coordinate water demand for agriculture, hydroelectricity, dam safety, municipal supplies, agriculture, and ecological water demand.

Associated Thresholds: Fluvial processes and habitat conditions vary by water year. Releases for environmental water uses are determined based on precipitation volumes. Figure 1 provides an example of this concept from the Trinity River Restoration Program. As shown, during drier years a larger portion of the overall flow is dedicated to environmental uses to maintain certain minimum base-flows thought to be necessary to sustain sensitive habitat.

Considerations & Impacts:

Community Engagement:

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring:
Forecasting & Outcomes:

REFERENCES

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SECTION 3.

3. Collaborative Implementation & Planning (VCRCD, IRWM, VRWC)
    a. Resilient Agriculture Efficiency & Transition Network
    b. Land Resilience Partnership (Ag & Built Environment)
    c. Prescribed Burn & Grazing Associations
    d. Watershed Project Dashboard: Water View for Watersheds
    e. Pollinator Programs (VCRCD)
    f. Water Quality Initiatives
        i. TMDL (RWQCB, Ventura County)
        ii. Manure Management Program (RWQCB, VCRCD)

Image 1: Thacher orchard. (Source: Watershed Progressive)

Tool Profile: Resilient Agriculture Efficiency & Transition Framework

TOOL SUMMARY

Toolkit Project Type(s): Reduced Consumptive Use, Water Quality Improvements, Time Management of Water, Flow Augmentation

Related Tools: Climate Appropriate Plantings, Fire Management BMPs, Water Conservation Traditional BMPs, Erosion Control, Reduction and Prevention, Winter Water Storage, Crop Type Modifications, Vegetation Management, Fish Passage Improvements

Site Condition: This framework is suitable and applicable to agricultural land parcels.

Impacts to Stream Flow/Hydrology: Enhanced streamflow and water quality through increased water supplies, improved soil health, and reduced erosion.

Region: Ventura County

DESCRIPTION

The Agricultural Framework for Efficient & Healthy Watersheds is a planning document and toolkit that informs state officials of the current state and need to prioritize agricultural lands conversion in the upper Ventura River Watershed. The framework assists the agricultural community by providing planning guidance regarding local land use ordinances, state policies, and market mechanisms that support agricultural lands conversion in order to retain and maintain economic viability while promoting benefit to land and water conservation for environmental benefit.

Application for Tool in Watershed:

DATA & METRICS

Evaluation Metrics: Acres of agricultural land conserved. To assess the potential applications of this framework in the watershed, project partners have developed a multi-decision tool to prioritize parcels for conversion based on potential benefits to soils, wildlife resilience, and streamflow enhancement.

Primary Quantifiable Benefits:

- Enhanced streamflow
- Improved water quality
- Improved water quantity
- Land conservation

Secondary Benefits:

- Soil health
- Wildfire resilience
- Native plant restoration
- Erosion control
- Policy guidance

Data Gaps: Location of suitable parcel level approaches (IWS-TQ model)

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors:

- Community buy-in and engagement

Constraints vs. Benefits:

- Partner and landowner participation
- Funding

Permitting & Coordination:

Associated Thresholds:

Considerations & Impacts:

Community Engagement:

- Multi-agency task force and stakeholder advisory group
- Landowner outreach and engagement

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring:

Forecasting & Outcomes:

REFERENCES

Figure 1: Land Resilience Partnership implemented bioswale. (Source: Watershed Progressive)

Tool Profile: Land Resilience Partnership

TOOL SUMMARY

Toolkit Project Type(s): Reduced Consumptive Use, Water Quality Improvements, Time Management of Water, Flow Augmentation
Related Tools: All tools within this toolkit are considered for use within the Land Resilience Partnership program.
Site Condition: Applicable on all scale residential, commercial, and small agricultural sites.
Impacts to Stream Flow/Hydrology: The program's primary impacts are from the aggregated effects of many projects designed and/or installed using tools that either reduce consumptive use or increase infiltration and stream flow.
Region: Ventura County and the City of Ojai.

DESCRIPTION

The Land Resilience Partnership (LRP) engages with community members and landowners to promote local on-site land and water management treatments, such as rainwater harvesting, greywater reuse, stormwater recharge projects, and water-efficient, fire-resilient landscaping. The LRP provides per-parcel direct technical assistance to landowners and managers to support the design and implementation of tools that enhance streamflows. The Land Resilience Partnership identifies opportunities, plans for creative and technical design solutions, and transforms land through site assessments, project cataloging, designs/plans, installation of identified tools, and funding support. The program also provides education and outreach throughout the community to enhance awareness, and spark further actions.

Application for Tool in Watershed: Applicable on all parcels and land-use types, including agriculture, ranching, schools, commercial, public, open space, residential, light industry.

DATA & METRICS

Evaluation Metrics: Water quality/quantity improvements (AFY) and reduced consumptive use (AFY).

Primary Quantifiable Benefits:

- Quantity of partners/projects
- Impact quantification for tools designed/implemented
- Cost to quantified impact ratio
- Reduced consumptive use
- Water quality/quantity improvements
- Enhanced streamflows

Secondary Benefits:

- Habitat enhancement
- Fire resilience
- Extreme heat mitigation
- Carbon reduction
- Groundwater recharge

LAND RESILIENCE PARTNERSHIP

- Food security
- Energy resilience
- Healthy communities
- Soil health
- Workforce development

Data Gaps:

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors:

- Community support and engagement
- Funding available for project implementation
- Potential for city or state-government sponsored incentives for specific project type implementation

Constraints vs. Benefits:

- Partner participation
- Funding

Permitting & Coordination:

- The Land Resilience Partnership coordinates with residential land stewards, commercial business owners, public and private landowners, renters, local and regional water districts, regional Resource Conservation Districts, city governments, and more.
- Permitting conditions related to specific tools within the toolkit (ie: greywater reuse, rainwater harvesting)

Associated Thresholds:

Considerations & Impacts:

Community Engagement:

- Community Events
- Demonstration Workshops
- Outreach and engagement via social media, podcasts, news-blasts

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring:
Forecasting & Outcomes:

Image 2: An LRP demonstration project for elementary school students. The program engages community members in watershed literacy activities. (Source: Watershed Progressive)

REFERENCES

1. *WaterToolkit.org*

Image 1: Prescribed burning at Bobcat Ranch conducted by CalFire personnel the along Hwy 128 Corridor - a common source of historic ignitions. (Source: Dash Weidhofer, via Audubon California)

Tool Profile: Prescribed Burn & Grazing Associations

TOOL SUMMARY

Toolkit Project Type(s): Water Quality Improvements
Related Tools: Rangeland BMPs, Vegetation Management, Upland Vegetation Management, Traditional Ecological Knowledge & Cultural Burning
Site Condition: Rangelands, grasslands and forests
Impacts to Stream Flow/Hydrology: Improved surface/subsurface water quality and quantity, and improved riparian and watershed function.
Region:

DESCRIPTION

Prescribed burning is the controlled application of fire to the land to reduce wildfire hazards, clear downed trees, control plant diseases, improve rangeland and wildlife habitats, and restore natural ecosystems. Sometimes called a controlled burn or prescribed fire, prescribed burning is one of the most important tools used to manage fire today (*California Air Resources Board*).

Most rangelands are fire-dependent ecosystems, whose health and restoration rely on the restoration of historical fire regimes. Prescribed Burn Associations (PBAs) are community-based, mutual aid networks made up of ranchers, volunteer firefighters, non-profit organization and other community members that help private landowners put "good fire" back on the land. PBAs form as private citizens and landowners decide that it is in their best interest to manage woody fuels and vegetation for the safety, economic and ecological benefit of their communities (*California Cattlemen's Association*).

The California Vegetation Management Program (VMP) provides guidance on prescribed fires with assistance from CalFire. The VMP's objectives for prescribed fires are:

1. Prevention of high-intensity wildland fires through reduction of the volume and continuity of wildland fuels
2. Watershed management
3. Range improvement including the control of noxious and invasive weeds.
4. Vegetation management
5. Forest improvement
6. Wildlife habitat improvement.
7. Maintain air quality

Furthermore, the USDA-NRCS Practice Standard for Prescribed Burning (CODE 338) describes the following purposes: 1) to control undesirable vegetation, 2) prepare sites for harvesting, planting, and seeding, 3) to control plant diseases, 4) to reduce wildfire hazards, 5) to improve wildlife habitat, 6) to improve plant production quantity and/or quality, 7) to remove slash and debris, 8) to enhance seed production, 9) to facilitate distribution of grazing and browsing animals, and 10) to restore and maintain ecological sites.

*Please see Rangeland BMPs to learn more about Prescribed Grazing.

Application for Tool in Watershed: On rangelands and grasslands.

DATA & METRICS

Evaluation Metrics: Numbers acres burned or wildlife habitat conserved and/or restored.

Primary Quantifiable Benefits:

- Wildfire resilience
- Increased water quantity and maintained water quality from managed watersheds

  Secondary Benefits:
- Protected and enhanced habitat for wildlife, fisheries, and endangered species
- Soil quality improvements, increased soil productivity, decreased erosion
- Restoration of natural ecological functions and plant communities
- Reduce the number and intensity of large, damaging wildfires with corresponding savings of suppression costs
- Increased public safety
- Decreased potential for damage from flooding and siltation
- Improved oak woodlands through fire management and regeneration
- Propagation of rare or endangered species of plants, which are fire dependent
- Improved air quality over the long term
- Improved forage and browse for livestock
- Increased opportunities for recreation and improve scenic vistas.
- Decreased risk to firefighters and other responders during wildland fires

Data Gaps:

- Studies should be conducted at multiple scales and the research should recognize the limited ability to translate conclusions across scales
- More focus on fire effects on all processes of ecosystem structure and function is needed
- Longer-term studies to understand effects of restoring fire regimes to rangelands and grasslands needed
- Knowledge of smoke characteristics and smoke management needed

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors: Decisions around prescribed burning are therefore complex and require consideration of the costs of implementation. Costs will depend on region-specific data about weather, fire history and ignition locations.

Factors that affect prescribed burning costs include:

- Burn preparation and line building
- Ignition type, mop-up requirements
- Number of acres burned
- Potential damage from escape
- Related social costs such as smoke intrusion, air quality, safety issues and aesthetics (*6*).

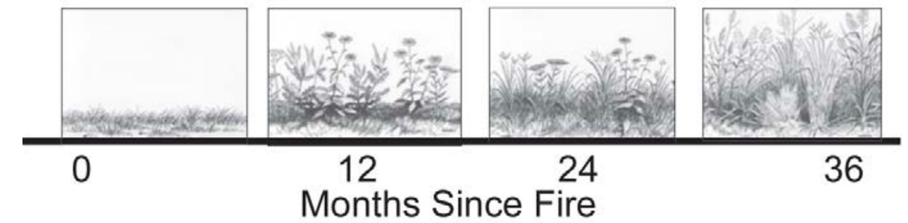

Figure 1: Illustration, grassland response to Prescribed Burning as conservation (Source: Jay Kerby and Gary Kerby via nrcs.usda.gov)

Constraints vs. Benefits:

- Risk is an inherent factor in controlled fire.
- Wildland Urban Interface (WUI) zones are areas that can benefit immensely from prescribed burns. These areas are high in human density, making coordination and preparation a challenge for land managers.

Permitting & Coordination:

- Conform to all applicable Federal, State, Tribal and local laws.
  Burn: California Air Resources Board (CARB); Obtain burn permit and submit a Smoke Management Plan *(Title 17, Sub Chapter 2 -https://ww2.arb.ca.gov/sites/default/files/2021-06/Title17.pdf)*
  Grazing: Prescribed Grazing Management Plan
- The California Inter-Agency Burn Permit (Form LE-5) is issued to State and local agencies wishing to conduct controlled burns.
- Project Type Burn Permit (Form LE-7) allows landowners to conduct controlled burns on burn days as determined by the local Air District when burning is not prohibited. This permit sets Minimum Precautions (Form LE-8) that must be taken by the permit holder to conduct the burn.

Associated Thresholds: N/A

Considerations & Impacts:

- Inappropriate fire regimes can result in significant impacts on biodiversity.
- Seek measures to avoid adverse effects to endangered, threatened, and candidate species and their habitats.
- Consider NRCS 'Conservation Standard for Prescribed Grazing' (*See "considerations" section within each standard document*)

Community Engagement:

- Coordination among forest managers, rangeland managers and public
- Public perception and social acceptance are crucial to the effectiveness of this tool
- The LANDFIRE LF Program provides 20+ national geo-spatial layers (e.g. vegetation, fuel, disturbance, etc.), databases, and ecological models that are available to the public for the US and insular areas.
- Training opportunities for personnel in incident organization, operations, fire behavior, firing method and effects of weather influences.

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring:

- Burn: All fires will be monitored and evaluated post-fire to determine that predetermined burn objectives and metrics were met based on the identified resource concern. This may include but is not limited to targeted—
    - Density, structure, and composition of native plant communities.
    - Plant productivity and health.
    - Reduction of plant pest populations and nonnative plants.
    - Reduction in hazardous fuels.
    - Improvements in wildlife habitat elements.
- Perform air monitoring for smoke conditions associated with prescribed burns and air quality data collection. (*See Shasta Monitoring Plan for reference.*)
- Grazing: Monitoring data and grazing records will be used on a regular basis within the prescribed grazing plan to ensure that objectives are being met, or to make necessary changes in the prescribed grazing plan to meet objectives.

Forecasting & Outcomes:

- Burn: All post-fire monitoring will be used to inform prescriptions for future burn plans to ensure safe, efficient, and effective application of prescribed fire to achieve resource concern objectives across all scenarios and land uses.

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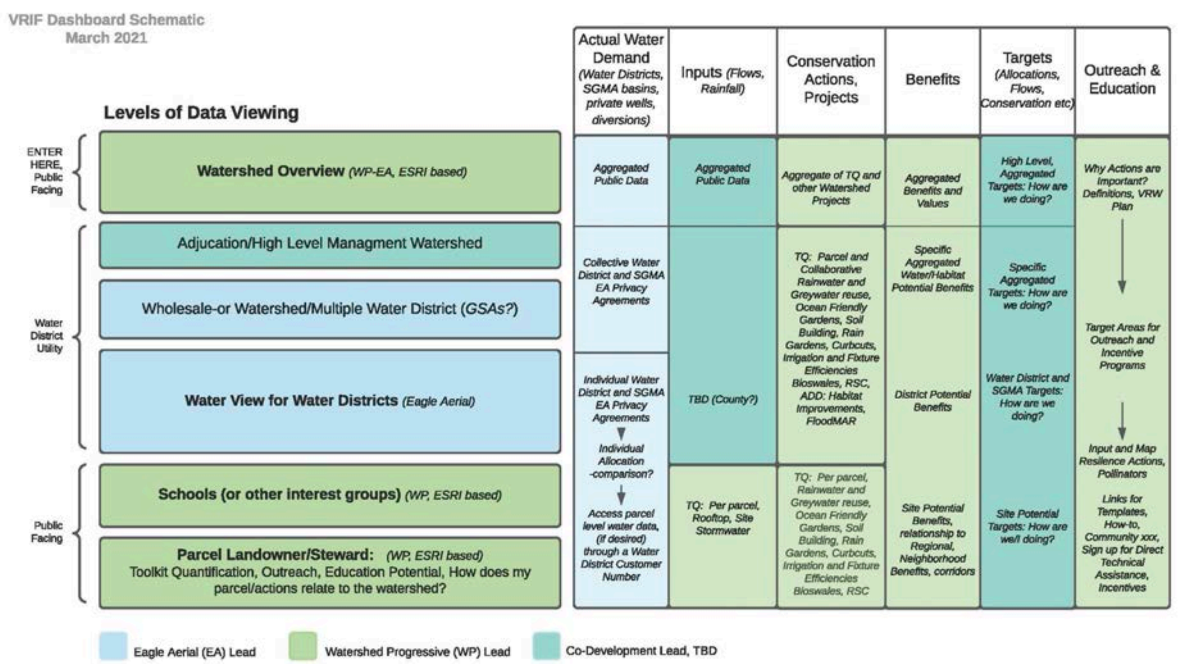

Figure 1: WRIF Dashboard Schematic, March 2021 (Source: Watershed Progressive)

Tool Profile: Watershed Project Dashboard

TOOL SUMMARY

Toolkit Project Type(s):
Related Tools: The Watershed Project Dashboard helps to identify areas and regions most suitable for all tools within the toolkit.
Site Condition: Remote, GIS, Parcel-based

Impacts to Stream Flow/Hydrology:
Region:

DESCRIPTION

Ventura Water Dashboard Project Team will develop an online Ventura Water Dashboard prototype (Dashboard) that will operate with the Ventura River Watershed Council Map Viewer, storing data as well as applied resource user metrics. The Dashboard will supply customized informative values to perform best return on investment versus streamflow enhancement in each region, as well as provide assessment tools and data visualizations of relevance to a diverse array of stakeholders (e.g., school age children, landowners, water managers, general public) that promote better understanding of water resources. Outreach strategies will be incentive based to focus on innovative tool kits, and data evaluation will further refine study results. In total, the components and processing steps will be encapsulated into an interactive, scalable model for assessing stream flow enhancement opportunities in other intermittent stream-based watersheds in (primarily Southern) California.
Application for Tool in Watershed:

DATA & METRICS

Evaluation Metrics:
Primary Quantifiable Benefits:
Secondary Benefits:
Data Gaps:

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors:
Constraints vs. Benefits:
Permitting & Coordination:
Associated Thresholds:
Considerations & Impacts:
Community Engagement:

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring:
Forecasting & Outcomes:

Image 1: The Ventura River Preserve. (Source: AllTrails.com)

Tool Profile: Watershed Literacy & Engagement

TOOL SUMMARY

Toolkit Project Type(s):

Related Tools:

Site Condition:

Impacts to Stream Flow/Hydrology:

Region: Anywhere

DESCRIPTION

Application for Tool in Watershed:

DATA & METRICS

Evaluation Metrics: Enhanced stream flows

Primary Quantifiable Benefits:

- Improved water security
- Workforce development
- Food security
- Energy resilience

Secondary Benefits:

- Healthy communities
- Habitat creation
- Water conservation
- Soil health
- Groundwater recharge
- Fire resilience
- Extreme heat reduction
- Carbon reduction

Data Gaps:

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors:
Constraints vs. Benefits:

Permitting & Coordination:
Associated Thresholds:
Considerations & Impacts:
Community Engagement:

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring:
Forecasting & Outcomes:

REFERENCES

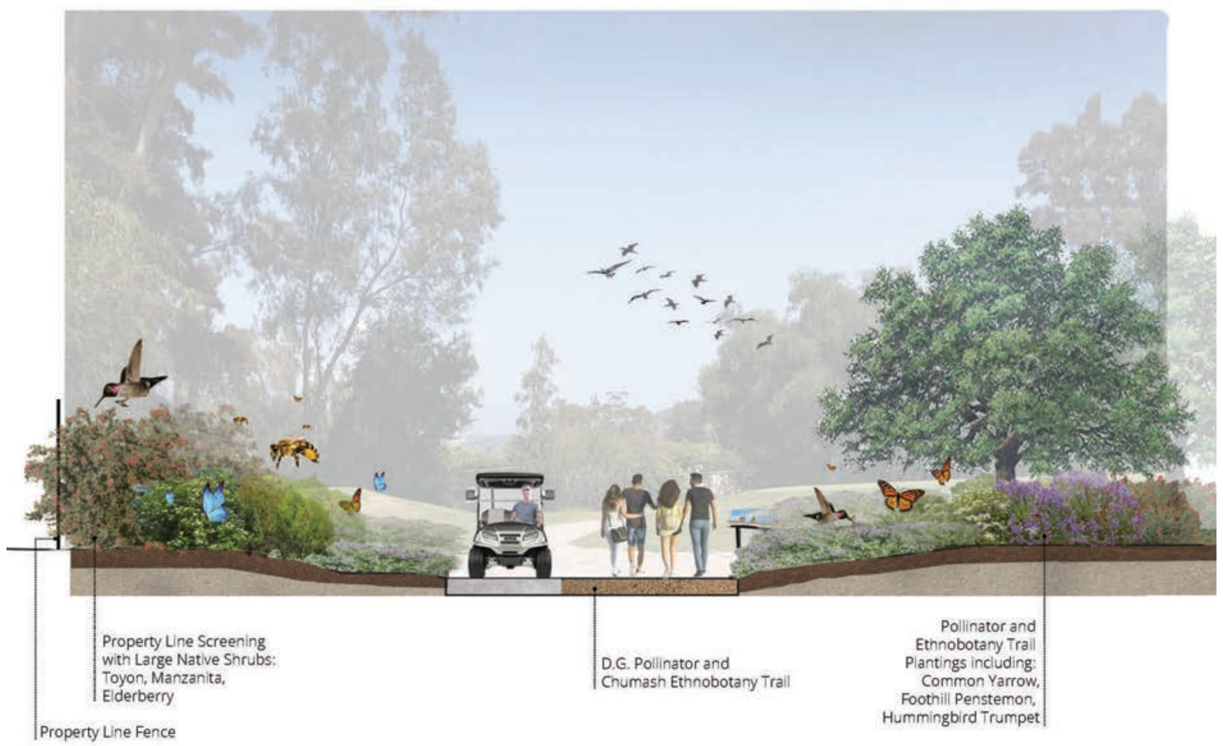

Image 1: Rendering for a proposed Pollinator Corridor (Source: Watershed Progressive)

Tool Profile: Pollinator Programs

TOOL SUMMARY

Toolkit Project Type(s): Reduced Consumptive Use, Water Quality Improvements
Related Tools: Climate Appropriate Plantings, Low Impact Development, Stormwater Reuse, Green Roofs, Upland Vegetation Management, Meadow Restoration
Site Condition: Where native plants can help intercept rain (slow and sink water), increase soil organic matter (enhance water retention), replace high-water use vegetation, shade soil (reduce evaporation), intercept rainfall (enhance water quality by reducing erosional sediment loads).

Impacts to Stream Flow/Hydrology: Water quantity, quality, and timing.

Region: Anywhere

DESCRIPTION

Pollinator pathways are corridors of native plants that provide nutrition and habitat for pollinator species, including birds, insects and bats. Pollinator pathways help to restore and enhance habitat, providing pathways into new habitat for wildlife in response to climate change.

Application for Tool in Watershed:

DATA & METRICS

Evaluation Metrics: Acreage of habitat created/restored.
Primary Quantifiable Benefits:

- Enhanced habitat
- Protected wildlife and pollinator species
- Soil health

Secondary Benefits:

- Enhanced streamflows
- Water quality improvements
- Fire resilience
- Recreational space and community resilience

Data Gaps:

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors:
Constraints vs. Benefits:
Permitting & Coordination:
Associated Thresholds:
Considerations & Impacts:
Community Engagement:

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring:
Forecasting & Outcomes:

Image 1: (Source: PPIC.org)

Tool Profile: Water Quality Initiatives

TOOL SUMMARY

Toolkit Project Type(s):
Related Tools:
Site Condition: Interconnected surface and groundwater in the watershed.
Impacts to Stream Flow/Hydrology: Water quality improvement.
Region:

DESCRIPTION

Total Maximum Daily Loads (TMDLs), NPDES and MS4 can help assist in water quality of the Ventura River flows.

From the USEPA Region 9 report on the TMDL:

The Ventura River Estuary and the Ventura River (including its tributaries), located in Ventura County, are identified on the 1998, 2002, 2006, and 2010 Clean Water Act (CWA) Section 303(d) list of impaired water bodies due to algae, eutrophic conditions, low dissolved oxygen, nitrogen, pumping and water diversions (Table 1-1). The CWA requires the development of Total Maximum Daily Loads (TMDLs) to restore impaired water bodies to fully support their beneficial uses. The Algae, Eutrophic Conditions, and Nutrients Total Maximum Daily Loads for Ventura River and its Tributaries (Ventura River Watershed Algae TMDL; LARWQCB, 2012) is concurrently being developed to address the algae, eutrophic conditions, low dissolved oxygen, and nitrogen impairments (LARWQCB, 2012). In conjunction with the Ventura River Watershed Algae TMDL, this TMDL provides background information used by the United States Environmental Protection Agency (USEPA) on the pumping and water diversion impairments associated with Ventura River Reach 3 (Reach 3) and Ventura River Reach 4 (Reach 4).

Application for Tool in Watershed: As surface water levels decline, water quality issues are exacerbated. Poor water quality can negatively impact riparian flora and fauna which can result in a cascade of impacts within the system and to receiving waters (e.g., the Pacific Ocean).

DATA & METRICS

Evaluation Metrics:
Primary Quantifiable Benefits:

- Improved water quality
- Habitat creation

Secondary Benefits:
Data Gaps: Water quality throughout the watershed, pollutant sources, water quality of groundwater basins

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors:
Constraints vs. Benefits:
Permitting & Coordination:
Associated Thresholds:
Considerations & Impacts:
Community Engagement:

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring:
Forecasting & Outcomes:

REFERENCES

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SECTION 4.

4. Built Environment
    a. Wastewater Reuse & Recycling
    b. Low Impact Development
        i. Green Infrastructure (Streets & Alleys)
        ii. Climate Appropriate Planting
        iii. Rainwater Reuse
        iv. Green Roofs
    c. Fire Management BMPs
        i. Hydrated & Vegetated Buffer Strips
        ii. Fire Resilience Landscaping & Home Hardening
    d. Industrial & Mechanical Reuse
    e. Irrigation Efficiencies
    f. Water Conservation Traditional BMPs
    g. Injection Wells & Dry Wells
    h. Erosion Control

Image 1: A greywater system installation showing mulch basins. (Source: GreyWaterAction.org)

Tool Profile: Wastewater Reuse & Recycling

TOOL SUMMARY

Toolkit Project Type(s): Reduced Consumptive Use, Flow Augmentation, Water Quality Improvements
Related Tools: Low Impact Development, Green Infrastructure, Stormwater Reuse, Rainwater Reuse, Climate Appropriate Planting, Green Roofs
Site Condition:
Impacts to Stream Flow/Hydrology:
Region:

DESCRIPTION

Wastewater reuse includes the reuse of blackwater, from toilets, and greywater from sinks, showers, and laundry machines. Blackwater reuse requires significant investments in treatment processes and are therefore more appropriate for larger scale developments. The California Plumbing Code (CPC) defines greywater as wastewater generated from bathroom sinks, showers, tubs, and washing machines. Systems of these sort can be used to offset potable demand or to satisfy the irrigation demand for new plants that can be used to create a lusher environment and enhance fire resilience. These systems can save water, reduce environmental impacts, and improve quality of life. Though all these sources represent great opportunities to transform waste to resource, the Laundry-to-Landscape system is the simplest, most cost-effective, and does not require a building permit, making it an excellent place to start.

The average family of four uses 5,000-8,000 gallons of water annually in their washing machine alone. If 100 families installed a simple Laundry-to-Landscape greywater system, this could keep 500,000-800,000 thousand gallons of water a year in the Ventura River.

There are many benefits to greywater re-use. Irrigating fruit trees with greywater increases food security. Shade trees irrigated with greywater can reduce heating costs and make outdoor spaces more comfortable. Greywater helps keep soils hydrated, improving fire resistance of homes and landscapes. As greywater seeps into the soil slowly over time it recharges groundwater supply. This eventually would help to sustain the Ventura River and its tributaries through dry months. Sustaining the river would increase habitat and health of fish, birds, and other wildlife.

Application for Tool in Watershed:

DATA & METRICS

Evaluation Metrics:

Primary Quantifiable Benefits:

- Improved water security
- Improved water quality

Secondary Benefits:

- Energy resilience
- Extreme heat reduction
- Fire resilience
- Carbon reduction

- Habitat creation
- Enhanced stream flows
- Soil health
- Improved air quality

Data Gaps:

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors: In addition to slope, low infiltration potential can affect the viability of greywater dispersion since larger dispersion areas are required when the infiltration rate is slower. Every greywater system must adhere to site-specific elements that are unique to that site; there is no "one size fits all" option for greywater reuse. There are, however, many similarities between the various types of greywater systems. The cost estimates shown in this report section reflect an average size residential home for a family of four. This report section will categorize residential greywater systems into four tiers: laundry to landscape, branched drain system, pumped irrigation system, and NSF 350 system. Each tier will be given an estimated price range for materials and labor based on typical costs for similar systems. For reference, Table 2 provides average potable and wastewater volumes for a family of four to demonstrate the amount of greywater that can be expected to be reused annually. Greywater generation estimates specific to the CRR site are provided below in Section 5, Site Potential.

Every greywater system must adhere to site-specific elements that are unique to that site; there is no "one size fits all" option for greywater reuse. There are, however, many similarities between the various types of greywater systems. The cost estimates shown in this report section reflect an average size residential home for a family of four. This report section will categorize residential greywater systems into four tiers: laundry to landscape, branched drain system, pumped irrigation system, and NSF 350 system. Each tier will be given an estimated price range for materials and labor based on typical costs for similar systems. For reference, Table 2 provides average potable and wastewater volumes for a family of four to demonstrate the amount of greywater that can be expected to be reused annually.

Constraints: When properly designed and implemented, greywater reuse systems represent a very safe alternative water supply for non-potable applications, like irrigation and toilet flushing. However, there are considerations that must be incorporated into greywater reuse planning efforts so that risks are minimized. The California Plumbing Code (CPC) and industry best management practices have been developed with years of feedback from real world projects to reduce risks and ensure installed systems are well designed

Although greywater can contain potentially hazardous pathogenic microorganisms, bacteria, and viruses, these contaminants can be easily managed with adherence to CPC standards and professional system installation. While the term greywater includes water from sinks, showers, and laundry; these sources of greywater carry different levels and types of contamination risk. In some cases, greywater is divided up into light and dark greywater. Light greywater is water from bathroom sinks, showers, bathtubs, laundry, drinking fountains, and equipment condensate. For most greywater systems, it is important to consider the user's product inputs such as detergents, soaps, and shampoos. In large enough doses, some chemicals present in these products can have adverse effects on the plants they are irrigating or the soils in the dispersal area. One way that the CPC prevents contamination is by requiring a diverter valve to allow the user to direct the flow of greywater to the building sewer or the dispersal area depending on what is going down the drain. When bleaches and other potentially harmful products are used, the greywater should be diverted to the sewer to protect the landscape and decrease the potential for contamination. For commercial laundry applications, ozone can be used to replace costly laundry detergents. There is a large and growing list of available products that are greywater-friendly, making this source of potential contamination relatively easy to mitigate.

Dark greywater is water from kitchen sinks and dishwashers. Dark greywater tends to contain higher levels of organic material, suspended solids, and food-borne pathogens. Greywater from kitchen sinks is not considered greywater per the CPC since it contains fats, oils, grease from food residue that could block plumbing and create nuisance odors. This highlights the importance of adherence to CPC standards and industry best practices.
A properly designed and maintained greywater reuse system can provide all the benefits of greywater reuse with very little contamination risk. Adherence to the CPC standards, industry best management practices, and professional installation can ensure a safe and sustainable greywater reuse system.

Infrastructure challenges associated with greywater reuse are not limited to the constraints on greywater reuse systems themselves. Since greywater reuse can offset the demand for potable water infrastructure by reusing greywater for irrigation and toilet flushing instead of drawing more water from the tap, expanded use of alternative water sources like greywater, rainwater, and stormwater can reduce the demand for new potable water infrastructure. These potable water infrastructure elements include dams, aqueducts, and reservoirs. This reduction in the demand for potable water infrastructure is an important aspect of the benefits of greywater reuse because new potable water infrastructure is energy intensive and usually results in significant environmental impacts including habitat depletion and loss of endangered species. Moreover, new large-scale potable water infrastructure is costly, and these expenses are passed on to rate payers. Since water is an essential need for all people, increased water rates take a proportionally greater amount away from low-income populations, which has equity implications. By increasing the reuse of greywater, the risks, costs, and environmental impacts associated with new potable water infrastructure are reduced.

Permitting & Coordination: The most important code requirements for these Laundry to Landscape (L2L) systems in Ventura County are:

- No human contact with greywater. This means all greywater must be discharged 2" subsurface, normally in a mulch basin.
- No ponding, no pooling and no runoff allowed. Greywater must be contained on your property.
- A 3-way diverter valve with signage and an owners' manual are required. This enables you to discharge to the municipal sewer or septic system as needed.
- No pump or electricity may be required to move water (unless you want to apply for a permit and deal with more maintenance)
- No alteration of existing plumbing (unless you want to apply for a permit)

To minimize risks associated with greywater systems, care must be taken to avoid conflicts with surrounding infrastructure elements and natural features. Greywater mulch basins too close to a building can undermine the integrity of that building's foundation. A greywater subsoil irrigation field too close to a property line can create a nuisance for surrounding property owners. To minimize these potential conflicts, the CPC prescribes required setbacks from elements of the built and natural environment.

Associated Thresholds:
Considerations & Impacts:
Community Engagement:

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring:
Forecasting & Outcomes:

OVERALL ANNUAL SUMMARY			
OCCUPIED DAYS:	351		CODE VS LOW FLOW % REDUCTION
	CODE / CAL-GREEN GAL/YR	LOW FLOW	
Total Non-potable Water Use	11,232	7,020	38%
Total Potable Water Use	76,167	61,706	19%
Total Water Use	87,399	68,726	21%
Total Greywater Available	56,146	44,577	
Total Blackwater Available	13,773	10,404	
Total Waste Water	69,919	54,981	21%
Waste Water (-GW reuse)	13,773	10,404	24%

Figure 1: Average Potable and Wastewater Volumes for a Family of Four (Source: Watershed Progressive)

TIER I: LAUNDRY TO LANDSCAPE

Laundry to landscape, or "Clothes Washer System" as it is referred to in the CPC, is a greywater system that uses the greywater from clothes washing machines for sub-surface landscape irrigation or dispersion. This system is the most economical since it typically requires the least amount of plumbing modifications and utilizes the clothes washing machine's pump for greywater distribution. Figure 5 provides a visual to explain laundry to landscape systems. Table 3 provides a cost estimate for this type of system.

Assumptions:

- The clothes washing machine is located in room with an exterior facing wall.
- The exterior facing wall is easily penetrable for the system's distribution pipes.
- The landscape to be irrigated with the greywater is level to or below the outlet for the clothes washing machine.
- The clothes washing machine has existing drain pipe to building's sewage system.

Typical Scope:

- Install manual 3-way valve for switching between greywater distribution to landscape, or greywater to building's sewage system, and connect to laundry outlet piping, existing drain piping, and piping for distribution to landscape.
- Install auto vent valve on distribution piping directly after 3-way valve to prevent siphoning of greywater back to clothes washing machine.
- Penetrate external wall for distribution pipe and run pipe to all areas where greywater will be distributed.
- Dig small basins near or around plants to be irrigated with greywater.
- Install small irrigation boxes in the basins with ball valves connected to distribution pipe for adjusting greywater flows to achieve even distribution.
- Install mulch throughout basins to ensure greywater is not exposed.
- Test system for optimal functionality.

Typical Material:

- Manual 3-way valve.
- Auto vent valve.
- Small irrigation boxes with purple lids.
- Ball valves with purple handle.
- Pipe and fittings.
- Mulch.

MATERIALS	$300 - $500
LABOR	$1,200 - $2,000
TOTAL	$1,500 - $2,500

Figure 2: Estimated System Costs for Laundry to Landscape

TIER II: BRANCHED DRAIN SYSTEM

A branched drain system is a greywater system that uses multiple greywater sources for sub-surface landscape irrigation. The branched drain system relies on gravity to distribute the greywater to mulch basins throughout the landscape. These systems require minimal maintenance and energy and are economical due to the limited equipment needed. These systems require planning and permitting, so the cost estimate reflects average fees for this work. Table 4 provides a cost estimate for this type of system.

Assumptions:

- The building's drain plumbing is accessible within a crawlspace or a basement, or the greywater sources' drain plumbing has already been segregated from the rest of the home's drain plumbing (homes on concrete slabs have increased costs for the greywater plumbing due to difficult access to pipes).
- There is a penetrable wall for bringing greywater distribution pipes to the landscape.
- The area to be landscaped is at a downhill slope from greywater plumbing.

Typical Scope:

- Design and go through permit process.
- Plumb greywater sources' drain pipes together.
- Install manual or automated 3-way valve for switching between greywater distribution to landscape irrigation, or greywater to building's sewage system.
- Penetrate external wall or foundation for distribution pipe and run pipe to all areas where greywater will be distributed.
- Dig basins near or around plants to be irrigated with greywater.
- Split distribution piping to get to all basins equally.
- Place irrigation box with cover for all outlets.
- Install mulch throughout basins to ensure greywater is not exposed.
- Test system for optimal functionality.

Typical Materials:

- 3-way valve with optional actuator for automation.
- Backwater valve to prevent connection to sewer system from contaminating irrigation system.
- Pipe and fittings for plumbing under house and distribution system.
- Small irrigation boxes with purple lids.
- Mulch.

MATERIALS	$500 - $1,000
LABOR	$3,500 - $5,000
TOTAL	$4,000 - $6,000

Figure 3: Estimated System Costs for Branched Drain System

Image 1: Rain Garden, an example of an LID project (Source: Surfrider Foundation website)

Tool Profile: Low Impact Development

TOOL SUMMARY

Toolkit Project Type(s): Flow Augmentation, Reduced Consumptive Use, Water Quality Improvements
Related Tools: Green Infrastructure, Stormwater Reuse, Rainwater Reuse, Green Roofs, Climate Appropriate Planting
Site Condition: New development, especially near waterways and green belts.
Impacts to Stream Flow/Hydrology: Low impact development helps manage wet weather flows, improves water quality, and provides flood protection. This tool promotes the natural movement of water within the landscape.
Region: Works well in most of the built environment throughout the watershed.

DESCRIPTION

Low Impact Development (LID) is a sustainable practice that uses site design and stormwater management to maintain the site's pre-development runoff rates and volume. The goal of LID is to mimic a site's natural hydrological functions by using design techniques that infiltrate, filter, store, evaporate, and detain runoff close to the source of rainfall *(SWRCB)*. LID practices include:

- Rainwater harvesting & reuse
- Rain gardens & bioretention
- Infiltration basins
- Dry wells & ponds
- Green roofs
- Permeable pavers
- Curb cuts
- Vegetated swales & buffer strips
- Soil amendments
- Tree preservation & habitat restoration
- Constructed wetlands

Application for Tool in Watershed: Bio-retention basins, rain gardens, vegetated rooftops, rain barrels and permeable pavements. Contour swales, hydro-seeding, permeable surfaces.

DATA & METRICS

Evaluation Metrics:

- Water conserved (AFY)
- Quantity water treated

Primary Quantifiable Benefits:

- Improved water quality
- Improved water security
- Carbon sequestration
- Groundwater recharge

Secondary Benefits:

- Energy resilience
- Flood mitigation
- Carbon reduction
- Habitat creation
- Groundwater recharge
- Enhanced stream flows
- Improved air quality
- Soil health
- Extreme heat island mitigation

Data Gaps:

- Location of suitable parcel level approaches (pending IWS-TQ model)
- Water agency streamflow diversion offsets for conservation
- Regional connectivity of interstitial flows to streamflow (pending SGMA GSPs, SWRCB SW/GW model)

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors:

- Can result in reduced construction and maintenance costs of new developments
- Reduction in drainage and flood control infrastructure
- Workforce development, creates 'green jobs'
- Increases land values and improves marketability

Constraints:

- Local codes that discourage the implementation of these strategies, including street widths for emergency vehicle access, street standard for stormwater management, and open space and parking requirements.
- Available lands square footage for implementation
- Initial costs
- Retrofit constraints and codes, and ensuring adequate maintenance

Permitting & Coordination: Interdepartmental coordination between land managers, government agencies, designers, engineers, and maintenance facilities may be necessary to implement Low Impact Development practices.

Associated Thresholds: N/A

Considerations & Impacts: Training and education are needed to properly maintain and manage LID installations and inform local agencies.

Community Engagement:

- Land conservancies
- Agricultural farmers and landowners to coordinate about Ah discharge
- Water Districts
- Groundwater basins

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring:
Forecasting & Outcomes:

Image 2: Curb Cuts, an example of an LID project. (Source: State Water Board)

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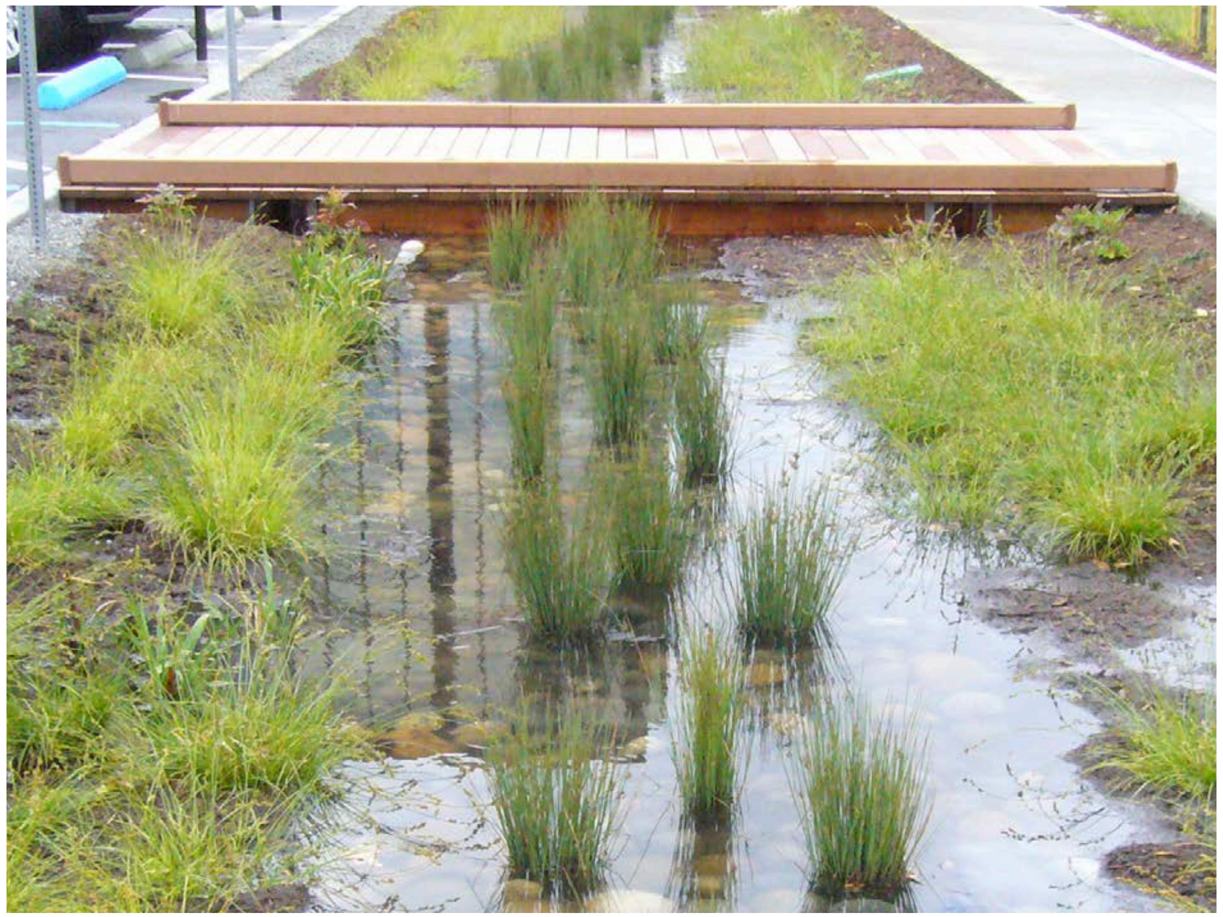

Image 1: Green Street bioswale to help slow, spread and sink stormwater. (Source: calcog.org)

Tool Profile: Green Infrastructures (Streets & Alleys)

TOOL SUMMARY

Toolkit Project Type(s): Flow Augmentation, Water Quality Improvements
Related Tools: Stormwater Reuse, Rainwater Reuse, Green Roofs, Climate Appropriate Planting, Low Impact Development
Site Condition: Most appropriate in urban areas with significant hydro-modification.
Impacts to Stream Flow/Hydrology: Water-oriented green infrastructure in urban areas primarily benefits streamflow and local hydrologic conditions by limiting the flow of contaminated runoff, which improves water quality. These contaminants can include suspended solids, fecal coliform, heavy metals, as well as many others often found in urban refuse. Moreover, by increasing infiltration these BMPs can serve to enhance groundwater recharge, which can enhance streamflow under certain conditions.
Region: Urban areas.

DESCRIPTION

Runoff from stormwater is a major cause of water pollution. Green infrastructure includes a variety of best management practices to mitigate the negative watershed-related environmental impacts of urban development from stormwater runoff by filtering and absorbing stormwater where it falls. Green streets and alleys are designed to help filter and store stormwater through bioswales, curb cuts and pervious pavement.

In 2019, U.S. Congress enacted the Water Infrastructure Improvement Act, which defines green infrastructure as "the range of measures that use plant or soil systems, permeable pavement or other permeable surfaces or substrates, stormwater harvest and reuse, or landscaping to store, infiltrate or evapo-transpirate stormwater and reduce flows to sewer systems or to surface waters."

These interventions are a means to slow the flow of water on impervious surfaces, sink the water into the ground where it can recharge groundwater supples, and reuse stormwater to enhance urban greening. Green infrastructure reduces reliance on grey infrastructure (a system of gutters, pipes and tunnels), mitigating the financial, social and environmental costs associated with construction and maintenance of grey infrastructure.

Application for Tool in Watershed: The primary indicators of the impact of green infrastructure are: 1) quantity of stormwater pollutants treated through bio-filtration or infiltration and 2) increased infiltration (for design storms and on an annual basis). Secondary indicators include decreases in reliance on grey infrastructure and associated reductions in cost.

DATA & METRICS

Evaluation Metrics:

- Amount of stormwater pollutants treated
- Increases in storm drain capacity
- Can be evaluated using sub-watershed analysis in GIS and annual runoff water resources calculations
- Number of trees and plants irrigated with stormwater, offsetting municipal supplies.

Primary Quantifiable Benefits:

- Increased Infiltration
- Urban green enhancement
- Reduction in maintenance of grey infrastructure

Secondary Benefits:

- Soil health
- Flood mitigation
- Healthy communities
- Extreme heat reduction
- Carbon reduction
- Groundwater recharge
- Habitat enhancement
- Enhanced streamflows
- Reduced consumptive use

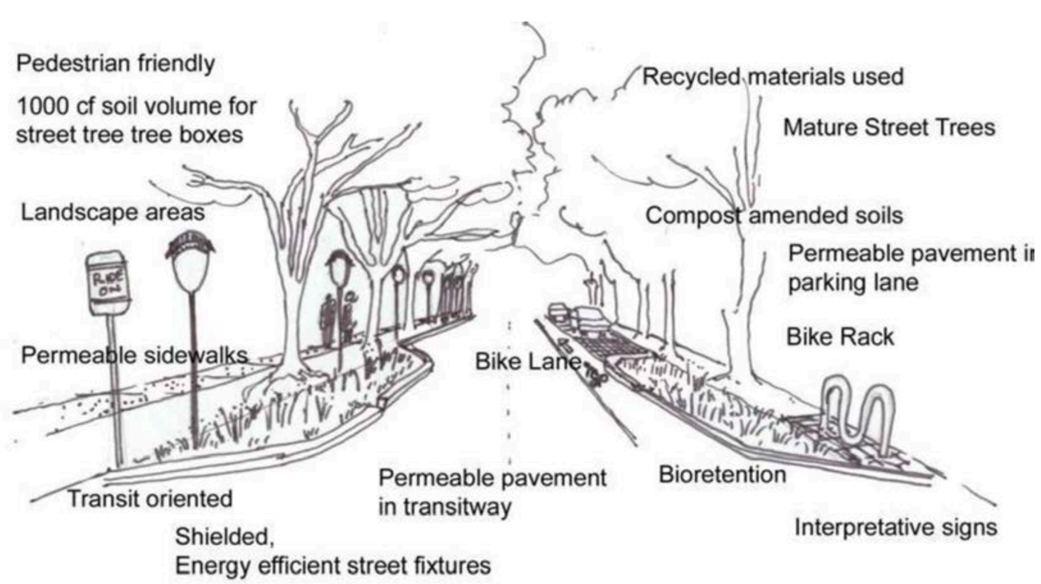

Figure 1: Anatomy of a Green Street (Source: EPA.gov)

Data Gaps:

- Localized average stormwater contamination rates by contaminant.
- Annual infiltration calculations that better account for the sponge effect of soils.
- Mapping of elements of the built environment that affect stormwater flow.
- Understanding of hydro-geology to better understand how increased infiltration related to increased instream flow.

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors:

Constraints:

- Design constraint based on site conditions (ie: slope limitations)
- Design, construction and permitting costs

Permitting & Coordination:

- Encroachment permit for treatments in the public right of way
- Grading permit when substantial grading is necessary
- Building permit

Associated Thresholds: N/A

Considerations & Impacts:

- Enhances instream flow quantity and quality with bioswales that increase infiltration and prevent contaminated runoff from reaching storm drains, streams, rivers and the ocean.
- In areas where water treated by a bioswale or pervious pavement does not reach a stream or river, these interventions would only enhance stream flow water quality.

Community Engagement:

- Changes to public spaces require coordination and planning with community members, stakeholders and city officials.
- Opportunities for interpretive signage that explain the benefits of green infrastructure and demonstration projects on site.

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring:

- Groundwater quantity and quality monitoring.
- Monitoring impacts to local ecosystems- anadromous fish species in particular.
  Forecasting & Outcomes:
- With climate change predicted to increase the occurrence of extreme weather events, the sizing of green infrastructure treatments may need to be altered as larger storms become more common.

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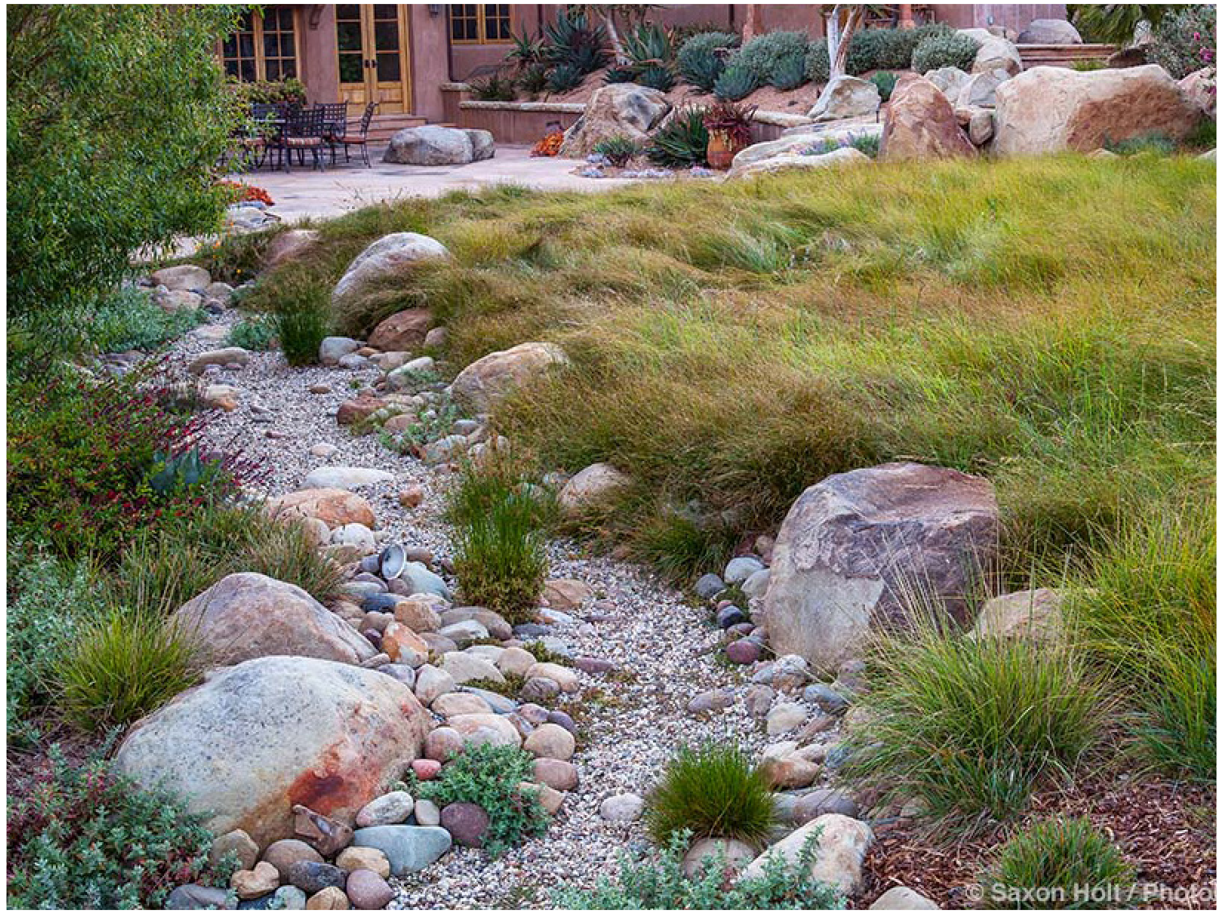

Image 1: Backyard bioswale, Carex lawn with dry creek rainwater bioswale for permeability (Source: photobotanic.com)

Tool Profile: Stormwater Reuse

TOOL SUMMARY

Toolkit Project Type(s): Reduced Consumptive Use, Flow Augmentation, Time Management of Water, Water Quality Improvements
Related Tools: Rainwater Harvesting & Reuse, Green Roofs, Climate Appropriate Planting, Low Impact Development, Green Infrastructure, Regenerative Stormwater Conveyance
Site Condition:

Impacts to Stream Flow/Hydrology: Stormwater reuse enhances water quality and in some cases improves streamflow quantity. Water quality is improved through the capture of stormwater on-site, preventing contaminated runoff from flowing down streets and into local rivers, streams and ultimately, the ocean. Stormwater reuse allows for increased flow quantities through reduced consumptive use when: 1) the municipal source comes from stream diversion or surface water sources that flow to stream and 2) the stormwater is reused to offset existing non-potable demand, like irrigation. Stormwater also increases infiltration on-site, recharging groundwater.

Region: Areas where there is a large concentration of water from precipitation, and where water is unable to sufficiently infiltrate into the ground, for reasons that include: expansive impervious or even semi impervious surfaces, precipitation rates in excess to the infiltration rates of the soil types, and infiltration zones which are already highly saturated.

DESCRIPTION

Water runoff from our cities, streets, industrial facilities and construction sites can carry pollutants, negatively impacting water quality. The regulation and treatment of stormwater runoff are designed to turn stormwater runoff into a resource while improving both water quality and quantity. Stormwater capture and reuse are realized through practices that include: Low Impact Development (LID) and Green Infrastructure (Streets and Alleys). Stormwater management practices provide a range of multiple benefits like improved air quality, habitat enhancement, extreme heat island effect mitigation, energy resiliency and higher property values.

"With longer drought periods and heavier rainfall events becoming more common, urban stormwater capture represents a significant opportunity to enhance community resiliency to climate change." (*Pacific Institute*

Application for Tool in Watershed:

DATA & METRICS

Evaluation Metrics:
Primary Quantifiable Benefits:

- Improved water quality
- Improved water quantity

Secondary Benefits:

- Habitat enhancement
- Enhanced streamflows
- Improved air quality
- Flood mitigation
- Extreme heat island effect mitigation
- Carbon reduction

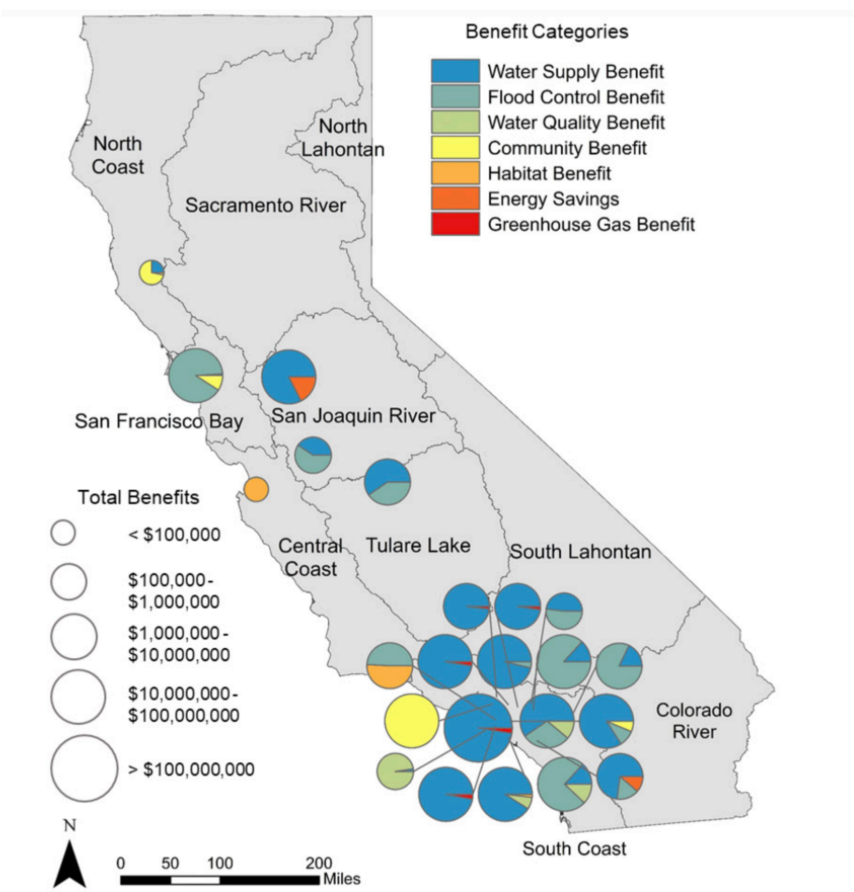

Figure 1: Reported benefits of stormwater capture projects in California. These benefits can help build partnerships among agencies that are interested in achieving these outcomes. (Source: Pacific Institute)

- Energy resilience

Data Gaps:

- Accurate precipitation data
- Accurate land surveys and analyses

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors: Stormwater reuse is feasible for most urban and rural environments.
Constraints:

- Precipitation forecasting for areas where stormwater strategies are being considered.
- Technical feasibility challenges when attempting storm water quality retrofit projects *(waterboards.ca.gov)*
- Legal considerations including water rights, instream environmental impacts and stormwater infiltration in adjudicated and non-adjudicated basins *(waterboards.ca.gov)*
- Available funding for project design, planning, and implementation.

Permitting & Coordination:

Associated Thresholds:

Considerations & Impacts:

Community Engagement:

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring:

Forecasting & Outcomes:

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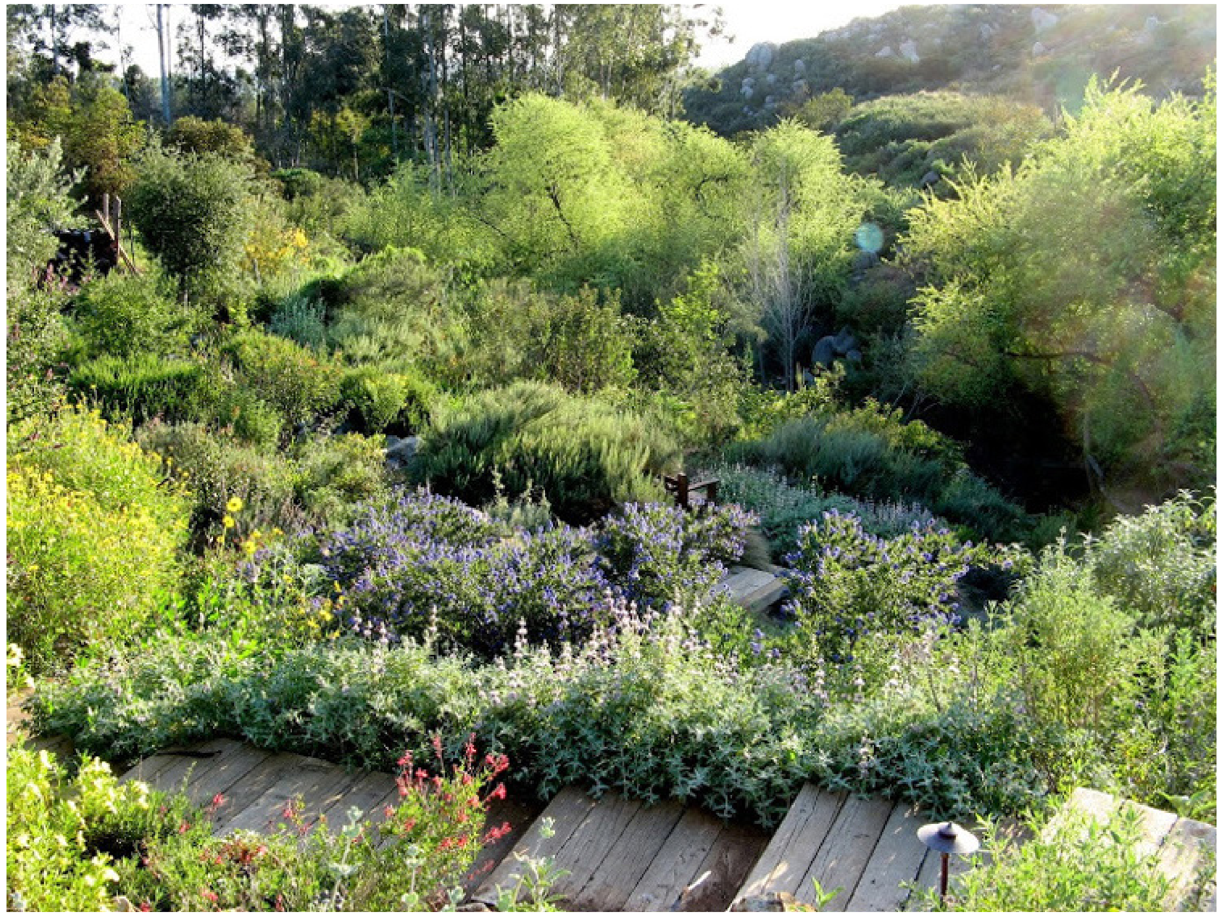

Image 1: Native plant garden (Source: CNPD, Dennis Mudd)

Tool Profile: Climate Appropriate Planting

TOOL SUMMARY

Toolkit Project Type(s): Reduced Consumptive Use, Flow Augmentation, Water Quality Improvements
Related Tools: Rainwater Harvesting & Reuse, Green Roofs, Stormwater Reuse, Low Impact Development, Green Infrastructure
Site Condition: Landscapes that are planted with lawns or other high water-use ornamental plants are ideal candidates for re-landscaping with Climate Appropriate Planting.
Impacts to Stream Flow/Hydrology:
Region: Applicable in most public and private landscapes, from residential to commercial.

DESCRIPTION

Climate Appropriate Planting (CAP) is the planting of native and drought tolerant plant species which require little to no additional irrigated water to survive. Native plants have evolved to thrive in their regions as part of an ecosystem habitat for birds, butterflies, insects and wildlife. Native and non-invasive drought tolerant plants are important elements in climate appropriate planting as they save water and provide habitat to create enriching and resilient landscapes.

Rainwater harvesting and greywater reuse can compensative for more water-intensive, community supported planting that provide critical shade and food crops. Climate appropriate planting promotes cultural and ecological resilience, integrating the need for plants to provide food, medicine, shade and wildlife habitat roles. The implementation of climate appropriate planting saves money on water bills. Climate appropriate plants are low-maintenance. Climate appropriate fruit trees and vegetable gardens provide food resilience and conserve more water than irrigated lawns, and in most circumstances can be irrigated with greywater or rainwater. Well-placed shade trees help mitigate extreme heat effects, providing energy resilience and reducing greenhouse gas emissions. Native plants also provide critical habitat for wildlife, including pollinators and migratory species that are important to multiple ecosystems and their functions.

Application for Tool in Watershed: Existing climate appropriate plantings should be protected and retained. On sites without existing planting or on constructions sites, climate appropriate planting can help reduce water use and enhance the landscape.

DATA & METRICS

Evaluation Metrics: Lower irrigation demand when replacing lawn or higher water use plantings.
Primary Quantifiable Benefits:

- Irrigation efficiencies

Secondary Benefits:

- Improved water quality
- Improved air quality
- Habitat enhancement
- Food security
- Carbon reduction

- Energy resilient
- Extreme heat island effect mitigation

Data Gaps: N/A

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors: Converting high water-use landscapes to CAP is one of the simplest and most affordable tools to save water and should be feasible on any site.

Constraints:

- Soil conditions vs. plant species should be considered
- Micro-climate constraints (shade/sun, drainage paths, etc.) affect which species will survive and thrive
- Most species require at least temporary irrigation for establishment even if they will require little to no water in the long term

Image 2: Climate Appropriate Landscaped border. (Source: Pacific Horticulture Society)

Permitting & Coordination: N/A
Associated Thresholds: N/A
Considerations & Impacts:
Community Engagement:

- The Ojai Valley Land Conservancy's native plant nursery provides plants to members of the community, local businesses, and government partners. To meet the growing interest in and need for Climate Appropriate Plantings, OVLC is expanding its nursery capacity and increasing its outreach efforts. By engaging the community and supplying landowners with plant native plant species, OVLC is ensuring a watershed-wide commitment to water efficiency and climate resiliency.

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring:

Forecasting & Outcomes:

REFERENCES

Climate Appropriate Planting Design and Installation Checklist

Climate Appropriate Planting is selecting native, low-water use, and drought tolerant plant species to replace existing high water use, invasive, and exotic plant species or when planting new landscapes. Climate Appropriate Planting uses much less water and provide much more ecological benefit in comparison with traditional landscaping. Climate Appropriate Plants require little or no irrigation once established.

1. Feasibility & Design

- **Remove high water use existing landscape:** remove lawn and other species that require a lot of irrigation.
- **Consider microclimates:** Observe your site. Which areas get sun or shade? Where are steep slopes or wetter drainages? What are the soil conditions?
- **Select plants:** choose plantings that are well suited for microclimates and site goals (sun/shade, screening, erosion control, pollinator habitat, etc.). These plants can be incorporated into your ornamental landscape and look beautiful!
- **Consider ecological and habitat value:** many native plants provide critical habitat as food and shelter.
- **Plant native and flowering pollinator plant species:** many native and flowering plants provide critical pollinator habitat as food and shelter.
- **Consider climate change:** are these species growing natively in regional locations that are hotter and dryer than your zone? These may be more adapted to future warmer and drier climate trends.

Climate Appropriate Planting.
Source: Watershed Progressive

2. Build & Maintain It!

- **Completely remove lawn and other exotic/ invasive species before installing Climate Appropriate Planting.** Maintain weeding when invasive species re-sprout.
- **Build Soils.** Loosen and amend soils with compost and 3" minimum of mulch cover as needed before planting.
- **DO NOT use pesticides and herbicides!** These harm pollinator species.
- **Keep leaves on the ground and postpone pruning and cutting back:** instead of removing in autumn and through winter, leave them behind for pollinating insects to use for their eggs and pupae.

Figure 1: Climate Appropriate Planting Design template developed for VRIF (Source: Watershed Progressive)

Climate Appropriate Plant Palette for Ventura County

Place High Water Use Plants at Low Point in Rain Garden, Medium Water Use on Lower Slopes, and Low Water Use on Edges of Rain Garden (Water Use: 💧💧💧 = High, 💧💧 = Medium, 💧 = Low; ✿ = Native, 🦋 = Edible)

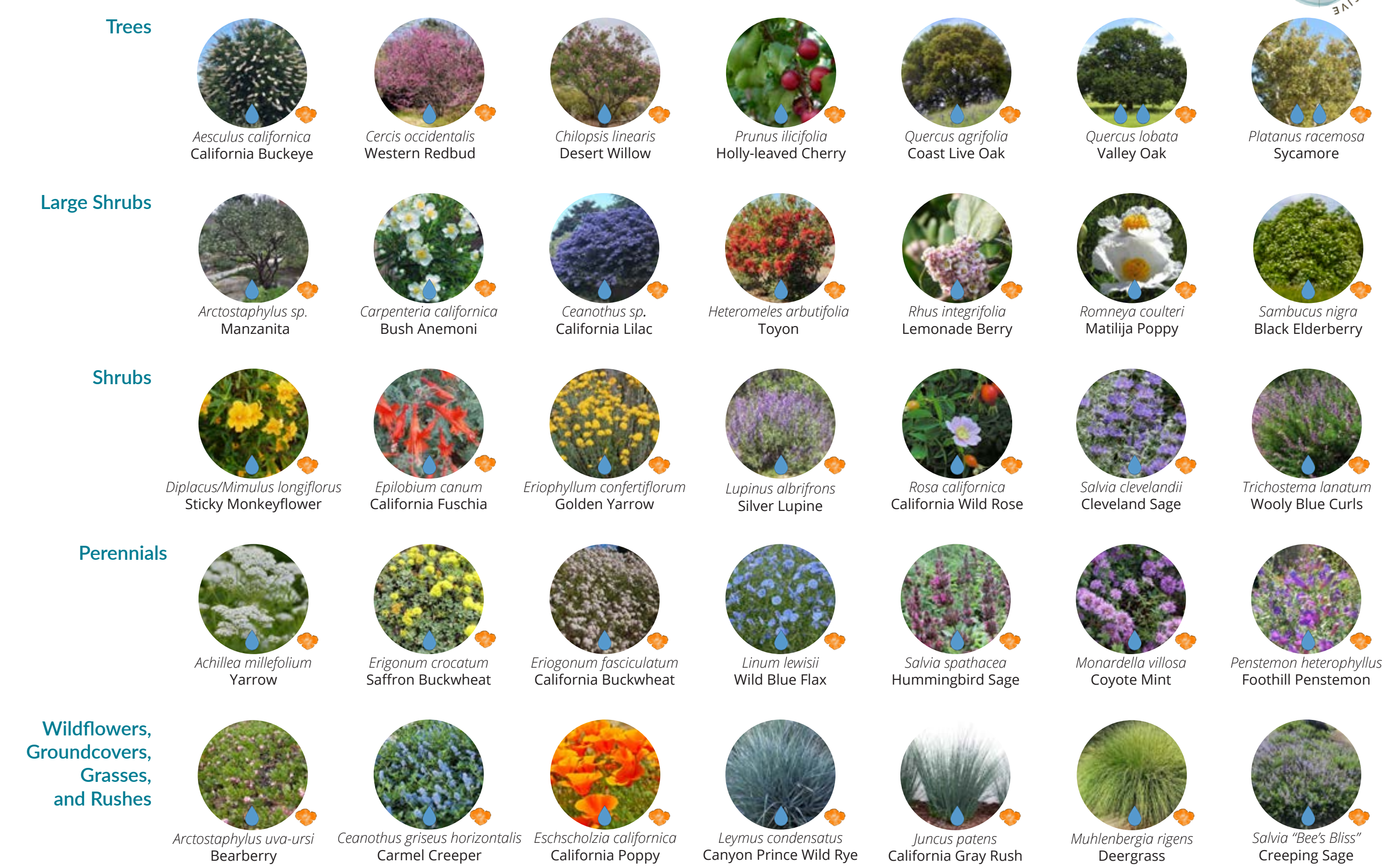

Figure 2: Climate Appropriate Planting Design template developed for VRIF (Source: Watershed Progressive)

Image 1: Rainwater Tanks

Tool Profile: Rainwater Reuse

TOOL SUMMARY

Toolkit Project Type(s): Reduced Consumptive Use, Flow Augmentation, Water Quality Improvements, Time Management

Related Tools: Green Roofs, Stormwater Reuse, Low Impact Development, Green Infrastructure, Climate Appropriate Gardens

Site Condition:

Impacts to Stream Flow/Hydrology: Rainwater capture and reuse enhances instream flow volume and quality. Rainwater capture reduces runoff, prevents erosion and conserves stormdrain system capacity, thereby mitigation flood risks.

By offsetting municipal supplies, instream flow volume is enhanced in instances where the municipal supply's source is diversion or where increased municipal supplies would allow for voluntary contributions to instream flow. Conserving municipal and mutual supplies is particularly important in the Ventura River Watershed where dry season base flows are one of the primary limiting factors on steelhead spawning habitat.

When rainwater captured from rooftops would otherwise flow to a municipal storm drain system, rainwater that is reused for irrigation serves to flatten the hydrograph and increase infiltration to groundwater basins. When rainwater would otherwise flow to pervious surfaces, there would be little to no impact on the design storm hydrograph. Rainwater that is reused for toilet flushing reduces infiltration to a degree, but these impacts are minimal in comparison to negative hydrological impacts of municipal water supply systems.

Region:

DESCRIPTION

Rainwater harvesting and reuse is the capture, storage, and reuse of rainwater that falls on-site. Rainwater harvesting systems collect rainwater from building rooftops or other impervious surfaces and direct it to storage tank(s) where it can be used to reduce the demand for municipal or mutual water supplies. While untreated rainwater is not a suitable replacement for potable sources, it can be used for outdoor applications and toilet flushing. By reducing municipal water consumption, these systems not only increase resiliency on-site but also reduce the demand for large water infrastructure projects which are costly to rate payers and harmful to the environment.

Rainwater reuse systems can range from a simple 50-gallon rain barrel used for irrigating small home gardens to a 800,000-gallon multi-tank system, capable of offsetting all non-potable water demand. Tank options include above ground plastic cisterns, corrugated steel tanks, open air reservoirs, and underground fiberglass tanks. Plastic piping is often used to move the rainwater from the collection surface to the tanks and a pump or gravity is used to move the water from the tank to the location where the water will be used. Tanks are fitted with an overflow outlet that is directed to an infiltration basin. Once stored, water can be used for irrigation and toilet flushing, and can improve fire resiliency by aiding in prevention and suppression.

Application for Tool in Watershed: As an example,in the Ojai Sphere of Influence alone, it is estimated that 148 million gallons (454 acre-feet) of alternative water supply could be harvested each year with rainwater collection and reuse.[1]

DATA & METRICS

Evaluation Metrics:

- Annual infiltration from irrigation served by rainwater reuse (where runoff would otherwise enter municipal storm drain).

Primary Quantifiable Benefits &

- Water quantity saved from municipal supplies offset by rainwater reuse
- Storm drain capacity savings
- Water quality

.

Secondary Benefits:

- Flood resilience
- Fire resilience
- Habitat enhancement
- Food security
- Energy resilience

Data Gaps:

- Accurate precipitation data
- Accurate data on demand from uses to be served by proposed rainwater reuse system

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors: Rainwater reuse is feasible for all buildings where there is adequate space for storage.

Constraints:

- Adequate precipitation to serve demand
- Space for water storage tank(s)
- Initial costs
- Water quality: If water is stored in ponds or tanks during the wet season, it has the potential to reduce stream flows during this period. Typically, the most critical periods to minimize diversions (in addition to the dry season) are during (1) the late fall and early winter when streamflows first rise and fish begin to move into and within the system, and (2) the spring and early summer when flows recede and fish require suitable flow and temperature to avoid stressful low-flow conditions. Most small-scale storage projects (e.g., rainwater catchment ponds) located away from stream channels can be managed to avoid risks to in-channel aquatic resources during these periods. However, landowner need to carefully manage their storage and conveyance systems. It can be detrimental to instream conditions if ponds or tanks are "topped-off" late in the spring. As these types of projects become more widespread, the cumulative impacts must be closely examined. Ideally, projects should be designed to capture water during the wettest portions of the winter to avoid adverse effects to the fall and/or spring flows. (Stillwater 2017)

Permitting & Coordination: Chapter 16 of the California Plumbing Code (CPC) regulates the installation, construction, alteration, and repair of non-potable rainwater collection and reuse systems. Section 1601.3 of the CPC states that a permit is not required for exterior rainwater catchment systems used for outdoor non-spray irrigation with a maximum storage capacity of 5000 gallons, where the tank is supported directly upon grade and the ratio of height to diameter or width does not exceed 2 to 1 and it does not require electrical power or a makeup water supply connection. In accordance with CPC section 1.1.8, Cities and Counties may adopt the CPC without changes and they may adopt more restrictive standards by ordinance, at their discretion.

Associated Thresholds: N/A

Considerations & Impacts: Municipal water supplies require vast amounts of energy to move water from its source to the point of use. The infrastructure used in municipal systems requires significant cost, which is passed on to rate payers. Not only do high water rates disproportionately affect low-income households, but also the infrastructure built for water conveyance and storage can have significant negative environmental impacts. These include destruction of sensitive habitat for endangered plant and animal species, carbon emissions for construction and operation, as well as physical barriers to human and wildlife movement. By offsetting municipal supplies, rainwater reuse systems not only enhance water security but also reduce the environmental impacts of large-scale water supply and distribution systems. Moreover, by reducing runoff that would otherwise flow from a roof to a storm drain, rainwater reuse systems reduce the demand for storm drain capacity during large storms and improve water quality by attenuating the flow of contaminated runoff from storm drain systems to the ocean.

Community Engagement:

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring:

Forecasting & Outcomes:

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2. 1.1 Rainwater Harvesting from Rooftop Catchments, www.oas.org/dsd/publications/unit/oea59e/ch10.htm.
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4. Spina, Anthony P., et al. "Downstream Migration, Rearing Abundance, and Pool Habitat Associations of Juvenile Steelhead in the Lower Main Stem of a South-Central California Stream." North American Journal of Fisheries Management, vol. 25, no. 3, 2005, pp. 919–930., doi:10.1577/m04-105.1.

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Rainwater Harvesting Tank and Installation Checklist

The following are typical best practices for on-site rainwater harvesting systems, adaptable to fit your space.

1. Feasibility & Design

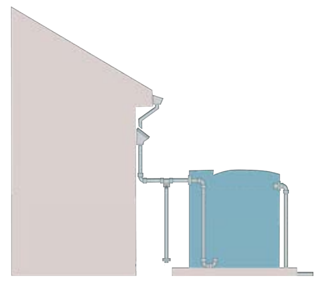
- **Identify your rainwater source and size tanks:**
  a. How many square feet is your roof/catchment area? A typical Ventura county home (2,000 sq. ft. roof) can capture up to 21,243 gal/year*
  b. One simple approach is to size tanks based on a typical large rainstorm:
     Rain capture volume = Roof area (sq_ft) * rainfall (ft) * runoff coefficent *7.48 (conversion to gal) *1.2 (20% climate shift)

     Ojai Example:
     Typical Roof area = 2,000 sq_ft
     95th percentile storm = 2.5 inches (.2 ft)
     Standard Runoff coefficient = .9

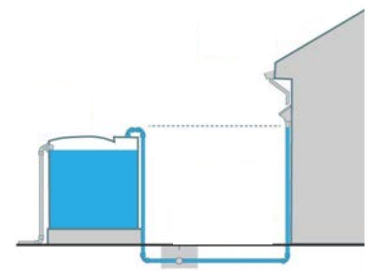
     Capture volume = 2,000 sq_ft * .2 ft * .9 *7.48 gal *1.2 =3,231 gallons per storm.
     To capture a large storm the tank volume should meet or exceed 3,231 gallons.
  c. Rainwater systems under 5,000 gallons with no cross-connections do not require a permit.
- **Identify your water needs:** How much water do you need ? Harvested rainwater can be used for irrigation, car washing, livestock watering, toilet flushing, laundry and fire supression.
- **Locate tanks close to the rainwater source and destination:** Identify a location close to the source (downspouts) and close to the irrigation destination (plants). Ensure a setback of 3 feet from any buildings and not blocking windows.
- **Make sure water flows downhill:** Check that your rainwater tank site is situated so that it can fill, supply plants, and overflow all by gravity to a desired location.
- **Allow for overflow to a rain garden:** When tank is full, water will find a way out. Design a rain garden downslope for rainwater overflow to empty into.
- **Install tank(s) on compacted and level footing:** Tanks with height to width ratio greater than 2-1 must be mounted to a structure.
- **Multiple tanks together:** Tanks may be plumbed together to fit on a site where one larger tank would not.

2. Build It!

- **Hire a professional** if you intend to install a large-scale, complicated system or to check correct installation of a small, simple system.
- **Abide by building codes:** Ensure that all gutters, roof drains, and associated piping complies with relevant California & County building codes. Over-size conveyance and tanks by 20%+ to accommodate for climate shifts and regional storm intensity.
- **Include a First Flush Diverter:** The first wash of rainwater may contain leaves, dust, bird droppings, and other debris. Keeping this part of the rainwater flow out of your rain tank helps keep the tank and supply clean.
- **Ensure that the overflow route is at least as big as the inflow:** Your tank may overflow in an uncontrolled way if not sized appropriately. This can cause erosion and/or flooding



Downspout to Rain Tank - "Dry" System



Downspout to Rain Tank - "Wet" System

There are two methods for conveying rainwater to a tank: 1) A dry conveyance system fully drains collected rainwater using gravity and slope. These systems work best when the tank location is closer to its collection roof. 2) A wet conveyance system enables a rain tank to be further from the building. Pipes to the tank go down and then back up in a closed system, using water's desire to find it's own level to push water back up into the tank. Source: Watershed Progressive

- **Install spigot or tank outlet 4" above the bottom of tank:** This prevents sediment from entering the supply.
- **Paint all installed, exposed PVC pipe:** UV rays will break down exposed PVC material.
- **Label rain water pipes and spigots:** Use "DO NOT DRINK" label shown below and access points to the tank should be marked with "Danger - Confined Space".
- **Install proper filtration on the supply-end of your rainwater system:**
  a. A gravity-fed hose may not require any filtration.
  b. Sub-surface drip-line should have a simple sediment filter.
  c. Rainwater pumped through sprinkler systems must be treated with mechanical and UV filtration.
- **If a pump is required:**
  a. Use an on-demand pressure pump to convey rainwater.
  b. Ensure the pump is approved by a listing agency and that it is sized sufficiently for the use.
  c. Consider installing potable make-up water in the event that rainwater is not present.

3. Maintain Your System

- Check your local code provisions for testing of potable water systems and storm drainage systems.
- Clean and inspect all inlets, outlets, filters and valves on the system.
- Drain first flush diverter of captured debris.
- Wet conveyance line systems should be drained after the rainy season.
- If you live in an area prone to freezing, ensure that your tank has adequate freeze protection.

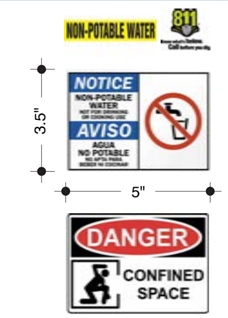
*[Average rainfall/year (1.42 feet)] x [Average Roof Size (2,000 sq. ft.)] x [7.48 gal/cu. ft.] = 21,243 gal/year

RW-1

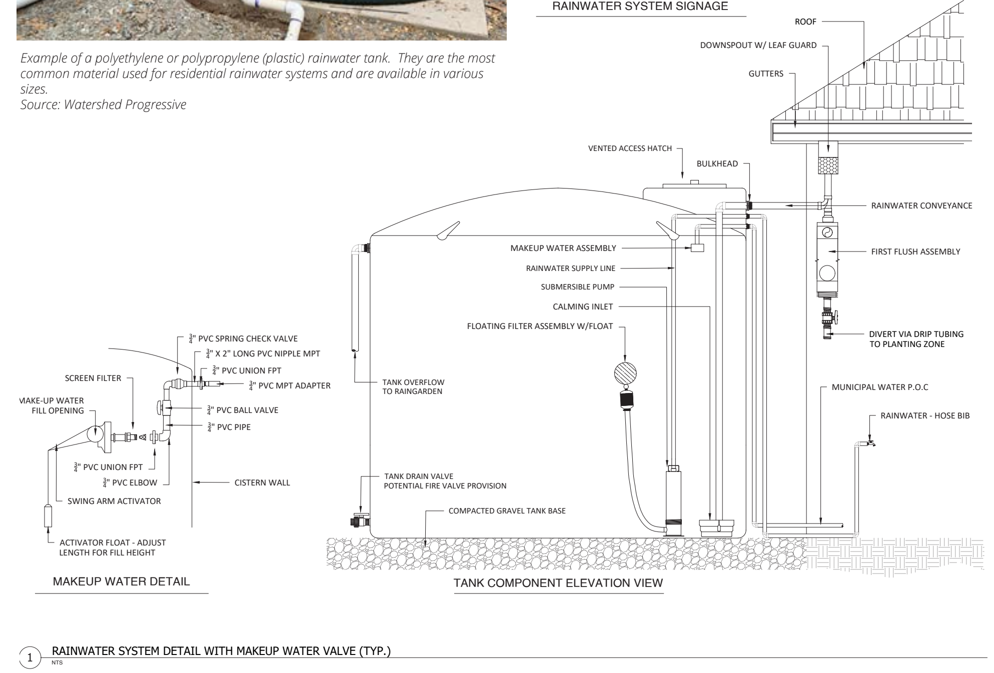
Figure 1: Rainwater Harvesting Design template developed for VRIF (Source: Watershed Progressive)

Rainwater Harvesting System with Make-up Water Valve Typical Detail

Example of a polyethylene or polypropylene (plastic) rainwater tank. They are the most common material used for residential rainwater systems and are available in various sizes.
Source: Watershed Progressive



RAINWATER SYSTEM SIGNAGE



General Notes:

A. The drawings are diagrammatic in nature and are created to represent the concepts as associated with on-site water reuse and storm water management / basin installations. for all site dimensions and exact relative locations, field condition as-builts should be requested from the property owner.

B. Above ground rainwater tanks:
1. Each outlet shall be marked "Caution Non-Potable Rain Water, Do Not Drink" in black, capital lettering.
2. Rainwater piping shall be marked "Caution Non-Potable Rain Water, Do Not Drink" with the international do not drink symbol of a circled water glass with a diagonal slash through it.
3. Tanks installed aboveground shall be of an opaque material or shielded from sunlight.
4. Rainwater tanks must be installed with a means of sufficient venting, draining and cleaning, including access for cleaning/inspection.
5. Overflow sizing shall match or exceed the area of all the inflow piping. Backflow prevention for overflow shall be equipped if the tank discharges directly to the storm drain system
6. All tank inlets, vents and overflows shall be protected with a 1/16" or smaller screen
7. Seal all gaps in metal sheeting greater than 1/16"
8. Tank marking: Tanks shall be permanently marked with "Non-Potable Rainwater", personnel tank entrances shall be marked "Danger-Confined Space"
9. Rainwater pumps serving rainwater catchment systems shall be listed (approved by a listing agency for expected use).
10. If the rainwater use within a building exceeds 80 psi, a pressure reducing valve shall be installed to reduce the pressure to 80 psi or less.
11. All gutters, roof drains and associated piping must comply with relevant California building codes.
12. Rainwater treatment devices must perform to the minimum standard determined by the authority having jurisdiction.
13. All equipment used for rainwater quality treatment shall be listed or labeled by an accredited listing agency and have approval for the intended purpose.
14. Tanks and piping installed in regions known to freeze must be provided with approved means of freeze protection.
15. Rainwater catchment inflow piping or conveyance piping must have a "debris excluder" or "leaf catcher" installed to prevent leaves, needles and sediment from entering the tank.
16. Prevention devices must be sized correctly for the system, accessible, and installed according to the manufacturer's guidelines.
17. Rainwater signs in buildings must follow the guidelines of sections CPC 1602.10.1 and 1602.10.2 and other requirements in the California Plumbing Code
18. Inpection: Rainwater catchment systems shall be inspected and tested in accordance with CPC sections 1602.11.1 and 1602.11.2.
19. Inspection inclusions: rainwater catchment systems shall be inspected and tested in accordance with code provisions for testing of potable water systems and storm drainage systems. Storage tanks shall be filled with water to the overflow line for a period of 24 hours and during inspection. Seams and joints shall be exposed during inspection and checked for watertight-ness.

C. Trenches will be covered during end of work day and crossing boards laid every 4 feet during work day. Trenches to be filled in and set properly.

D. All above ground pipes shall be protected from human/animal traffic before, during and after installation.

E. Devices installed shall be ANSI/NSF approved. All devices should be accompanied with reference and maintenance instructions as listed in maintenance contract.

F. "Wet Conveyance" plumbing pipes/systems shall be drained after the rainy season.

G. First Flush diverter shall be sized according to roof sq. ft. area and expected sediment levels.

Sheet Notes:

1. Provide leaf guard assembly at each downspout location (A/R per specifications)
2. Provide first flush filter assembly - wall mounted
3. Provide conveyance to rainwater tank w/ appropriate bulkhead size - matched to conveyance pipe size.
4. Rainwater tank specifications or approved alternate:
   - 5,000 gallon nominal
   - Make_____Model_____
   - Dimensions_____ - NSF certified
   - 24" vented manway access
5. Rainwater pump specifications:
   - Grundfos SBA-3-45 submersible pump w/ floating extractor.
   - 25 gpm, 147 total head
   - 1.4 hp @ 120 vac
7. Tie in tank overflow to bio-swale or equivalent overflow provision/zone.
8. Provide conveyance line to irrigation valve(s) - (A/R per specifications)
   - 5 zone irrigation valve set w/ 24" valve box (typ.)
   - Valve(s): 3/4" Rainbird inline valve w/ flow meter
   - Filter: 100 micron
9. Provide bulkhead with air-gap for municipal makeup line
10. Provide wall mounted rainwater conveyance line from downspout(s) @ 1% slope.
11. Provide "Silent-J" on tank pipe inflow.
12. Irrigation clock: Rachio generation 3 or approved equivalent (A/R per specifications)
13. Route 3/4" municipal makeup water line in trench from hose bib and provide stub-out and 3/4" gate shut-off valve for future p.o.c access.
14. Makeup water valve should be installed higher than the top of the overflow piping to create an air-gap and prevent back flow + a non-return check valve.
15. A dedicated 20-amp 120vac outdoor rated outlet to be installed per all applicable electrical codes.
16. Rainwater tank placement is diagrammatic. Project lead to coordinate placement of tank in field prior to installation of components.

RW-2

Figure 2: Rainwater Harvesting Design template developed for VRIF (Source: Watershed Progressive)

Image 1: Green Roof at the Thacher School in Ojai, California (Source: Watershed Progressive)

Tool Profile: Green Roofs

TOOL SUMMARY

Toolkit Project Type(s): Water Quality Improvements, Reduced Consumptive Use
Related Tools: Green Infrastructure, Stormwater Reuse, Low Impact Development, Green Infrastructure, Climate Appropriate Planting, Rainwater Reuse, Mechanical & Industrial Reuse, Fire Management BMPs
Site Condition:
Impacts to Stream Flow/Hydrology: Green roofs help filter and slow stormwater runoff, improving water quality in streams and rivers.
Region: Any

DESCRIPTION

Green roofs include building roofs that are partially or completely covered in vegetation, also considered "contained" green spaces on top of human-built structures. Green roof systems often include drainage layers, filter cloths, growing media and plants. Green roofs provide a range of benefits from aesthetic improvements to stormwater management, waste diversion, mitigation of urban heat island effects, improved air quality, energy efficiency and habitat creation, among others. There are two main types of green roofs:

- Intensive roofs which require 6-inches or more of growing medium, supporting a wider selection of vegetation like shrubs or trees.
- Extensive roofs which are generally a good selection for retrofits, need only a minimum of 6-inches of growing medium depth. Extensive roofs have a limited selection of vegetation .

Application for Tool in Watershed: Applicable on building structures depending on structural loading capacity, roof materials, drainage systems, waterproofing, and roof slope.

DATA & METRICS

Evaluation Metrics:

- Carbon reduction
- Enhanced stream flows

Primary Quantifiable Benefits:

- Improved water security
- Improved water quality
- Food security
- Energy resilience
- Extreme heat reduction
- Flood mitigation
- Habitat creation
- Improved air quality

Secondary Benefits:
Data Gaps:

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors:

- Costs vary based on factors such as growing medium, plant selection, installation size, irrigation use, accessibility
- Green roofs are often a greater initial investment that can pay off by extending the life of a structure's roof membrane, and reducing heating and cooling costs of the building.
- Accessing green roofs is essential for their maintenance and this must be kept in mind when designing.
- Impacts from other adjacent buildings may cause the planted vegetation to be affected by high wind velocities.

Constraints:

- Plant selection is dependent on climate, composition, structural loading capacity, height and slope of roof, maintenance expectations, and irrigation systems. Protection from wind erosion is also something which must be addressed, especially around the perimeter of the roof.

Permitting & Coordination: Accounting for the wet weight of green roofs may require coordination of structural engineers, civil engineers or architects as required by Sections 55338 and 6745 of the California Business and Professions Code.

Associated Thresholds:

Considerations & Impacts:

- Improved water quality by filtering and slowing stormwater runoff before it can enter a storm drain, river, stream, or the ocean
- Reduce waste going to landfills by using recycled materials and prolonging the service life of HVAC systems through decreased use
- Reduce Urban Heat Island Effect
- Improve air quality
- Increase habitat creation and recreational space
- Improve fire retardation by burning at a lower heat load than conventional roofs
- Increase biodiversity and contribute to healthier, equitable communities

Community Engagement:

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring:

Forecasting & Outcomes:

Image 2: Patio cover green roof with sedums and wildflowers in Altadena, California. (Source: Image by Bronwyn Miller; Design by Flower to the People, via Pacific Horticulture)

REFERENCES

1. About Green Roofs. Green Roofs for Healthy Cities. (n.d.). Retrieved November 15, 2021, from https://greenroofs.org/about-green-roofs.

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Images 1a, 1b: A before image (TOP) shows a wooded site on the North Fork pre-clearing and prescribed burning, and an after image (BTM) shows the site after prescribed burn, one method used in Fire BMPS. (SourceL: Emily Underwood and Chris Paulus via CNPS.org)

Tool Profile: Fire BMPs

TOOL SUMMARY

Toolkit Project Type(s): Reduced Consumptive Use, Time Management of Water
Related Tools: Upland Vegetation Management, Rangeland BMPs, Riparian Invasive Removal, Giant Reed Removal & Restoration, Climate Appropriate Planting, Prescribed Burn Associations
Site Condition: Within the built environment, or in the Wildland Urban Interface (WUI), fire suppression has contributed to dense growth which is fuel for destructive wildfires. Dry soils accelerate the die-off and add to fire danger. When not maintained through Fire Management BMPs, ladder fuel (small trees, shrubs, grasses), leads to high fire risk potential, especially in remote areas that may be difficult to access. This entry does not specifically look at USFS lands, however many of the BMPs can be applied to the upper landscape.
Impacts to Stream Flow/Hydrology:
Region: Wildland Urban Interface (WUI) zones, and areas densely vegetated with ladder fuel (low growing shrubs, trees and grasses).

DESCRIPTION

Fire mitigation by means of vegetation management is essential. Natural fires help perpetuate the ecosystem and/or stimulate germination of trees. When not managed appropriately, undergrowth or ladder fuel becomes dense, dry vegetation that is prime fuel for destructive wildfires. BMP's for fire resilience and mitigation include: prescribed burns, livestock grazing, mechanical techniques, fire breaks, vegetated buffer strips, shaded fuel breaks, and soil stabilization techniques that can reduce the risks associated with fire.

Mechanical technique (cutting down trees and shrubs) come at a higher price when compared to livestock grazing. Goats help clear out ladder fuel, minimizing the damage from crown fires. Vegetated buffer strips can be utilized in urban planned areas. These open vegetated spaces act as natural wildfire buffers by creating a vegetated distance between communities and approaching wildfires. Utilizing one or a combination of these Best Management Practices is essential in mitigating ever-increasing fires that affect our wildlands and urban communities alike.

Application for Tool in Watershed: Applicable in Wildland Urban Interface zones, and residential, commercial or wildland landscapes.

DATA & METRICS

Evaluation Metrics:

- Canopy Fuel Metrics (canopy height, base, and bulk density)

Primary Quantifiable Benefits:
Secondary Benefits:
Data Gaps:

- Environmental data
- Forest management reports

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors: Mechanical techniques are on average 2-3 times more expensive than livestock grazing. Mechanical techniques are not always feasible in remote and dense wildlands.

Constraints vs. Benefits: Land access and budgets.

Permitting & Coordination:

Associated Thresholds:

Considerations & Impacts:

Community Engagement:

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring:

Forecasting & Outcomes:

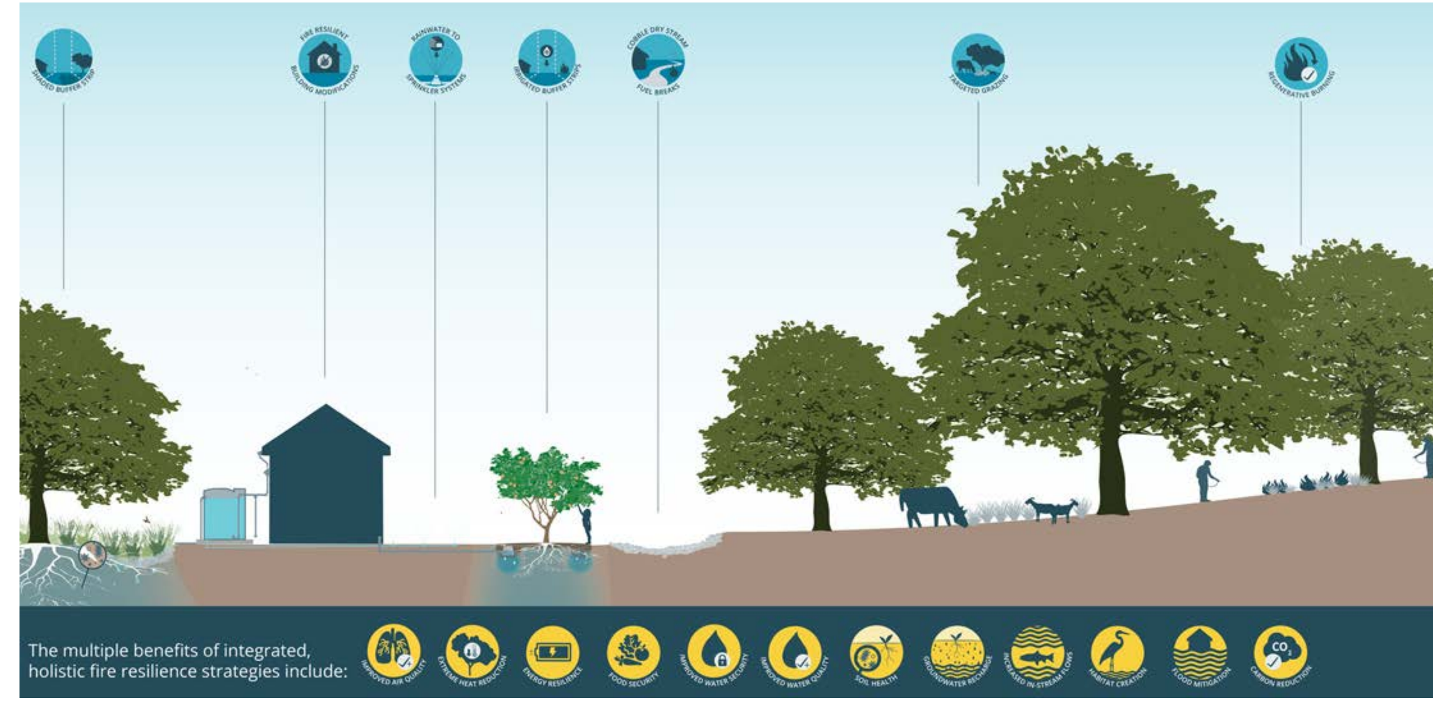

Figure 1: The multiple benefits of integrated, holistic fire resilience strategies (Source: Watershed Progressive)

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1. Starns, H. D., Fuhlendorf, S. D., Elmore, R. D., Twidwell, D., Thacker, E. T., Hovick, T. J., & Luttbeg, B. (2019). Recoupling fire and grazing reduces wildland fuel loads on rangelands. Ecosphere, 10(1). https://doi.org/10.1002/ecs2.2578

Image 1: Vegetated buffer strip in an agricultural setting (Source: Xiaoqiang Liu via Ohio State University)

Tool Profile: Hydrated or Vegetated Buffer Strips

TOOL SUMMARY

Toolkit Project Type(s): Flow Augmentation, Water Quality Improvements
Related Tools: Upland Vegetation Management, Riparian Invasive Removal, Giant Reed Removal and Restoration, Climate Appropriate Planting, Flood MAR, Off-Channel Storage
Site Condition: Along waterways and in areas of urban or agricultural development.
Impacts to Stream Flow/Hydrology:
Region:

DESCRIPTION

A hydrated or vegetated buffer strip is an area of herbaceous vegetation that removes contaminants from overland flow. Riparian herbaceous covers are typically grasses, sedges, rushes, ferns, legumes, and forbs tolerant of intermittent flooding or saturated soils. They are established or managed as the dominant vegetation in the transitional zone between upland areas such as agricultural fields and aquatic habitats such as agricultural drainage ditches and streams (*agbmps.osu.edu*). Vegetated buffers between urban development or agricultural areas and waterways serve to improve bank stabilization, water quality, flood control, fire mitigation, and wildlife habitat. Buffer strips function by slowing stormwater runoff and allowing sediment and other pollutants to settle and infiltrate. In agricultural settings, vegetated buffer strips help protect habitat, intercept chemical spray drift and wind, and create healthier soil interactions.

Application for Tool in Watershed: Applicable along riparian channels, residential and commercial landscapes.

DATA & METRICS

Evaluation Metrics:

Primary Quantifiable Benefits:

- Water quality improvements

Secondary Benefits:

- Soil conservation on slopes
- Enhanced habitat and biodiversity
- Shading and extreme heat mitigation
- Carbon sequestration
- Flow capture
- Biomass production
- Landscape diversity

Data Gaps: A question that remains unresolved is the ratio of drainage area to the buffer strip.

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors:

- Once established, buffers require minimal maintenance activity
- Flow characteristics and vegetation type and density can be closely controlled to maximize BMP effectiveness
- Costs are site-specific and will depend on the length/width of the buffer and the vegetation species used
- Construction and maintenance costs

Constraints:

- Requires sufficient drainage area and are not as effective for very large drainage areas
- Downstream stormwater collection needs to be considered during design process
- Prohibited in areas of known contamination
- Not appropriate for sites with high risk of landslides or other geotechnical concerns

Permitting & Coordination:

- Specifications for appropriate fertilizers and soil amendments should be based on soil properties determined through testing
- Install strips during time of year when there is reasonable chance of successful establishment without irrigation

Associated Thresholds:

- Slopes should not exceed 15%, shall be at least 2%
- Either grass or selection of low growing, drought tolerant, native vegetation should be specified
- Vegetation whose growing season corresponds to the wet season is preferred

Considerations & Impacts:

- Bank stabilization is possible with hydrated buffer strips which improves water quality by reducing sediment loads.

Community Engagement:

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring:

Forecasting & Outcomes:

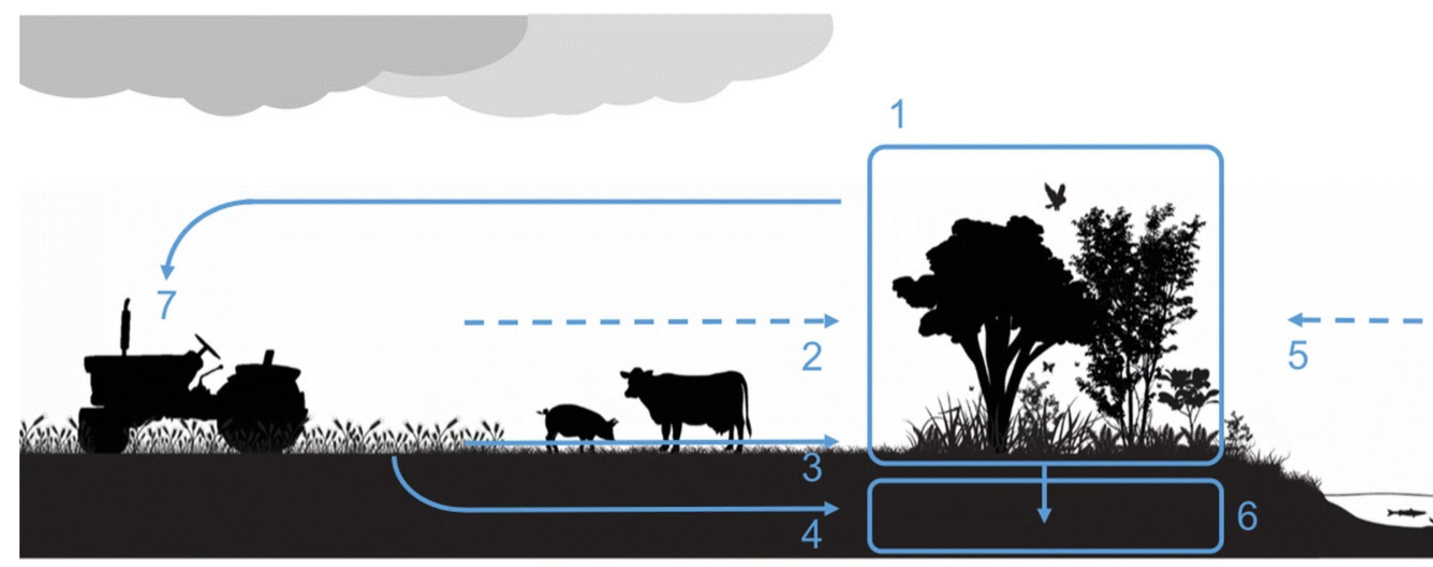

Figure 1: Diagram of a Vegetated Buffer Strip in an agricultural setting (Source: Neal R. Haddaway via Environmental Evidence Journal)

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Image 1: A fire resilient landscape populated with hydrated, low-growing foliage that provides a defense barrier from fire. (Source: CNPS.org)

Tool Profile: Fire Resilience Landscaping & Home Hardening

TOOL SUMMARY

Toolkit Project Type(s): Flow Augmentation, Water Quality Improvements
Related Tools: Upland Vegetation Management, Riparian Invasive Removal, Giant Reed Removal and Restoration, Climate Appropriate Planting, Flood MAR, Off-Channel Storage
Site Condition:
Impacts to Stream Flow/Hydrology:
Region:

DESCRIPTION

Fire resilient landsliding and home hardening are a set of physical tools that are implemented in order to reduce the risk of wildfires. These measures are most critical in areas within the wildland urban interface (WUI).

Application for Tool in Watershed: These fire resilience and home hardening measures improve instream flow in a few ways. For one, by reducing the risk of catastrophic wildfires, the negative impacts of sedimentation, water temperature, and gravel recruitment post-fire are mitigated. Secondly, use of fire resilient landscaping like succulents, can also improve instream flow since generally these types of plants have lower water demand than existing landscaping- meaning that they can serve to reduce consumptive use. The national Fire Protection Association has prepared the Firewise USA which residents can use to get guidance on how to implement these measures.

DATA & METRICS

Evaluation Metrics:

Primary Quantifiable Benefits :

Secondary Benefits:

Data Gaps:

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors:

Constraints vs. Benefits:

Permitting & Coordination: "NFPA publishes more than 300 consensus codes and standards intended to minimize the possibility and effects of fire and other risks. NFPA codes and standards, administered by more than 250 Technical Committees comprising approximately 8,000 volunteers, are adopted and used throughout the world."

Associated Thresholds:

Considerations & Impacts:

Community Engagement:

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring:

Forecasting & Outcomes:

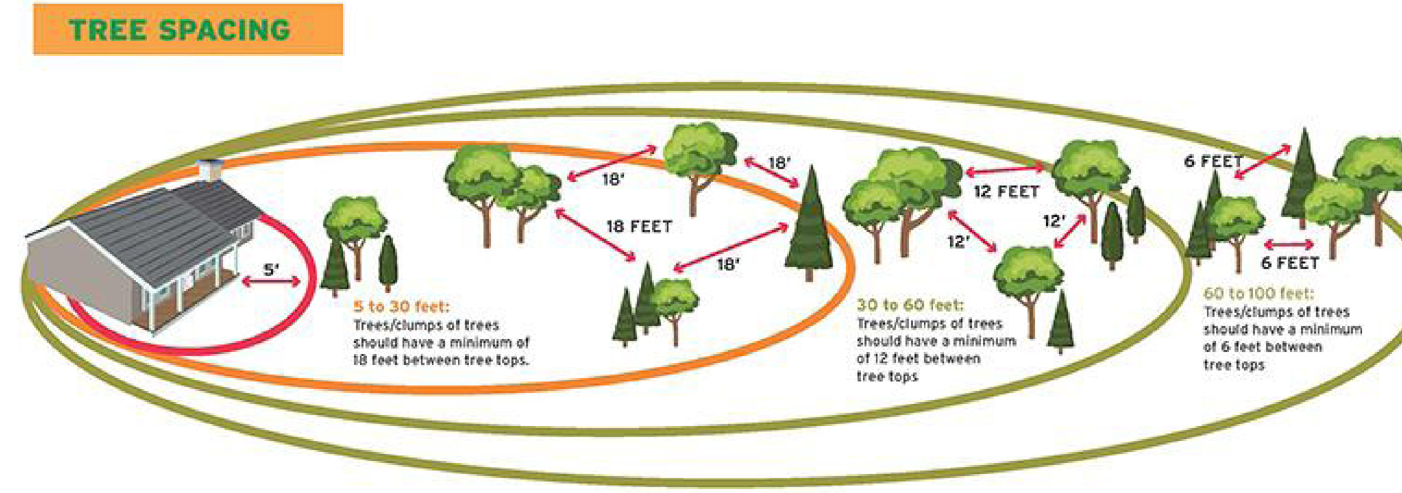

Figure 1: Diagram of tree spacing to maximize fire resilient landscapes. (Source: National Fire Protection Association)

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Image 1: Wastewater treatment process (Source: Water Education Foundation)

Tool Profile: Industrial & Mechanical Water Reuse

TOOL SUMMARY

Toolkit Project Type(s): Reduced Consumptive Use
Related Tools: Greywater Reuse, Rainwater Harvesting
Site Condition:
Impacts to Stream Flow/Hydrology: By offsetting municipal supplies, instream flow volume is enhanced in instances where the municipal supply's source is diversion or groundwater pumping, or where increased municipal supplies would allow for voluntary contributions to instream flow. Conserving municipal and mutual supplies is particularly important in the Ventura River Watershed where dry season base flows are one of the primary limiting factors on steelhead spawning habitat.

Region: Urban and developed areas.

DESCRIPTION

In warm climates where air conditioning is used, condensate can be captured and reused to offset municipal water sources. Industrial and commercial facilities with cooling towers or other relatively clean waste water streams can harvest and reuse the waste-streams when efficiency upgrades are not feasible. Harvested mechanical waters can be used in such non-potable applications as: irrigation, water features, secondary mechanical uses, and toilet flushing. The volume of most mechanical water waste generation is highest during hot and dry months making it ideal for drawdown and use of supply when it is needed most. Mechanical water reuse systems require mechanisms to capture, store and convey the water that may include plumbing/pipes, tanks, filters, pumps and treatment systems.

Application for Tool in Watershed: Most applicable at large hotels, restaurants, and industrial facilities where the volume of mechanical waste water is generated at larger scales. Residences and smaller commercial facilities may utilize mechanical water, especially in conjunction with other water reuse systems such as Greywater Reuse and Rainwater Harvesting.

DATA & METRICS

Evaluation Metrics:

- Metered volume of recycled water captured and reused (kept out of sewer/septic systems)

Primary Quantifiable Benefits:

- Improved water security
- Improved water quality

Secondary Benefits:

- Energy resilience
- Carbon reduction
- Enhanced stream flows
- Improved air quality

Data Gaps:

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors: In many cases, mechanical water alone can have relatively low volume making it a less feasible and effective tool compared to other waste streams. For sites where other water reuse systems are present, mechanical water can in some cases be easily integrated into capture and conveyance systems making it more feasible and effective. Large commercial sites are mostly likely to present the best opportunities for implementation where efficiency upgrades (cooling systems) are not feasible.

Constraints:

Permitting & Coordination: A Permit is required to construct a water reuse system in a building according to Chapter 15 of the California Plumbing Code.

Associated Thresholds:

Considerations & Impacts: When used for irrigation, industrial and mechanical water reuse both reduce consumptive use and increase infiltration. Mechanical water would otherwise be routed to the sewer and irrigation demand would otherwise be met by potable supplies.

Community Engagement:

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring:

Forecasting & Outcomes:

REFERENCES

Image 1: Mulch in the landscape helps conserve water. (Source: ucanr.edu)

Tool Profile: Irrigation Efficiencies

TOOL SUMMARY

Toolkit Project Type(s): Reduced Consumptive Use, Time Management of Water
Related Tools:
Site Condition: Implementing irrigation efficiencies is an option for any landscape but during the time when landscapes are redesigned or when climate appropriate plantings are added can be a particularly good time to implement these measures.
Impacts to Stream Flow/Hydrology: By reducing transmission loss and losses to evaporation, irrigation efficiencies can reduce consumptive use while maintaining the same amount of plants. Moreover, since inefficient irrigation systems can often result in runoff, by incorporating irrigation efficiencies contaminated stormwater runoff can be prevented from reaching rivers, streams, and the ocean. As such, irrigation efficiencies both increase the amount of water left instream and enhance the quality of water instream.
Region: Irrigation efficiencies can be implemented in all regions but are most beneficial in areas experiencing a dry climate.

DESCRIPTION

Irrigation efficiencies are a group of strategies aimed at minimizing the loss of water from the source to the plant roots. These strategies are grouped into three categories: efficient water delivery, irrigation dose timing, and mulch. In general, these approaches are intended to minimize losses from evaporation, leaks, and runoff. The State of California's Model Water Efficient Landscape Ordinance (MWELO) requires specific irrigation efficiency measures for new development when a local agency requires a permit, plan check, or design review. While useful on their own, when used in combination these approaches can achieve significant reductions in water demand while maintaining healthy and attractive landscaping or crops.

- Efficient Water Delivery: Irrigation systems should be designed so that water delivered meets the plant demand with minimal losses. Efficient water delivery can reduce consumptive while maintaining the same amount of healthy and attractive landscaping. Moreover, inefficient water delivery systems can cause soil damage, erosion, and can result in an increase in contaminated stormwater runoff. This means that efficient water delivery impacts instream flow enhancement by affecting both reduced consumptive use and water quality.

  Water delivery systems span a wide range of sophistication and efficiencies. From manual flood or surface irrigation, which is very inefficient to drip irrigation based on soil moisture sensors, which is very efficient. Between those techniques on the spectrum of efficiency is traditional sprinkler irrigation, micro irrigation, and many others. While more efficient systems usually have higher initial costs than less efficient systems, depending on the per unit price of water, there may be a payback period where the savings in water costs would offset the initial costs of a more efficient system.
- Irrigation Dose Timing: Irrigation dose timing refers to changes to the timing and quantity of water delivered in an irrigation system to maximize efficiency and reduce water demand. Maintaining soil moisture and reducing evaporative losses are the primary factors affecting irrigation dose timing. A simple change that many homeowners have already adopted is switching to irrigating landscapes in the morning or the evening when temperatures are lower, and less water is lost to evaporation. The State of California's Model Water Efficient Landscape Ordinance (MWELO) requires regulated landscapes be irrigated using automatic irrigation controllers and requires that overhead irrigation be scheduled for the hours between 8pm and 10 am unless weather conditions prevent it. Additionally, the MWELO requires that plant demand for irrigation scheduling is based on either recent reference evapotranspiration (ETo) or soil moisture sensors.

- **Mulch:** In forest environments leaves and other organic materials fall from trees to the ground as part of a natural process that recycles minerals from fallen organic material back into the soil. The same benefits of this natural system can be applied to landscaping and agriculture. Mulch treatments insulate soils which serves to reduce evaporation from the soil and plant roots, prevent erosion, regulate soil temperature, and prevent weed growth. Although the amount of water savings varies based on the mulch used, species of crop, and various other environmental factors, previous scientific literature has estimated that using mulch reduces evaporative losses by around 30% (Scott 2007; Shaw et al. 2005; McMillen 2013). The application of around 4 inches of mulch is optimal, with soil water content staying in a similar range with mulch depths exceeding 4 inches in depth (McMillen 2013). Further, a study in Spain demonstrated that the water use efficiency of mulched fruit trees was 50% higher in comparison to non-mulched trees, with mulched trees producing more fruit and enhancing irrigation efficiency (Pascual et al. 2015).

  Mulch is used to cover topsoil and can be made from a variety of materials. Organic mulches are often made from materials like wood chips, bark, evergreen needles, straw, and a variety of other plant byproducts. Inorganic mulches are made from materials that do not decompose like rock, pulverized rubber, and landscape fabrics. Inorganic mulches are ideal for decorative uses, walking paths, and for controlling weeds in cool climates. Organic mulches decompose and therefore must be replenished on a regular basis, but they offer significant soil health benefits over their inorganic counterparts.

Application for Tool in Watershed:

DATA & METRICS

Evaluation Metrics:
Primary Quantifiable Benefits:

- Scientific literature has estimated that using mulch reduces evaporative losses by around 30%.
- It is reasonable to assume a 30 percent reduction to ETo when calculating plant demand for crops that will have mulch treatments.
- Irrigation efficiencies from efficient water delivery methods and irrigation dose timing can be calculated with changes to transmission loss and irrigation at or above ETo.
- Existing conditions for transmission loss will vary but can be as high as 25 percent in some cases and with implementation of drip irrigation can be brought down to around 2 percent.

Secondary Benefits:
Data Gaps:

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors: The primary factor affecting the feasibility of implementing irrigation efficiencies is cost. New, more efficient irrigation systems can require significant cost to install and there is some technical knowledge needed to match the irrigation design to the plant demand. Unless a homeowner has some previous knowledge or the time to invest in research, professional installation may be needed to achieve optimal results. Moreover, there are some higher and lower cost options. When implementation of irrigation efficiencies includes more high-tech solutions like remote sensors and automation, costs can be comparatively higher than more low-tech solutions.

Some of the largest companies and cost leaders in the market for supplying the parts needed for implementing irrigation efficiencies are Rain Bird Corporation, Netafirm, The Toro Company, and Valmont Industries. Some of these companies also offer smart irrigation technologies like soil moisture sensors and smart irrigation controllers.

Constraints:

Permitting & Coordination: Irrigation efficiencies are small scale treatments that can be implemented by residents on their own or with the help of a consultant and contractor. There will usually be no permit needed for this type of work. However, MWELO-regulated projects would be subject to the requirements of the relevant ordinance. In some areas there may be rebates available for irrigation efficiencies components and that may require some coordination with those entities.

Associated Thresholds:

Considerations & Impacts: Irrigation efficiencies serve to reduce consumptive use and can prevent contaminated stormwater runoff from reaching storm drains and the ocean. Reduced consumptive use has positive environmental impacts in a few ways. For one, depending on the potable water source, reduced consumptive use can leave more water instream. This benefits riverine ecosystem health by maintaining the flow rates that native species have adapted to. This is of particularly important for anadromous fish species like steelhead trout, which migrate from the ocean into freshwater streams to spawn. Another way that reduced consumptive use can result in positive environmental impacts is by reducing the need for new potable water infrastructure, like dams, reservoirs, and aqueducts. These large-scale infrastructure elements are not only costly but also very energy intensive and destructive to the habitat of sensitive species. Finally, as described above, some inefficient irrigation systems can result in runoff that travels across surfaces like roads, picking up contaminants on the ground and carrying them through storm drains to the ocean. Since irrigation efficiencies eliminate runoff, they can both reduce the demand for storm drain capacity and reduce the amount of contaminated runoff reaching riverine ecosystems and the ocean. Similar to the impacts of reduced consumptive use, these factors serve to reduce infrastructure costs and improve habitat for sensitive species.

Community Engagement:

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring:

Forecasting & Outcomes:

Image 2, 3, 4: Irrigation Efficiency Methods. (TOP) Irrigation Timer. (MIDDLE) Irrigation Dose setup. (BOTTOM) Mulch

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Tool Profile: Water Conservation Traditional BMPs

TOOL SUMMARY

Toolkit Project Type(s): Reduced Consumptive Use
Related Tools: Irrigation Efficiencies, Industrial & Mechanical Water Reuse, Erosion Control, Injection Wells, Climate Appropriate Gardens
Site Condition:
Impacts to Stream Flow/Hydrology:
Region:

DESCRIPTION

Water conservation BMPs, like water audits, are some of the lowest hanging fruits that we can greatly benefit from, as audits help us understand and put into perspective our own unique water use. As we shift into more severe weather patterns, water conditions are being significantly impacted and water-use and quality are in prime focus. Due to the inherent nature of development practices, directly or indirectly, in both urban and rural regions alike, water is not utilized all the same. Water audits highlight not only inefficiencies in our water systems, but also opportunities where money can be saved on indoor water fixtures and flow rates, water quality, total use per household, complying with water regulations, and more.

Understanding our water consumption is the first step to water conservation. Indoor water audits help to identify the potential water savings inside our homes. We can also use outdoor water audits for our landscapes. More often than not, landscapes are over-watered. The audit guidelines bring to focus the inefficiencies in our water source, irrigation equipment and watering schedule which all play into the overall water budget. Guidelines and requirements put forth by the local municipality (MWELO) help us navigate efficient watering strategies.

Application for Tool in Watershed: Applicable for commercial sectors, agricultural regions, and urban housing communities.

DATA & METRICS

Evaluation Metrics:

Primary Quantifiable Benefits:

- Monthly water savings from water audit findings and fixes
- Water budget tables
- ETo reference
- Precipitation and audit data

Secondary Benefits:
Data Gaps:

- Accurate audit data

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors: Water audits can be performed by utilizing simple guidelines provided by the local municipality or may be more complex and require hiring a professional water auditor. It can be done in urban, rural, and agricultural regions alike. The level of complexity and granularity is all decided within context of where the audit is needed and for what purpose. Cost leaders include:

- Findings from water audits; i.e. replacement fixtures (from high flow to low flow)
- Irrigation system upgrades or removal (as needed)
- Leak repairs
- Professional auditor fees

Constraints: Rent v. Owning home / property

Permitting & Coordination:

Associated Thresholds:

Considerations & Impacts: Most municipalities offer rebates and other incentives to lower and or improve inefficient water practices/equipment.

Community Engagement: Performing volunteer led water audits in a community empowers individuals to be more in-sync with their water uses and in turn, promote awareness of water saving opportunities as they arise.

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring:

Forecasting & Outcomes:

Figure 1: (Source: Watershed Progressive)

REFERENCES

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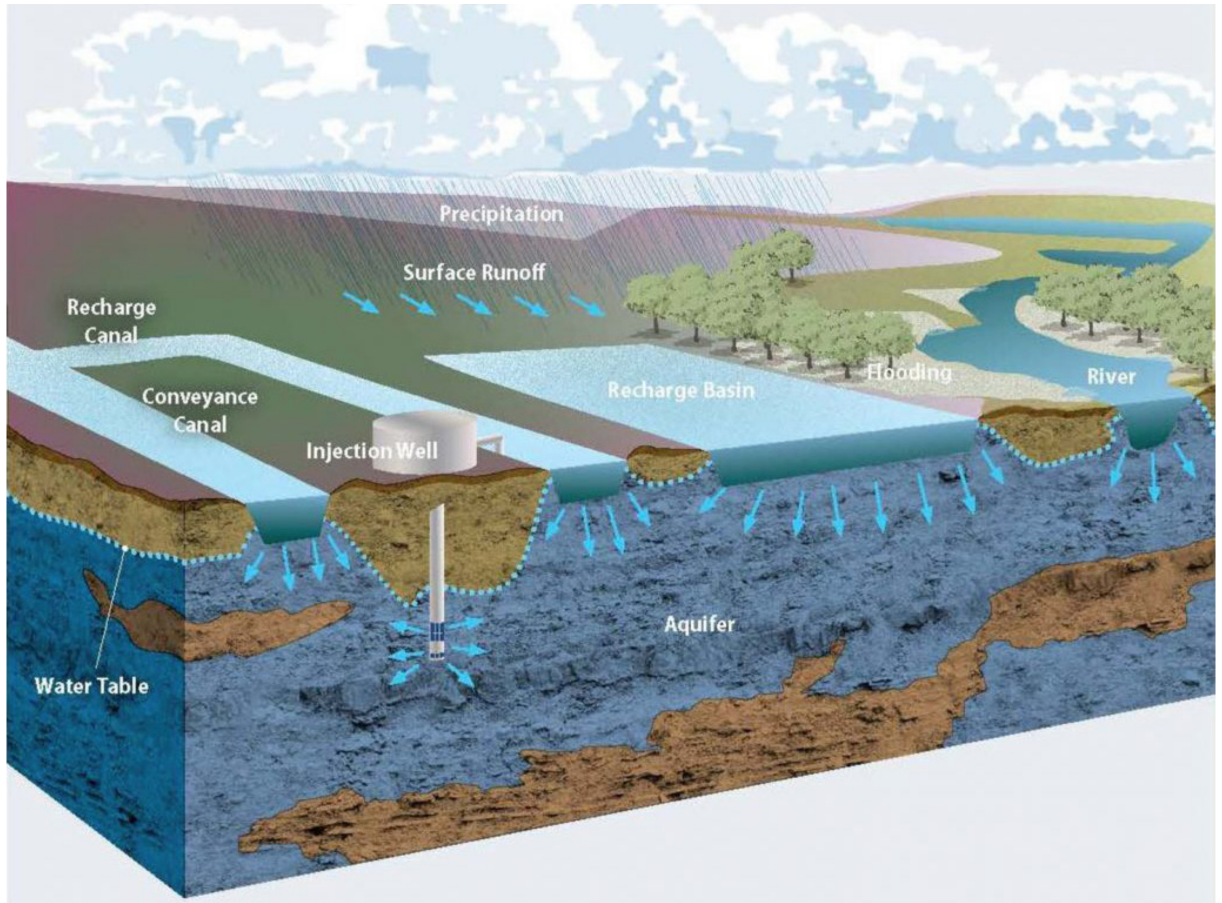

Figure 1: Water can be stored in aquifers through multiple methods including injection wells. (Source: California Department of Water Resources)

Tool Profile: Injection Wells & Dry Wells

TOOL SUMMARY

Toolkit Project Type(s): Flow Augmentation, Time Management of Water

Related Tools: Injection wells are related to treatments that increase infiltration, like bioswales and regenerative stormwater conveyance, in that groundwater supplies are recharged, but injection wells require more engineering and may recharge groundwater supplies more quickly since flow is facilitated by an engineered structure.

Site Condition: Injection wells benefit instream flow when water is injected into non-isolated formations. In contrast to injection wells that serve different purposes like waste disposal and carbon sequestration, these types of injection wells are usually classified by the EPA as Complex Class V wells (though not all injection wells are Class V wells.) The septic system, regardless of size, receives any amount of industrial or commercial wastewater (also known as industrial waste disposal wells or motor vehicle waste disposal wells); or the septic system receives solely sanitary waste from multiple family residences or a non-residential establishment and has the capacity to serve 20 or more persons per day (also known as large-capacity septic systems).

Impacts to Stream Flow/Hydrology: When water is injected into underground formations that lead to a spring, that water can enhance stream flow quantity by replenishing groundwater supplies and improve water quality by diluting existing pollutants that are present in the stream or river. Additionally, increased water quality can prevent negative ecosystem impacts related to water temperature as a result of shallow stream sections.

Region: Appropriate in areas with suitable hydro-geology conditions.

DESCRIPTION

Underground injection wells are structures designed to allow water to flow into the ground, usually under the force of gravity. These structures are often referred to as dry wells. Use of injection wells involves a process where surface water is injected underground to replenish groundwater supplies. Class V (EPA Classifications & Guidelines) wells are used to inject fluids into or above underground sources of drinking water. These are the broadest and largest class of underground injection wells. About 90% of Class V wells are stormwater drainage wells, agricultural drainage wells or septic system leach fields. An additional use of these wells is for aquifer recharge.

Application for Tool in Watershed: Aquifer recharge relates to instream flow enhancement when the underground formation is such that the aquifer is not isolated and water is able to move to a spring where it can contribute to improved streamflow. This enhances water quantity because more water is added to the aquifer. It also enhances water quality because when the water is injected underground, the natural filtration properties of porous rock filters out impurities. This natural purification means that a cleaner source of water would be added to instream flow and existing pollutants would be diluted.

DATA & METRICS

Evaluation Metrics:

Primary Quantifiable Benefits:

- Acre feet of water injected
- Increase in streamflow CFS

Secondary Benefits:

Data Gaps:

- Detailed understanding of subsurface hydro-geology features like perched aquifer boundaries

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors: Is the supply of water available for injection sufficient to justify the cost of injection well construction?

Constraints: Cost of analysis, design, permitting, and construction.

Permitting & Coordination:

- The Safe Drinking Water Act (SDWA) requires that EPA protect underground sources of drinking water from injection activities. EPA has set minimum standards to address the threats posed by all injection wells, including stormwater drainage wells.
- Grading permit from local building authority

Associated Thresholds:

Considerations & Impacts:

- Enhances instream flow quantity in instances where the hydro-geology is such that the aquifer feeds a spring that feeds a river or stream.
- Increased flow quantity can also improve water quality when existing pollutants are diluted.
- Increased flow quantity can also help to maintain water temperatures consistent with conditions that native plants and animals have adapted to.

Community Engagement:

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring:

Forecasting & Outcomes:

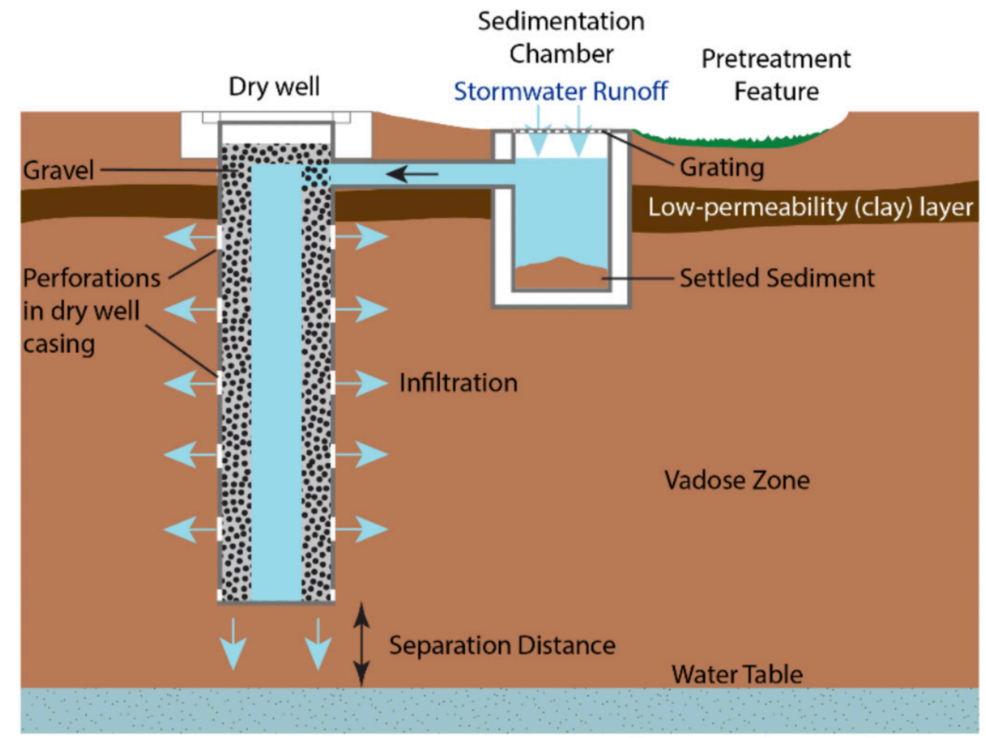

Figure 2: Schematic of a Drywell System (Source:: americangeosciences.org)

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Image 1: Rendering of a check dam section in the San Antonio Creek. Check dams are one method of erosion control BMPs (Source: Watershed Progressive)

Tool Profile: Erosion Control, Reduction & Prevention

TOOL SUMMARY

Toolkit Project Type(s): Flow Augmentation
Related Tools: Climate Appropriate Gardens, Green Infrastructure, Irrigation Efficiencies, Water Conservation Traditional BMPs, Upland Vegetation Management, Meadow Restoration, Carbon Farming BMPs, Rangeland BMPs, Agricultural BMPs, Crop Type Modification, Wetland & Riparian Restoration, Giant Reed *Arundo donax* Removal, Low Impact Development
Site Condition:

Impacts to Stream Flow/Hydrology: Erosion has been noted as the most significant cause of impaired water quality in our rivers and streams. Erosion from mismanaged rural and urban landscapes and construction sites alike move soil into waterways and in turn impact the water quality. Due to erosion, the sediment that settles below in water is a contributing factor in the decline of Salmonid population as the sediment fills up the voids in gravel, which spawning fish need. Additionally, sediment in wetlands can greatly reduce seed germination and in turn reduce flood storage. Another environmental impact; Turbidity from all the excess sediment, which reduces in-stream photosynthesis and resulting in less food for the habitat.

Region: Areas where there is poor soil quality accompanied with minimal ground cover or plantings. Additionally, sloped landscapes which do not have appropriate erosion control measures such as wattles, check dams, swales or bio-retention areas to reduce the velocity of water laden with excessive amounts of soil/ sediment.

DESCRIPTION

Erosion control includes a plethora of strategies and prevention is of paramount importance. Erosion prevention is much more effective than reactive control measures. Prevention not only helps protect the soil surface, it also helps maintain water quality by retaining soils in place, and by increasing infiltration through reduced flow. When designing new site elements, employ preventative approaches such as retaining existing vegetation whenever feasible, vegetate and mulch denuded areas, divert runoff away from denuded areas, minimize length and steepness of slopes wherever feasible.

Understanding soil types from soil reports greatly helps in strategizing which prevention practice is best suited for a location. Hillsides with sparse planting (natives) or ground covers, contribute a great deal to erosion which in turn leads to expensive land management remedies. Some erosion prevention BMPs include: Buffer zones, ground cover, seeding. Some erosion control BMPs include: Check dams, diversion swales, pipe slope drains, wattles, sediment basins. Additionally, urban area control and prevention strategies includes trail drainage and gully erosion management along with trail construction and maintenance improvements intended to prevent erosion.

Application for Tool in Watershed:

DATA & METRICS

Evaluation Metrics:

Primary Quantifiable Benefits :

- Water quality
- Salmonid population
- Water quality reports

Secondary Benefits:

Data Gaps: Accurate land survey and analysis; Environmental Data; Climate and Precipitation Data

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors:

Constraints vs. Benefits: Understanding of land survey data and reports, project budgets

Permitting & Coordination: Erosion and Sediment Control Plan

Associated Thresholds:

Considerations & Impacts:

- Erosion control, reduction and prevention efforts improve water quality by reducing sediment loads.

Community Engagement: Community volunteer planting days, installing wattles on contour, creating swales.

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring:

Forecasting & Outcomes:

REFERENCES

SECTION 5.

4. Landscape Scale

- a. Traditional Ecological Knowledge (TEK) & Cultural Burning
- b. Upland Vegetation Management
- c. Meadow Restoration
- d. Carbon Farming BMPs
- e. Rangeland BMPs

Figure 1: Map of tribal lands in California. (Source: U.S. Census Bureau)

Tool Profile: Traditional Ecological Knowledge & Cultural Burning

TOOL SUMMARY

Toolkit Project Type(s):
Related Tools: Range Management, Fire Resilient Landscapes, Upland Vegetation Management, Watershed Literacy, Wetland, Riparian Restoration
Site Condition: Treatments are focused on Wildland Urban Interface (WUI) communities and along roads and travel systems.

Impacts to Stream Flow/Hydrology: Cultural burning has been practices to reduce vegetation density and increase water availability. Tribes have recognized that burning can increase water levels in springs and meadows that favor many culturally important plants. Research has documented increased water flows in a forested montane watershed that has been managed with extensive use of wildland fire. Indigenous burners indicated that smoke would benefit salmon and other fish by reducing water temperatures.
Region: Within Ventura County

DESCRIPTION

Also called by other names including Indigenous Knowledge or Native Science, refers to the evolving knowledge acquired by indigenous and local peoples over hundreds or thousands of years through direct contact with the environment. This knowledge is specific to a location and includes the relationships between plants, animals, natural phenomena, landscapes and timing of events that are used for life-ways, including but not limited to hunting, fishing, trapping, agriculture, and forestry. TEK is an accumulating body of knowledge, practice, belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (human and non-human) with one another and with the environment. It encompasses the world view of indigenous people which includes ecology, spirituality, human and animal relationships, and more. (*U.S. Fish and Wildlife Service*)

Indigenous societies have used fire to manage their land for thousands of years. Indigenous fire management refers to "the intergenerational teachings of fire-related knowledge, beliefs, and practices among fire-dependent cultures regarding fire regimes, fire effects, and the role of cultural burning in fire-prone ecosystems and habitats." (*Lake & Christianson, 2019*).

Management techniques used by indigenous tribes include:

- Burning: application of fire to distinct vegetation with specific environmental conditions and characteristic including season, fire-return interval, and intentional goals Irrigating: Supplying areas of land with water through methods such as diversion and artificial channels
- Pruning: The removal of dead and living parts of plants to enhance its growth and production of seeds and fruits
- Selective Harvesting: Harvesting with the intention of receiving specific traits that will lead to evolutionary modifications such as the enlargement of the favored plant part
- Sowing: : Scattering seeds from native plants onto an area, usually burned ground
- Tilling: Removing earth in the harvest of underground perennial plant organs
- Transplanting: Moving a plant or a portion of a plan to another location
- Weeding: Removing unwanted plant species away from favored plant species

Application for Tool in Watershed: Management techniques are applicable in areas where fire has historically been used and can be easier to manage to achieve resource objectives. Treatments are also focused on Wildland Urban Interface (WUI) communities and along roads and travel systems.

DATA & METRICS

Evaluation Metrics:
Primary Quantifiable Benefits:
Secondary Benefits:

- Soil health
- Species and ecosystem biodiversity
- Pollinators
- Pest and disease regulation
- Wildfire regulation
- Enhanced hydrology

Data Gaps: Need to address shortcomings of controlled experiments and establish long-term collaborative studies.

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors:

Constraints vs. Benefits:

- Addressing challenges between Indigenous objectives and government agency objectives
- Addressing policy constraints on cultural burning
- Avoiding negative effects

Permitting & Coordination: During certain times of the year and in certain parts of the state, residential landscape debris burning of dead vegetation is allowed. However, homeowners should always check with their local fire station or CAL FIRE station, as well as local air quality management agency before burning. Burn permits may be required and during the dry months, CAL FIRE will suspend burning altogether. Burning can only be done on permissive burn days. Burning permits are only valid on "Permissive Burn Days" as determined by the State Air Resources Board or the local air district.

Associated Thresholds:

Considerations & Impacts: Holistic understanding of overlapping benefits for social-ecological well-being

Community Engagement:

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring:
Forecasting & Outcomes:

Image 1: Controlled burn facilitated by the North Fork Mono Tribe (Source: water.ca.gov)

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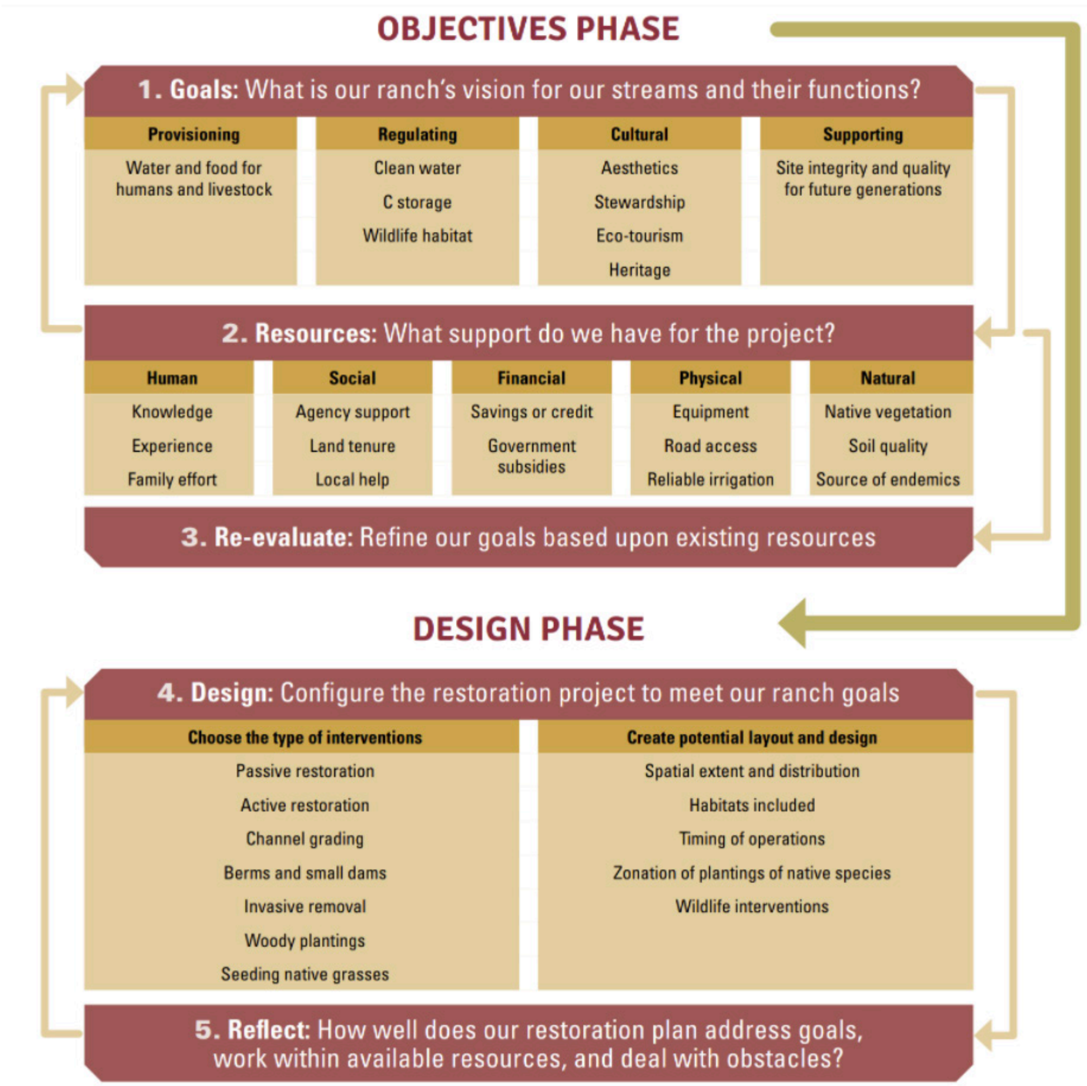

Figure 1: Diagram for riparian habitat planning worksheet for California rangelands, showing an Objectives Phase and a Design Phase. The idea is to work through the five steps sequentially. The Design Phase begins after Step 1 (goals) and Step 2 (resources) have been re-clarified. The actual design (Step 4) consists of choosing the types of interventions and practices, then creating a potential layout and site design. Step 5 has you reflect on goals, resources, and obstacles in order to continue refining the actual design before implemented.

Tool Profile: Upland Vegetation Management

TOOL SUMMARY

Toolkit Project Type(s): Reduced Consumptive Use, Time Management of Water, Water Quality Improvements
Related Tools: Riparian Invasive Removal, Giant Reed *Arundo donax* Removal & Restoration, Climate Appropriate Plantings
Site Condition:

Impacts to Stream Flow/Hydrology:
Region:

DESCRIPTION

Upland vegetation management and native plant restoration includes the removal of non native species and replacement of those plants with native species in upland regions that serve as stream headwaters. This discussion includes native plant restoration, vegetation buffer strips in the form of natives, hedgerows, or bioreactors, as well as erosion control treatments. Restoring native vegetation can reduce environmental water demand and leave more flow instream, while reducing sediment loading through erosion control. Additionally, native vegetation management can reduce fire severity, increase soil health and soil water holding capacity, all increasing water quality and hydrograph for Ventura River watershed highly variable precipitation events.

Upland and riparian restoration in California rangelands has been shown to improve the aquatic habitat for fish and density of native trees and shrubs and thereby increase watershed functions (Lennox et al. 2009) which may have correspondence to the Ventura River Watershed land-use activities.

Vegetated buffers strips can be easily applied to most the agricultural and even some larger residence and school parcels in the San Antonio Watershed, as well as the Upper Ojai Basin, and some parts of the Lower Ventura River Watershed. These vegetation management BMPs can not only can diminish water temperature, but also reduce sediment, phosphorus, and nitrogen (N) discharge to drainage water in agricultural areas (Osborne and Kovacic 1993). A vegetative buffer strip is one vegetation management tool that acts as a sponge that filters and can reduce the amount of runoff (Hubbard et al. 2004). Vegetated buffers can reduce stream bank erosion and increase water infiltration by providing a root structure that stabilizes soil (Florsheim et al. 2008).

It is estimated that two-thirds of California's drinking water passes through or is stored in oak woodlands (O'Geen et al. 2010). Vegetated buffers reduce pathogenic materials that contaminate waterways (Tate et al. 2004; 2006); even buffers of <2 meters width effectively filter pathogens. They also reduce nitrogen runoff through the process of de-nitrification, infiltration, and plant uptake (Hill 1996), but the magnitude varies according to various factors, such as the slope, the type of hydrologic flow path, and the presence or absence of a durapan that forces water to move laterally through the surface soil. (Jackson 2017)

Rooting depths of selected riparian plants and upper riparian banks, according to the depth of the water table. Knowing the depth of the water table across the restoration site will help decide on the spatial distribution of species that will establish well and persist over the long-term. Excerpted from Griggs (2009)- (See Figure X)

Application for Tool in Watershed: This tool is widely applicable to most the watershed, including small parcels.

DATA & METRICS

Evaluation Metrics:

- Reduced water quantity demand

Primary Quantifiable Benefits:

- Water quality
- Habitat enhancement
- Pre, post and ongoing photo-monitoring
- Percent cover, habitat enhancement (sq ft/acre)
- Reduced sediment loading
- Reduced erosion (sq ft.)

Secondary Benefits:

Data Gaps:

- Willing landowners
- Costs for Vegetation Management Types in Ventura River Watershed
- Habitat and land-use potential identified

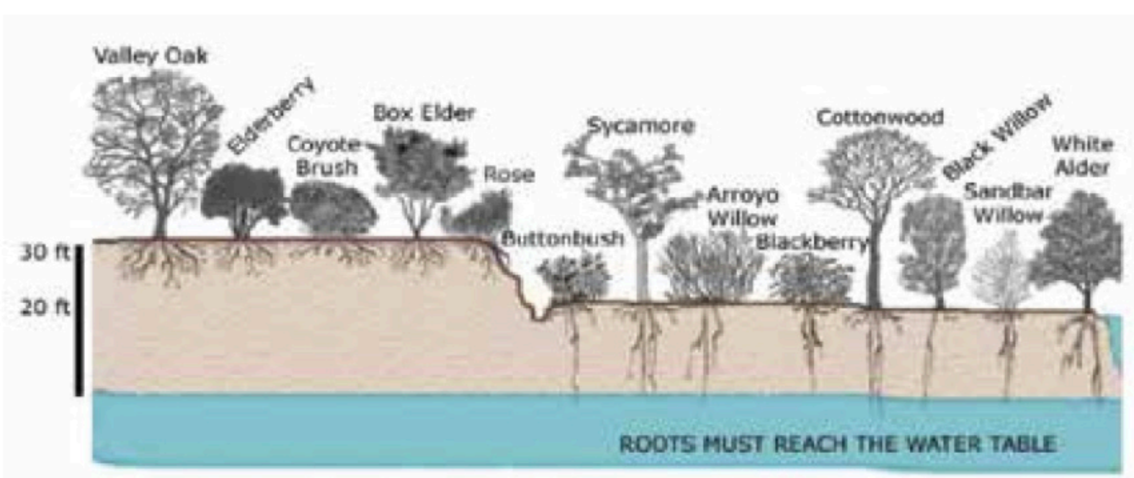

Figure 2: Rooting depth requirements of select riparian plants. (Source: NEED CITATION)

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors:

- Costs for Prescribed Burning and Grazing
- Costs for Hedgerows
- A stepwise approach by Long and Anderson (2010) for establishing hedgerows on farms provides guidelines that are relevant for selecting, analyzing, designing, and preparing a rangeland riparian site for active restoration and planting.
- $3847 is the estimated three-year cost for establishing and maintaining a 1000-foot long hedgerow's shrubs, trees, native grasses and forbs on a farm in the Central Valley
- Weed control is the single largest expenditure ($1,065) The steps outlined above are Long and Anderson's (2010) suggestions for establishing hedgerows on California farms, which are applicable to a range of re-vegetation projects.

Constraints:

- Workforce Availability
- Funding
- Direct Technical Assistance
- Contiguous Landowner Blocks
- Baseline and ongoing monitoring for effectiveness
- Accuracy of documentation of restoration and ecological integrity due to long term fluctuations and streamflow changes. (Jackson 2017)

Permitting & Coordination:

- Outside of 200' of blue line creeks, no permitting needed as long as no other local permits (such as grading) are not triggered. Coordination of activities with landowner and any funding or monitoring agencies and organizations.
- Within 200' of blue line waterways, x permit needed. Coordination with Ventura County Watershed Protection District and CDFW prior to permit pathway.

Associated Thresholds: Not applicable.

Considerations & Impacts:

- Reduces environmental water demand since invasive
- Species often require more water than plants that are adapted to the climate of the area.
- This reduction in environmental water demand leaves more water instream, which allows for the natural geomorphological function of rivers and streams to be retained to the benefit of native species and human communities downstream.

Community Engagement:

- Landowner engagement- Identify the habitat restoration goals (e.g., wildlife habitat, water and soil quality, stream bank stability), decide if the project is well-suited for the site, and determine whether particular reaches at the site satisfy specific goals b. Consult an aerial map to examine topography, hydrology and drainage, land use types nearby, and buildings (Long and Anderson)
- Farm Vegetation Management Approaches
    a. Prescribed Burn and Grazing Cooperatives

b. Farm Hedgerow and Bioreactor

c. Native Plant Buffer Strips

d. Erosion Control

e. Regenerative Stormwater Conveyance

f. Invasive Plant Identification and Control

- Coordinate with VCRCD and Ventura County on TMDL and other Water Quality Nutrient management programs.
- Utilize to assist with planning goals and objectives with landowners.
- Data Collection Plan for Landowners
- The Ojai Valley Land Conservancy has extensive experience conducting upland vegetation management on its preserves and conservation easements. The Conservancy has implemented several upland vegetation management approaches in its restoration practices, including prescribed grazing, invasive plant removal, erosion control, and regenerative stormwater conveyance, and seeks to coordinate and partner with other entities implementing upland vegetation management strategies in the Ventura River Watershed.

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring:

- Drone monitoring (various groups)
- Ventura County Watershed Protection District water quality, vegetation monitoring
- OVLC monitoring

Forecasting & Outcomes: Soil quality in vegetated buffers along creeks may increase only slowly after restoration. The accumulation of soil carbon and nitrogen depends on several factors, such as whether channels are susceptible to scouring (Smukler et al. 2010) and whether the area is grazed by livestock or not. Soil biodiversity, as indicated by nematode community composition along a lowland floodplain in Yolo County, showed no differences between restored and non-restored areas, but was higher in ungrazed zones of the creek (Briar et al. 2012). This may be because ungrazed sites provide higher vegetation cover and greater supply of soil nutrients and food sources which support more diverse groups of nematodes. The lack of effect of native vegetation restoration on trophic complexity of the nematode community may be due to slow changes in soil properties, heterogeneity in plant species establishment, or lack of colonization of soil fauna from other riparian areas due to the fragmentation of the landscape. Attraction of beneficial insects for pollination and pest management (e.g., predatory and parasitic insects) in nearby fields is another benefit of riparian buffer strips (Steingröver et al. 2010). (Jackson- largely copied and pasted….)

The Xerces Society (http://www.xerces.org/) has been collecting data for pollinators in California rangelands and recently released a booklet on habitat assessment (Jordan et al. 2014).

A study of native bees in Northern California showed that both the amount and the stability of pollination services increased with increasing area of upland habitat (riparian forest, chaparral and oak woodland) which, in Northern California, is mostly provided by private ranches (Kremen et al. 2004). For some insect and disease pests, information exists on their distribution and habitat preferences in riparian corridors in California.

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Image 1: The Ojai Valley Meadow Preserve after a January rain. (Source: OVLC.org)

Tool Profile: Meadow Restoration

TOOL SUMMARY

Toolkit Project Type(s): Flow Augmentation, Water Quality Improvements
Related Tools: Upland Vegetation Management, Carbon Farming BMPs, Rangeland BMPs
Site Condition:

Impacts to Stream Flow/Hydrology:
Region:

DESCRIPTION

Meadows are areas where shallow groundwater enables grass-like plants and wildflowers to flourish. They play an important role in the mountain ecosystem, serving to slow, spread, and sink stormwater. Healthy meadows benefit people, wildlife and rivers by acting as natural reservoirs that allow rain, snow and runoff to slow, spread and sink into the soil, filtering and storing water. Meadows that have degraded due to issues like grazing, climate change, lack of fire, timber harvesting and road and trail building are more susceptible to channel erosion and a lowered groundwater table. Meadows are of both hydrological and ecological importance. They help store and clean water, provide critical wildlife habitat, and sequester carbon.

Restoration activities include:

- Beaver Dam Analogues
- Channel Restoration
- Rangeland Management
- Vegetation Management

Application for Tool in Watershed: Meadow restoration serves to enhance instream flow by restoring the natural function of meadows to facilitate infiltration and improve water quality through natural filtration.

DATA & METRICS

Evaluation Metrics:
Primary Quantifiable Benefits:

- Improved water quality
- Habitat creation
- Carbon sequestration
- Enhanced streamflows

Secondary Benefits:

- Habitat restoration
- Pollinator habitat
- Improved air quality

Data Gaps:

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors:

Constraints vs. Benefits:

Permitting & Coordination: Depending on project size and other project components and circumstances, there are permit streamlining options through the Department of fish and wildlife as well as CEQA categorical exemptions.

- Carbon sequestration and Greenhouse Gas Emissions studies, monitoring and assessing
- Groundwater monitoring

Associated Thresholds:

Considerations & Impacts:

Community Engagement: To meet the increasing need for meadow restoration, the Ojai Valley Land Conservancy is expanding seed banking efforts to preserve the local genetics of native grasses and wildflowers. These are saved and redistributed at restoration sites that were historically meadows, such as the Ojai Meadows Preserve. Contact OVLC for more information on how to support these efforts.

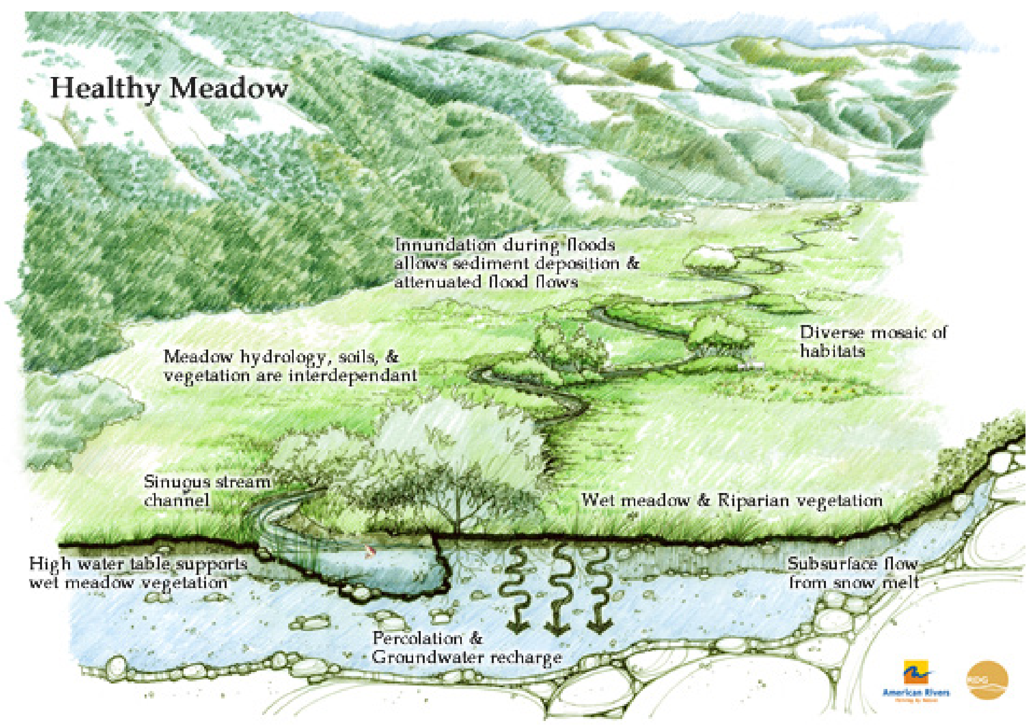

Figure 1: Benefits of a healthy meadow. (Source: AmericanRivers.org)

Image 2: The Ojai Valley Land Conservancy and the C.R.E.W. partnered to remove non-native trees and plant native Oak trees at the Ojai Valley Meadow Preserve. Vegetation management and native species restoration are critical to healthy meadows. (Source: OVLC.org)

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring:

Forecasting & Outcomes:

REFERENCES

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Image 1: Soil from a no-till farming field. (Source: Ron Nichols via USDA/NRCS)

Tool Profile: Carbon Farming BMPs

TOOL SUMMARY

Toolkit Project Type(s): Reduced Consumptive Use, Time Management of Water, Water Quality Improvements
Related Tools: Rangeland BMPs, Crop Type Modification
Site Condition: Agricultural land parcels
Impacts to Stream Flow/Hydrology: Practices like mulching serve to reduce consumptive use since they reduce evaporation and lower irrigation demand. BMPs like wetland and riparian restoration serve to enhance instream flow by increasing infiltration and improving water quality by contributing water that has been filtered through natural processes. Additionally, BMPs like filter strips serve to manage the flow of contaminated runoff and thereby improve water quality in areas downstream.
Region: Viable in all regions. Most effective in arid regions.

DESCRIPTION

Carbon farming involves implementing practices to maximize the land's ability to lock up carbon dioxide and other greenhouse gases. This can help mitigate the impacts of a changing climate, making the land more resilient. More specifically, carbon farming BMPs include practices like cover crops, conservation tillage, buffer strips, selective harvesting, and grass planting. There are a subset of carbon farming BMPs that also enhance instream flow. For example, practices like conservation tillage can serve to prevent runoff which in turn improves water quality. Additionally, practices like restoration of riparian areas on farmlands have the capacity to both sequester carbon and enhance instream flow. Carbon is sequestered because wetland and riparian areas are a net carbon sink and instream flow is enhanced because wetland and riparian restoration serves to increase runoff capture and increase infiltration. In some cases there are incentive programs in place to encourage adoption of such measures. According to the Carbon Cycle Institute, carbon farming is successful when carbon gains resulting from enhanced land management and conservation practices exceeds carbon losses. A set of online tools (COMET) developed by researchers at Colorado State University, NRCS, CCI and the Marin Carbon Project, allows the quantification of GHG benefits. In addition to the BMPs described above, the following list of interventions prepared by the Carbon Cycle Institute can be incorporated into agricultural practices in order to lower a site's carbon footprint and, in some cases, enhance instream flow:

- Mulching/Compost Application
- Residue and Tillage Management, No Till/Strip Till/Direct Seed
- Anaerobic Digester
- Multi-Story Cropping
- Windbreak/Shelterbelt Establishment
- Pastureland Establishment
- Forage and Biomass Planting
- Nutrient Management
- Tree/Shrub Establishment
- Forest Stand Improvement
- Contour Buffer Strips
- Riparian Restoration
- Riparian Forest Buffer
- Vegetative Barrier

- Windbreak/Shelter belt Renovation
- Alley Cropping
- Riparian Herbaceous Cover and Wind Barriers
- Range Planting
- Critical Area Planting
- Residue and Tillage Management
- Forest Slash Treatment
- Filter Strip
- Grassed Waterway
- Hedgerow Planting
- Cross Wind Trap Strips Conservation Cover
- Wetland Restoration

Application for Tool in Watershed: Detailed on-site stormwater flow analysis could be used to evaluate the flow of water on-site and the potential for reductions in contaminated runoff. Sub-watershed analysis and water resources analysis in Geographic Information Systems (GIS) could be used to assess the infiltration and water quality impacts of infiltration- and bio-filtration-oriented BMPs.

Image 2: Cover Crops are a tool that can help orchards survive drought. LEFT: Barley is growing in a lemon orchard before harvest , and RIGHT Triticale in an avacado orchard. (Source: CoverCropStrategies.com)

DATA & METRICS

Evaluation Metrics:

- Instream flow enhancement (Quantity) in cubic feet per second (CFS)
- Percent reduction in contaminated runoff
- Annual increase in infiltration
- COMET Planner allows for the quantification of GHG benefits.

Primary Quantifiable Benefits:

- Enhanced streamflow
- Improved water quality and quantity Reduced green house gas emissions
- Carbon sequestration
- Improved soil health

Secondary Benefits:

- Increased biodiversity
- Land and climate resilience
- Reduced pollution through erosion control and minimized nutrient run-off
- Improved air quality
- Improved native vegetation

Data Gaps: Detailed understanding of subsurface hydro-geology features like perched aquifer boundaries

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors: The cost of the BMP relative to the profit margin for the farmer

Constraints:

- Availability of incentives to implement BMPs.
- Social impacts of interventions that increase the cost of production and therefore increase the cost of food.

Permitting & Coordination:

- Most small-scale BMPs on private land would not require permits. Larger scale efforts like riparian and wetland restoration may require some permitting when done in environmentally sensitive areas.
- Carbon Farm Plan

Associated Thresholds: The amount of respiration and increased infiltration necessary to satisfy functional flows requirements.

Considerations & Impacts: There is a subset of carbon farming BMPs that enhance instream flow.

Community Engagement: For large scale projects like restoration projects, permitting authorities may require opportunities for public engagement. However, in most cases carbon farming BMPs would not increase conflicts between agricultural uses and surrounding sensitive users.

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring: Testing and water quality monitoring related to Ag Order 4.0 (Irrigated Lands Program) in California Water Quality Control Board Region 3.

Forecasting & Outcomes: According to Marin Carbon Project research, sequestration of just one metric ton per hectare on half the rangeland area in California would offset 42 million metric tons of CO2e, an amount equivalent to the annual green house gas emissions from energy use for all commercial and residential sectors in California (*Carbon Cycle Institute*).

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Image 1: Cattle grazing (Source: CA Rangeland Conservation Coalition)

Tool Profile: Rangeland BMPs

TOOL SUMMARY

Toolkit Project Type(s): Reduced Consumptive Use, Water Quality Improvements
Related Tools: Upland Vegetation Management, Meadow Restoration, Carbon Farming BMPs, Agricultural BMPs, Stormwater Reuse, Invasive Species Removal, Traditional Ecological Knowledge & Cultural Burning, Fire Management BMPs, Pollinator Pathways

Site Condition: Applicable for use on public and private agricultural rangelands, ranches and pastures.

Impacts to Stream Flow/Hydrology:

Region: In Ventura County, rangeland accounts for 954,683 acres of land, about 81% of total land area (*See Figure X below).*

DESCRIPTION

Rangelands (private and publicly owned) account for over 10 million acres of land throughout California and include dry annual grasslands, grassland/hardwood ranges and coastal prairies. The majority of rangeland is managed for livestock production; rangelands and irrigated pasturelands are an important source of forage for grazing cattle and sheep. More than two-thirds of surface waters used for municipal and crop production in California are derived from rangeland watersheds (*UC Rangelands*). Since rangelands cover a large portion of land throughout California, the quality of rangeland soils has an extensive impact on ecosystem function and health. Rangelands provide a wide range of ecosystem services including plant and animal diversity, migration corridors, climate regulation, water/nutrient cycling, carbon sequestration, and recreational space.

Best management practices for rangeland stewardship and maintenance can protect and improve water quality, soil health, and enhance critical wildlife and pollinator habitat. Rangeland BMPs include:

- Rotational grazing: to manage invasive weed species, enhance biodiversity of native plants, enhance soil quality and soil cover, reduce erosion
- Prescribed fire: prescribed burns help reduce invasive plant species and overgrowth and remove dead fuels, enhancing fire resiliency.
- Habitat restoration: through practices that include grazing, prescribed fire, native plant restoration and wetland/woodland restoration practices, rangelands can become regenerative landscapes that support pollinator species and provide critical habitat for endangered and migratory species.
- Stormwater BMPs: stormwater management practices reduce streambank erosion and help slow the spread of water and infiltrate it to enhance streamflows and improve water and soil qualities.

Application for Tool in Watershed:

DATA & METRICS

Evaluation Metrics:

- Evaluation/monitoring study: " Monitoring Protocols to Evaluate Water Quality Effects of Grazing Management on Western Rangeland Streams"

Primary Quantifiable Benefits:

- Habitat enhancement
- Water quality

	Ventura	Santa Barbara
Total Land Area	1,173,060	1,634,555
Rangeland	954,683	1,492,569
Percent of county	81.4%	91.3%
Annual Grassland	48,835	234,196
Coast Oak Woodland	16,115	103,882
Blue Oak Woodland	0	21,143
Valley-Foothill Riparian	3,223	12,914
Valley Oak Woodland	0	37,456
Coastal Scrub	226,374	206,903
Chamise-Redshank Chaparral	313,977	312,326
Mixed Chaparral	167,422	482,087
Montane Riparian	36,536	37,752
Pinyon-Juniper	155,743	31,428
Juniper	9,398	35,856
Sagebrush	13,597	6,292

California Gap Analysis Project (GAP); habitat classes from the "California Wildlife Habitat Relationships" database; CA Fish & Wildlife Service and UCSB.

	Ventura	Santa Barbara
Rangeland	954,683	1,492,569
Grazing lands	197,859	579,054
Percent of county in grazing lands	16.9%	35.4%

Figure 2: Rangeland type by acre in Ventura and Santa Barbara Counties. (Source: UCANR, Matthew Shapero)

Secondary Benefits:

- Fire resilience
- Food security
- Carbon reduction
- Improved air quality
- Increased streamflows

Data Gaps:

- Climate variability and change: shifts in precipitation patterns, temperature increases and frequency of extreme events like fire, overgrazing, and invasive animal and plant species have impacts on soil quality
- Understanding soil water dynamics at the watershed scale
- Understanding soil water can inform soil restoration and basic management practices and mitigation options for drought, flooding, and sea-level rise *(Forest & Rangeland Soils of the U.S. Under Changing Conditions)*
- Understanding local and regional soil differences in order to customize mitigation actions for disturbed soils *(Forest & Rangeland Soils of the U.S. Under Changing Conditions)*
- Understanding regional and local urban and non-urban land uses and their impacts on rangelands and their soils

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors: The economic impacts of Rangeland BMPs on ranching and agricultural operations need further understanding. Depending on management actions and land acreage, it make take several years for a ranch to come to a new equilibrium. Much of this information is place-based and requires collaboration and communication between private landowners, rangers, public lands, scientists, hydrologists and others.

Constraints vs. Benefits: (see above)

Permitting & Coordination:

- USFS
- Grazing on BLM-managed lands requires permits and leases issued by the BLM to public land ranchers
- CAL FIRE issues Burn Permits for prescribed burns

Associated Thresholds: N/A

Considerations & Impacts: There are a subset of rangeland BMPs that enhance instream flow. As described in the stormwater reuse section of this catalogue, stormwater BMPs serve to not only improve infiltration (which increases streamflow quantity) but also improve water quality by preventing contaminated stormwater runoff from reaching rivers, streams, and the ocean.

Community Engagement:

- California Rangeland Conservation Coalition works to keep ranching viable while having a positive impact on the sustainability of California's landscapes
- University of California Agriculture and Natural Resources (UCANR) provides education and applied research on rangeland ecosystems
- University of California, Davis Rangelands program provides tools and education on science-based solutions for sustainable rangeland management
- California Landscape Conservation Partnership (CA-LCP) fosters landscape conservation and climate adaptation strategies on California rangelands

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring: Soil monitoring and assessments can help determine the impacts and outcomes of rangeland BMPs.

Forecasting & Outcomes: N/A

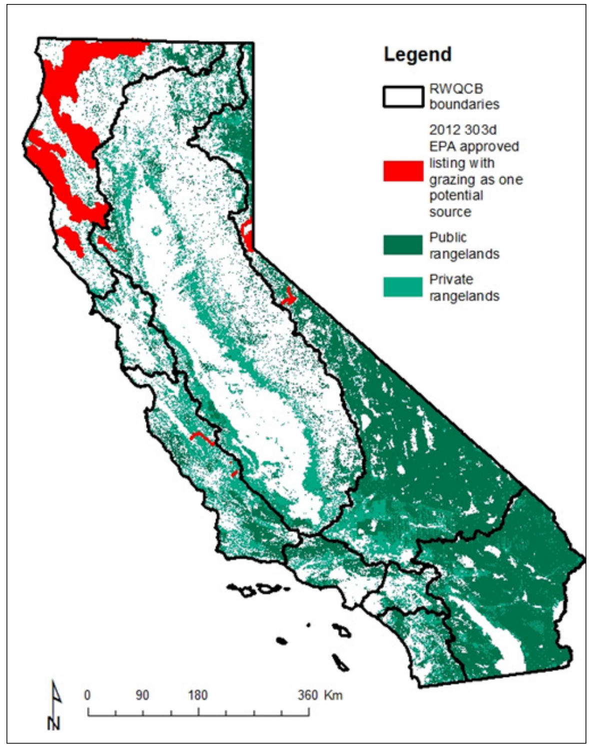

Figure 3: Map highlighting extent of California's public and private rangelands, and regional scope of water quality impairments with grazing listed as one potential source (Source: UC Rangelands)

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SECTION 5.

4. Wildland Urban Interface
    a. Winter Water Storage (Storage & Forbearance)
        i. Off-Channel Storage
        ii. Rainwater Harvesting & Reuse
        iii. Flood Managed Aquifer Recharge
    b. Agricultural BMPs
        i. Crop Type Modification
        ii. Flood Managed Aquifer Recharge
    c. Wetland & Riparian Restoration
        i. Vegetation Management
            ia. Riparian Invasive Species Removal
            ib. Giant Reed *Arundo donax* Removal
            ic. Upland Vegetation Management
        ii. Fish Passage Improvements
        iii. In-Channel Pond Structures
            iiia. Regenerative Stormwater Conveyance

Image 1: Mattole River has a voluntary partnership with landowners to get the water storage capacity they need in order to give up pumping from the river during critical dry season. (Source: SanctuaryForest.org)

Tool Profile: Winter Water Storage (Storage & Forbearance)

TOOL SUMMARY

Toolkit Project Type(s): Time Management of Water

Related Tools: Off-Channel Storage, Rainwater Harvesting, Flood MAR, Stormwater Reuse

Site Condition: This tool is best applied in areas where the majority of precipitation falls during the winter and summers are fairly dry.

Impacts to Stream Flow/Hydrology: If water is stored in ponds or tanks during the wet season, it has the potential to reduce stream flows during this period. Typically, the most critical periods to minimize diversions, in addition to the dry season, are during (1) the late fall and early winter when streamflows first rise and fish begin to move into and within the system, and (2) the spring and early summer when flows recede and fish require suitable flow and temperature to avoid stressful low-flow conditions. Most small-scale storage projects (e.g., rainwater catchment ponds) located away from stream channels can be managed to avoid risks to in-channel aquatic resources during these periods. However, landowners need to carefully manage their storage and conveyance systems. It can be detrimental to instream conditions if ponds or tanks are "topped-off" late in the spring. As these types of projects become more widespread, the cumulative impacts must be closely examined. Ideally, projects should be designed to capture water during the wettest portions of the winter to avoid adverse effects to the fall and/or spring flows. (Stillwater 2017)
Region:

DESCRIPTION

Storage and forbearance is a habitat restoration approach where a water user diverts and stores water quantities exceeding their water right allocation in wet season months, while diverting less than their allotted amount during dry season months. This is done to improve base flows for the benefit of wildlife that rely on them during this time of year. The information provided on functional flows shows that peak flows in the Ventura River Watershed tend to occur between the end of January and the first day of March. Dry season base flows tend to occur from mid-April to the beginning of November. However, the flow variation hydrograph shows that flows in the Ventura River watershed are highly variable throughout the year.

Application for Tool in Watershed: Variable, pending tool. Most of the agricultural and built environment has room for some storage, even residential parcels, for forbearance, pending scale.

Regional Example, Mattole River: Sanctuary Forest is addressing this problem using three main approaches: water storage, stream flow monitoring, and public education. The centerpiece of our response is the "tanks and forbearance" program for landowners in critical reaches of the Mattole headwaters. This innovative, voluntary partnership helps these landowners get the water storage capacity they need in order to give up pumping from the river during the critical dry season—and keeps that water flowing when the river needs it most. (Sanctuary Forest website)

DATA & METRICS

Evaluation Metrics:
Primary Quantifiable Benefits:

- Water supply
- Stream flow enhancement
- Water quality
- Fire resilience

Secondary Benefits:
Data Gaps:

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors: As a percentage of flow, cumulative diversions for human use have a much greater effect on the natural hydrograph in the summer and early fall than in the winter and spring. However, peak flows transport a significant portion of sediment load, inundate floodplains, and maintain and restructure river corridors over the long term. Therefore, while diversion during periods with higher flow rates is preferred, it is important that the natural function of peak flows be preserved. Functional flows are key components of a flow regime that sustains ecological function over time. Quantified functional flow data is only provided in the Watershed Criteria Reports for watersheds with a long-term gauge. While these functional flows are intended to be representative of other reaches in the watershed, site-specific evaluations may be necessary for accurately quantifying maximum diversion during peak flow events.

Constraints: Space for water storage; Maintaining the natural function of peak flows

Permitting & Coordination:

- Water Rights
- CDFW
- NMFS

Coordination of Forbearance agreements need to be localized. An example of the Water Storage and Forbearance Program (Sanctuary Forest) in the Mattole River Watershed discusses the varying degree of water rights application (directly cited):

In a forbearance agreement, a water user contracts with the local water trust to forego withdrawals of water pursuant to the terms and conditions set forth in the contract. The main advantage of a forbearance agreement is its simplicity and efficiency. No formal SWRCB or court approval is required and the terms of the agreement can be structured to fit the needs of the parties. The disadvantages of a forbearance agreement include lack of protection of dedicated flows from downstream users and the risks posed to holders of appropriative water rights.

Downstream users with riparian rights are not restricted to specified quantities of water withdrawals. If upstream dedications result in increased flows riparian rights holders can legally increase their water use. Downstream users with appropriative rights could also use the increased water flows as long as it does not exceed the total quantity specified on their water right. One way to avoid these problems is to notify downstream users in advance and seek their participation or obtain from them a written agreement stating that they will not divert increased flows. Appropriative water rights owners are potentially at risk if they participate in forbearance agreements for more than 5 years. If the non-use clause goes into effect, the right holder can lose the rights to the quantity of water dedicated through the forbearance agreement. Riparian rights cannot be forfeited by non-use and are not put at risk by forbearance agreements.

Conservation easements could serve as a type of forbearance agreement with the same advantages and disadvantages with regard to water law. The water restrictions of the easement would be structured to fit the landowner needs and no SWRCB process would be required. There would be no legal protection of the water from downstream users, and appropriative rights landowners could lose their seasonal water rights after 5 years of reducing their seasonal water use as per the non-use clause.

The SWRCB Cannabis Irrigation Registry (2019) also may provide guidance in a Ventura River Watershed Storage and Forbearance program. An excerpt from the SWRCB states:

Cannabis Small Irrigation Use Registration Since January 1, 1989, the Water Rights Registration Program has been available for expedited acquisition of appropriative water rights for certain small projects. In accordance with the Water Code section 1228, water right registrations are available for small irrigation, small domestic, and livestock stock pond users. SIURs are applicable to irrigated crops for sale or trade, including commercial cannabis cultivation once general conditions are adopted. Small Domestic Registrations (SDR) may be used for small, incidental watering and personal gardens and are not subject to this Policy (SDRs may not be used for obtaining CDFA commercial cannabis cultivation licenses). Livestock stock pond registrations are not available for cannabis cultivation. (SWRCB 2019)

To allow for physical tool treatment for a Storage and Forbearance Program, the following three sub-tool discussions are most applicable to the Ventura River Watershed:

- Off-Channel Storage
- Rainwater Harvesting
- Flood MAR

Associated Thresholds:

Considerations & Impacts: There is a subset of rangeland BMPs that enhance instream flow. As described in the stormwater reuse section of this catalogue, stormwater BMPs serve to not only improve infiltration (which increases streamflow quantity) but also serves to improve water quality by preventing contaminated stormwater runoff from reaching rivers, streams, and the ocean.

Community Engagement:

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring:
Forecasting & Outcomes:

REFERENCES

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Image 1: Mattole River has a voluntary partnership with landowners to get the water storage capacity they need in order to give up pumping from the river during critical dry season. (Source: SanctuaryForest.org)

Tool Profile: Off-Channel Storage

TOOL SUMMARY

Toolkit Project Type(s): Reduced Consumptive Use, Flow Augmentation, Time Management of Water
Related Tools: Fire BMPs, Water Conservation, Winter Water Storage, Rainwater Harvesting, Flood MAR, In-Channel Pond Structures
Site Condition: A singular or series of ponds or reservoirs diverting winter flows in to offset demand of ecologically sensitive surface diversions. Typically for irrigation or livestock demands.

Impacts to Stream Flow/Hydrology: If water is stored in ponds or tanks during the wet season, it has the potential to reduce stream flows during this period. Typically, the most critical periods to minimize diversions (in addition to the dry season) are during (1) the late fall and early winter when streamflows first rise and fish begin to move into and within the system, and (2) the spring and early summer when flows recede and fish require suitable flow and temperature to avoid stressful low-flow conditions. Most small-scale storage projects (e.g., rainwater catchment ponds) located away from stream channels can be managed to avoid risks to in-channel aquatic resources during these periods. However, landowners need to carefully manage their storage and conveyance systems. It can be detrimental to instream conditions if ponds or tanks are "topped-off" late in the spring. As these types of projects become more widespread, the cumulative impacts must be closely examined. Ideally, projects should be designed to capture water during the wettest portions of the winter to avoid adverse effects to the fall and/or spring flows. (Stillwater 2017)

Region:

DESCRIPTION

This winter water storage strategy utilizes water storage reservoirs that are constructed away from the main channel of the source waterway. This allows for reduced riverine ecosystem impacts compared to in channel storage.

Application for Tool in Watershed:

DATA & METRICS

Evaluation Metrics:

- TDS of stream flow
- AFY yield

Primary Quantifiable Benefits:

- Elongated hydrograph
- Offset ecological sensitive summer flow diversions
- Water quality
- Improved flows
- Water supply reliability
- Fire suppression
- Off-channel storage allows for reduced impacts to riparian habitat compared to in-Channel storage.
- Retains and restores the natural function of riparian habitats to be retained or restored,

- Improves stream water quality, TDS and nutrients
- Recharges groundwater supplies and instream flow depending on the subsurface hydro-geology conditions.
- Infiltration

Secondary Benefits:

Data Gaps:

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors:

Constraints:

- Vegetation Type, Land Use
- Percolation Rate to determine Detention, Retention opportunities
- Hydro-geology, soil
- Slopes
- Proximity to stream channel
- Estimated demand to offset surface diversions during ecologically sensitive base flows
- Conveyance infrastructure
- Willing Landowners
- Permitting, Biological Opinion, Water Availability Analysis
- Water Right Appropriative due diligence
- Section 1707 and/or Forbearance Program
- Collaborative Funding for maintenance, monitoring

Permitting & Coordination:

Associated Thresholds:

Considerations & Impacts:

- Potential impacts can be avoided and/or mitigated through appropriate planning, design, and maintenance.
- Increased erosion
- Ponds (or tank flats) that are not constructed at suitable locations or engineered properly have the potential to cause significant negative impacts, including increased surface erosion and/or mass wasting. In the worse-case scenario, failed ponds and/or fill slopes can cause significant gullying or landslides. Experienced licensed professionals should design all ponds and grading sites, and experienced licensed contractors should perform all construction work. Long-term monitoring and maintenance by the landowner is also critical to insure that all project components are functioning as designed. (Stillwater 2017)
- Reduction in flows during active diversions
- Lower water quality streams (water quality)
- If water is stored in ponds or tanks during the wet season, it has the potential to reduce stream flows during this period. Typically, the most critical periods to minimize diversions (in addition to the dry season) are during (1) the late fall and early winter when streamflows first rise and fish begin to move into and within the system, and (2) the spring and early summer when flows recede and fish require suitable flow and temperature to avoid stressful low-flow conditions. Most small-scale storage projects (e.g., rainwater catchment ponds) located away from stream channels can be managed to avoid risks to in-channel aquatic resources during these periods. However, landowner need to carefully manage their storage and conveyance systems. It can be detrimental to instream conditions if ponds or tanks are "topped-off" late in the spring. As these types of projects become more widespread, the cumulative impacts must be closely examined. Ideally, projects should be designed to capture water during the wettest portions of the winter to avoid adverse effects to the fall and/or spring flows. (Stillwater 2017)
- The potential to introduce and propagate invasive species (e.g., bullfrogs, canary reed grass, mosquitoes, bass and other Centrarchids) can be an important issue in building ponds. Ponds design plans (especially those in close proximity to a creek) should include a plan to manage and/or eradicate invasive species. At a minimum, periodically draining the pond every year or another type of bullfrog eradication plan is necessary. (Stillwater 2017)
- Reduces crop type viability and land availability for economic production.
- Unknown impact to crop productivity.
- Unknown connection to direct stream flow enhancement in some regions, however increased groundwater storage is most likely viable in the upper OBGMS basin.

Considerations:

- Prioritize locations via GIS tool identifies potentially suitable large-scale groundwater recharge and/or surface storage sites based on topography, soils, vegetation cover, land use, and proximity to connected stream course in the Upper Ojai Basin, San Antonio watershed, Lower Ventura, or in the Upper Ventura River Groundwater Basin. (Deitch 2016)
- Small Irrigation Use permitting pathway SWRCB for smaller decentralized ponds

Community Engagement:

- Research on other Community Engagement programs such in the Mill and Dutch Bill Creek Watersheds:

a. Funding is often available to implement streamflow restoration projects, but project implementation requires interest among landowners and a willingness to have activities (and associated regulatory scrutiny) conducted on their properties. Cooperative partnerships with competent partners are especially important for streamflow restoration: landowners often cite grave concerns about regulatory oversight of water use and potential loss of livelihood and land value that could be incurred by inviting regulators and the general public to scrutinize project plans for water storage, even if it would increase their personal water supply security and benefit over-summering salmonids. Surface water abstractions for agricultural, residential, and recreational uses all are possible sources of streamflow impairment, so partnerships must have the capacity to address a wide range of landowners and land managers. Property values are also very high in Sonoma County, with premium vineyard land valued as high as $120,000 United States Dollars (USD) per acre Fitchette 2016)]; because of the high cost of land, new vineyard owners need to maximize revenue and converting land from vineyard to a reservoir may not be financially prudent. (Deitch Dolman Water 2017)

- Clinics and Work groups on:

a. Discussion on willingness and economic conditions with current Appropriative Water Right Holders/ Surface Water Diverters

b. Small Irrigation Use permitting pathway (SWRCB) that will allow for storage of surface water from springs or creeks under certain conditions.

c. Ventura River Watershed SGMA Basin GSP events

Table 2. Typical costs for common water storage projects.

	Site assessment, Engineering, and permitting	Earthwork	Water storage supplies—pond liners/tanks	Plumbing	Total	Cost per gallon
100,000 gallon system						
Water tank system	$10,000	$5,000	$80,000	$5,000	$100,000	$1.00
Lined pond	$10,000	$10,000	$5,000	$2,500	$27,500	$0.28
Unlined pond	$10,000	$10,000		$2,500	$22,500	$0.23
300,000 gallon system						
Water tank system	$10,000	$5,000	$240,000	$15,000	$270,000	$0.90
Lined pond	$10,000	$20,000	$10,000	$2,500	$42,500	$0.14
Unlined pond	$10,000	$20,000		$2,500	$32,500	$0.11
Average						
Water tank system						$0.95
Lined pond						$0.22
Unlined pond						$0.17

Table 2 highlights the fact that water tank systems are significantly more expensive than ponds at a per-gallon rate. Additionally, larger ponds become more cost effective whereas tank systems have little economy of scale. Based on these considerations, landowners can achieve significantly more water storage for the same investment utilizing ponds instead of tanks for their agricultural storage. Based on the water use estimates previously described in Table 1, if all landowners in the watershed fully forbear from diversion for the five-month dry season, each parcel on average would need 45,000 gallons of storage for domestic use and approximately 100,000 gallons of storage for irrigation use. Based on these water storage volumes, the total cost of water storage for the study area has been calculated and summarized in Table 3. These calculations include the following assumptions: unlined ponds cost $0.23/gallon; lined ponds cost $0.28/gallon; tanks cost $1.00/gallon (values for 100,000 gallon system from Table 2). Note that significant additional cost savings could be achieved by landowners pooling resources to construct larger ponds where feasible (i.e. community water systems).

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring:

- OBGMA VRIF Monitoring, GSP Monitoring Plan
- UPVGSA GSP Monitoring Plan
- VRIF Thacher Creek Monitoring
- Senior Canyon Mutual Water Company Stream Flow Monitoring

Forecasting & Outcomes:

- Prioritizing best available soils, vegetation and land use for off-channel storage.
- Economic incentive program for landowners and water agencies.
- Fire Impact study.
- Land-owner survey (Deitch Dolman Water 2017)
- Ventura River Water Management Plan: Instream Flow Resilience Chapter (see Mill Creek Streamflow Improvement Plan. 2016)

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Image 1: (Source: Department of Water and Power, June 2018)

Tool Profile: Flood Managed Aquifer Recharge (FloodMAR)

TOOL SUMMARY

Toolkit Project Type(s): Flow Augmentation

Related Tools: Fire BMPs, Water Conservation, Winter Water Storage, Rainwater Harvesting, Off-Channel Storage

Site Condition: This tool is best applied in areas where the majority of precipitation falls during the winter and summers are fairly dry.

Impacts to Stream Flow/Hydrology: Flood-MAR can provide ecosystem benefits by reconnecting and inundating floodplains; creating floodplain habitat (e.g., riparian), marsh, and wetlands; supplementing base-flows; and supporting groundwater dependent ecosystems through increased base-flow resulting from higher groundwater levels. Factors that will determine the potential ecosystem and habitat enhancement opportunities are land use, proximity and connectivity to the river, timing of recharge flows, and length of flooding. Seasonal flooding of land will boost food productivity (e.g., insects, zoo-plankton) to support aquatic and terrestrial species. For example, flood bypasses and large areas of flooded rice straw decomposition in the Sacramento Valley provide ecosystem benefits that can accrue when water is spread out and slowed down, such as important benefits to birds along the Pacific Flyway, food web production, and salmon-rearing habitat. Recharging groundwater supplies also has the potential to provide ecosystem benefits by boosting instream base-flow or reducing surface water temperature through surface and groundwater interactions. This resource management strategy may also help reduce undesirable conditions caused by overdraft by restoring the physical conditions of an aquifer. Groundwater may also be used to support environmental water accounts that use water stored in the ground during wetter periods to help increase instream flows during drier years (via groundwater extraction or in-lieu use). (DWR 2018)

Region:

DESCRIPTION

A strategy that uses flood water for managed aquifer recharge on agricultural lands and working landscapes. Summarized from DWR website, it describes Flood MAR as:

"Flood-MAR" is an integrated and voluntary resource management strategy that uses flood water resulting from, or in anticipation of, rainfall or snow melt for managed aquifer recharge (MAR) on agricultural lands and working landscapes, including but not limited to refuges, floodplains, and flood bypasses. Flood-MAR can be implemented at multiple scales, from individual landowners diverting flood water with existing infrastructure, to using extensive detention/recharge areas and modernizing flood management infrastructure/operations.

Flood-MAR projects can provide broad benefits for Californians and the ecosystems of the state, including:

- Water supply reliability
- Flood risk reduction
- Drought Preparedness
- Aquifer Replenishment
- Ecosystem Enhancement
- Subsidence Mitigation
- Water Quality Improvement
- Working Landscape
- Preservation and Stewardship

- Climate Change Adaptation
- Recreation and Aesthetics

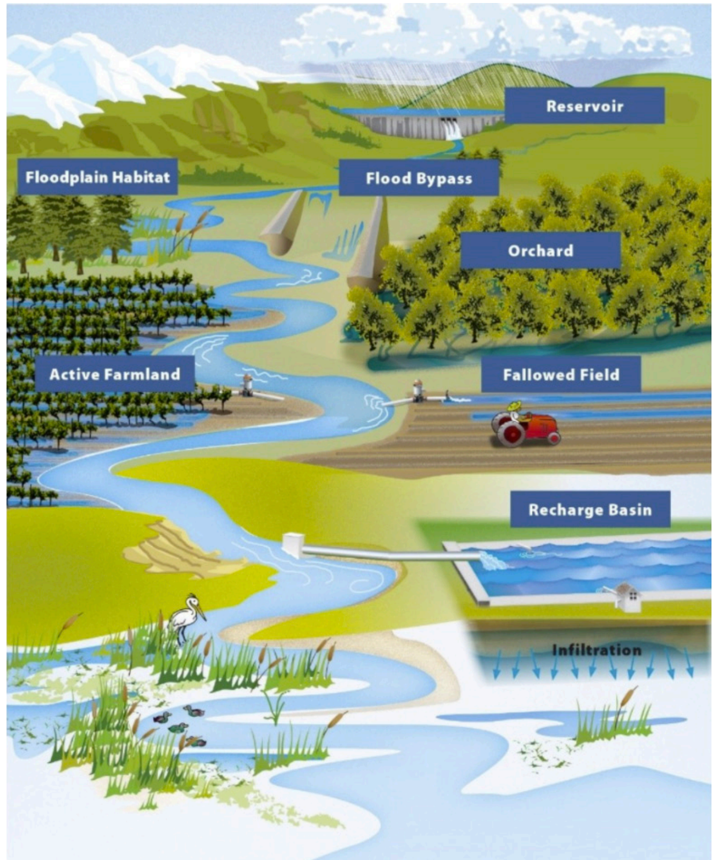

Figure 1: (Source:: https://water.ca.gov/programs/all-programs/flood-mar)

There is strong, and growing, interest across the state in understanding the benefits, limitations, concerns, costs, and funding opportunities for Flood-MAR projects. DWR plans to work with other state, federal, tribal, and local entities; academia; and landowners. Together, we will build on the knowledge and lessons from past and ongoing studies and programs, pursue expanded implementation of Flood-MAR, and make Flood-MAR an integral part of California's water portfolio.

Application for Tool in Watershed:

DATA & METRICS

Evaluation Metrics:

- AFY recharge to groundwater basins or to perched aquifer (OBGMA only)

Primary Quantifiable Benefits:

- Water quality improvements
- Agricultural viability/productivity

Secondary Benefits:

Data Gaps: (*Refer to Flood-MAR Research and Data Development Framework for further information.*)

- Governance
- Feasibility
- Willing landowner
- Coordination and ongoing maintenance costs
- Design constraints (high variability of precipitation patterns, sediment loading)
- Landowner incentive programs
- Sustainable funding model

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors: Flood-MAR strategies could compensate landowners for keeping their lands in their current use (e.g., agricultural production) while allowing periodic flooding. This strategy allows farmland to stay in production, rather than retiring lands to create recharge basins (Bachand et al 2014, 2016; Dahlke et al 2018). This strategy relies on thriving landscapes that can adapt to changing hydrologic conditions. These recharge areas should be protected in a manner that ensures they remain available for recharge, rather than be converted to other uses, such as urban infrastructure. Recharge areas should also be protected to prevent pollutants from entering groundwater. As there is local authority over land use planning, activities need to be coordinated and consistent with local general planning and other local land using planning efforts. Water and flood managers will need to work with local land use planners to protect watersheds and recharge areas. (DWR 2018). Kiparsky et al 2019 discusses successful local level groundwater governance: scale, human capacity, funding, authority, independence, representation, participation, accountability, and transparency.

Funding models can be via a Water Banking method or a Santa Cruz Recharge Net Metering to Enhance Groundwater Sustainability model as illustrated below (Kiparsky 2018):

The Pajaro Valley ReNeM pilot program uses this rebate equation:

Rebate = W50 × (Inftot–Infinc) where Infinc is the incidental infiltration that would have occurred without the project, Inftot is total measured infiltration, and W50 is a 50% discount factor to account for uncertainties and storage of soil water, and ensure financial viability.

Additional factors to understand feasibility are discussed in the Figure x.x below (DWR 2018):

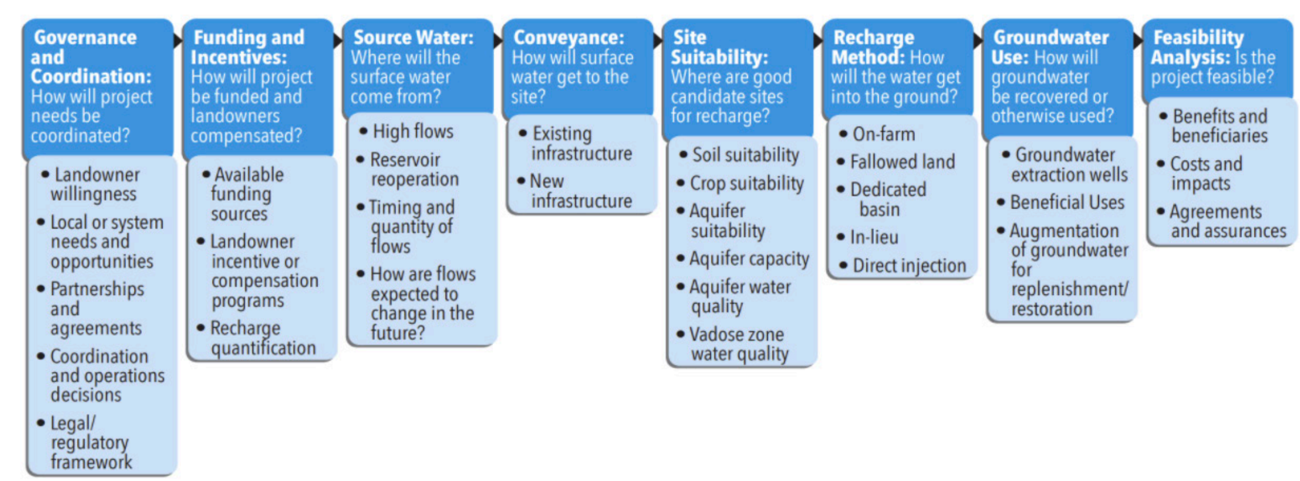

Figure 2

Constraints: Space for water storage; Maintaining the natural function of peak flows

Permitting & Coordination:

Associated Thresholds:

Considerations & Impacts: Water Quality: DWR states that flooding recharge areas could mobilize surface/soil pollutants from current or past land uses contaminate aquifers. Increasing recharge could also further spread contaminated groundwater contaminant plumes by altering rates and direction of groundwater flow. It is anticipated that any potential adverse water quality changes will be short term and local, followed by long term and regional benefits as a result of dilution. (DWR 2018).

- Enhances instream flow in instances where the hydro-geology is such that the aquifer feeds a spring that feeds a river or stream
- Increased infiltration enhances water quality by preventing runoff and directing water to areas where it can percolate into the earth and be naturally filtered.

Community Engagement: Strategic outreach is necessary for implementation. Entities pursuing FloodMAR projects must prioritize engagement with agricultural landowners and buy-in from the community to be successful. OVLC has relationships with agricultural landowners throughout the watershed, which can provide opportunities to pursue FloodMAR projects at a larger scale.

Seven Ways Water Managers Use Stream Flow Information	
1	Allocating water during drought
2	Predicting floods and managing floodplains
3	Managing dams and reservoirs
4	Protecting California's ecosystems and species
5	Implementing and overseeing water rights
6	Monitoring groundwater-surface water interactions for SGMA compliance
7	Revising water management plans to meet changing conditions

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring: Two of the groundwater basins in the region already monitor their levels in compliance with SGMA. Additional monitoring to help understand how to best provide a Ventura River Watershed wide Flood MAR program may need to include a larger regional monitoring effort such as recommended by Miller, et al. 2018.

Forecasting & Outcomes: Investigate current programs such as the 2016, Recharge Net Metering Resource Conservation District- Santa Cruz County and the Pajaro Valley Water Management Agency, the first (ReNeM) program in California. ReNeM creates a basis and mechanism to incentivize improvements to water supply and quality in over-drafted basins. (Recharge Initiative 2016)

Figure 3

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Image 1

Tool Profile: Agricultural BMPs

TOOL SUMMARY

Toolkit Project Type(s): Reduced Consumptive Use, Water Quality Improvements
Related Tools: Irrigation Efficiencies, Resilient Agriculture Efficiency & Transition Framework, Land Resilience Partnership, Hydrated or Vegetated Buffer Strips, Carbon Farming BMPs, and Crop Type Modification.

Site Condition: Small to large-scale agricultural parcels. The primary crops grown within the watershed are citrus and avocado; citrus comprises about 44% of the acreage, and avocados 25%. Other crops include grains, row crops, berries, flowers, and other tree crops (Ventura River Watershed Management Plan, 2015)

Impacts to Stream Flow/Hydrology: Agricultural BMPs can address all aspects of instream flow enhancement including Reduced Consumptive Use, Water Quality Improvements, Time Management of Water, Flow Augmentation. By offsetting municipal supplies, instream flow volume is enhanced in instances where the municipal supply's source is diversion or where increased municipal supplies would allow for voluntary contributions to instream flow. Conserving municipal and mutual supplies is particularly important in the Ventura River Watershed where dry season base flows are one of the primary limiting factors on steelhead spawning habitat. Ag BMPs can decrease consumption of groundwater supplies as most Ag demand is supplied by wells. This can bolster streamflow in locations where groundwater has direct connectivity to streams in the Ventura River Watershed.

Region: Agricultural BMP opportunities can be applied to most non-urban areas, with large concentrations in typical Ag zones like flood plains atop alluvial groundwater basins.

DESCRIPTION

Collection of best management practices intended to maximize irrigation efficiency and reduce evaporation in agricultural settings, protecting water and air quality. Examples of agricultural BMPs include irrigation schedule timing, efficient irrigation technologies, shaded fuel breaks, and mulch treatment.

1. Irrigation schedule timing: Improved scheduling and application is a feasible way to meet the minimum demands of orchards and farms. Proper irrigation application rates and timing can be achieved using irrigation technologies or through traditional moisture monitoring/observation and manual application.

2. Efficient irrigation technologies: A large opportunity for modernizing Ag irrigation management exists in installing flow meters, moisture sensors/automatic valves, weather sensors and efficient emitters. Technologies can help Ag managers achieve proper distribution uniformity and application rates to improve efficiency. These devices can increase flow monitoring for analysis and help with leak detection.

3. Grading and stormwater capture: Keeping more storm water on-site within large agricultural lands can benefit irrigation efficiency, local soil hydration and groundwater recharge. Water kept from running off sites can decrease flash streamflows and capture more groundwater in upper watershed areas. This practice is typically not feasible on existing orchards but makes sense for crop replacement.

4. Mulch: Applying organic mulch and compost in feeder root areas of orchards helps retain moisture from irrigation and rain, builds soil permeability and water holding capacity in soils, and can improve crop health/ yield. It is estimated that applying 4-6" of mulch to orchards with bare soils can increase irrigation efficiency by 30% (Needs reference)

5. Shaded Fuel Breaks: Productive agriculture can provide the co-benefit of creating a fire buffer. Efficiently irrigated crops like citrus and avocados have been shown to withstand the assault of wildland firestorms, specifically within the Ventura River Watershed.

Application for Tool in Watershed: Though it is decreasing in acreage due to policy and development, agriculture in the Ventura River Watershed accounts for approximately 45% of the total water demand (Ventura River Watershed Management Plan, 2015). This singular large use presents a scaled opportunity for reducing consumptive use of municipal and groundwater that could be incentivized through policy and rebates.

DATA & METRICS

Evaluation Metrics:

- Crop yield data
- Water quality measurements/sampling
- Calculated percent reduction in pollutant load
- Stream flow data / Seasonal Kendall test of monthly steam flows

Primary Quantifiable Benefits:

- Improved water security
- Improved water quality
- Food security
- Energy resilience
- Habitat creation
- Enhanced instream flows
- Distribution uniformity of irrigation
- Metered demand accounting for Ag water sources
- Crop yield and health evaluation
- Infiltration of stormwater

Secondary Benefits:

Data Gaps:

- Accurate groundwater pumping and agricultural demand data
- Ag efficiency opportunities analysis across the watershed
- Aggregate demand analysis of Ag in the watershed

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors: Ag BMPs range in effectiveness and feasibility though all may provide substantial net economic benefits to land mangers and producers.

Constraints: Replacing or retrofitting existing irrigation systems with updated components and/or pipe networks can be costly and can disturb crops. Some tools like grading for stormwater capture are not feasible for existing orchards, but rather can only be implemented when planting or re planting. Tools like mulching and improved scheduling are cost effective and less invasive ways to increase efficiency without extensive planning or infrastructure work.

Permitting & Coordination: Most Ag BMP implementation does not require permitting or advanced coordination, namely on existing farms and orchards.

Associated Thresholds:

Considerations & Impacts:

- Implementing irrigation efficiencies reduces consumptive use by using existing water supplies more efficiently
- Stormwater BMPs increase infiltration and improve water quality by preventing contaminated runoff from reaching storm drains, streams, rivers, and the ocean
- Storage and forbearance practices enhance instream flow and native species habitat through time management of water.

Community Engagement: Agriculture land managers are typically associated with a strong cultural connection with their practices and land. Getting buy-in and participation from influential Agriculture managers in the watershed could help to encourage more innovative practices to improve efficiency. Incentives and rebates could bolster participation in the implementation of these tools by increasing the cost/benefit equation. Social media and programs that connect the Agricultural community to new ideas and technologies, facilitate farm tours and connect mulch sources with landowners are other avenues to increase adoption.

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring:

- Soil Samples

Forecasting & Outcomes:

REFERENCES

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Image 1: Sustainable agriculture through crop type modiciation. (Source: USDA NRCS via CalClimateAg.org)

Tool Profile: Crop Type Modifications

TOOL SUMMARY

Toolkit Project Type(s): Reduced Consumptive Use, Flow Augmentation, Time Management of Water, Water Quality Improvements

elated Tools: Ag BMPs, Carbon Farming BMPs, Irrigation Efficiencies, Climate Appropriate Plantings

Site Condition: Small to large-scale agricultural parcels. The primary crops grown within the watershed are citrus and avocado; citrus comprises about 44% of the acreage, and avocados 25%. Other crops include grains, row crops, berries, flowers, and other tree crops (*Ventura River Watershed Management Plan, 2015*)

Impacts to Stream Flow/Hydrology: Crop rotation improves soil function and reduces erosion; efficient irrigation and soil health contribute to better distribution of water throughout the soil, improving infiltration and impacting streamflow.

Region: Most opportunities can be applied in non-urban areas, with large concentrations in typical Ag zones like flood plains atop alluvial groundwater basins.

DESCRIPTION

Crops have different needs, including soil types, nutrients and amounts of water. The amount of water required by the plant depends on the regional climate it's grown in, and seasonal changes. Selecting the crop best suited to the given conditions of the region and climate can optimize yields, reduce water demand through a more efficient use of irrigation water, and in some cases, improve water quality runoff. Climate shifts present an opportunity to for Ag producers to modify their crops as it makes sense with grow and life cycles.

Application for Tool in Watershed: Applicable on all agricultural parcels. Agriculture in the Ventura River Watershed accounts for approximately 45% of the total water demand (Ventura River Watershed Management Plan, 2015).

DATA & METRICS

Evaluation Metrics:

Primary Quantifiable Benefits:

- Improved water security
- Improved water quality
- Workforce development
- Food security
- Healthy communities
- Energy resilience
- Habitat creation
- Enhanced instream flows
- Irrigation demand delta
- Crop yield and health

Secondary Benefits:

Data Gaps:

- Opportunities analysis of Ideal crop modification options for gross benefits
- Current status of watershed crop modification

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors:

- Climate
- Crop Type
- Plant growth stage
- Cultural and aesthetic concerns of altering the landscape
- Profitability and management of new crop types

Constraints:

- Nutrient requirements
- Soil texture and testing
- Crop markets and prices

Permitting & Coordination: Most crop modification implementation does not require permitting or advanced coordination, namely on existing farms and orchards. Williamson Act tax shelter can stand by keeping the perceived economic value of the crop in tact.

Associated Thresholds: N/A

Considerations & Impacts:

- Reduced consumptive water use through lowering irrigation needs, which can serve to increase instream flow quantity
- Conserves and improves soil quality
- Protects soils from erosion
- Increased crop yields
- Higher diversity in plant production
- Reduced risk of pest and weed infestations

Community Engagement: Public perception/agricultural community understanding as value

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring:

- Remote sensing time series analysis for crop monitoring

Forecasting & Outcomes:

REFERENCES

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Image 1: Consumnes River Preserve shows how critical wetlands are for wildlife habitat and migrating birds (Source: CalMatters.org)

Tool Profile: Wetland & Riparian Restoration

TOOL SUMMARY

Toolkit Project Type(s): Reduced Consumptive Use, Flow Augmentation, Water Quality Improvements
Related Tools: Regenerative Stormwater Conveyance, In-Channel Pond Structures, Climate Appropriate Plantings
Site Condition: Seasonal or perennial transition zones between land and water such as stream beds, creeks, and topographic depressions where the flow of water, the cycling of nutrients and the energy of the sun meet to produce a unique ecosystem characterized by hydrology, soils and vegetation. These areas very important features of a watershed that support both aquatic and terrestrial species. The prolonged presence of water creates conditions that favor the growth of specially adapted plants (hydrophytes) and promote the development of characteristic wetland (hydric) soils.

Impacts to Stream Flow/Hydrology: By acting as a natural filter, the plants and soil within a wetland or riparian zone help to improve water quality, enhance groundwater recharge, provide erosion control, and aid in flood management. Wetland and riparian restoration also maintains critical fish and wildlife habitat.

Region: Wetlands vary widely because of regional and local differences in soils, topography, climate, hydrology, water chemistry, vegetation and other factors, including human disturbance. Typically wetlands are divided into two categories: coastal/tidal and inland/non-tidal. Coastal/tidal wetlands are closely linked to estuaries where sea water mixes with freshwater to form an environment of varying salinities. Inland/non-tidal wetlands are most common on floodplains along rivers and streams, in isolated depressions surrounded by dry land, along the margins of lakes and ponds, and in other low-lying areas where the groundwater intercepts the soil surface or where precipitation sufficiently saturates the soils.

DESCRIPTION

Restoration of a former or degraded wetland or riparian zone's physical, chemical and biological characteristics to return its natural functions. Restoration practices include re-establishment and rehabilitation of climate appropriate plantings, step pools, in-pond structures, and bank stabilization. In addition to restoration, voluntary protection of naturally occurring wetlands and riparian channels is a valuable part of habitat protection.

Wetlands play an integral role in the ecology of a watershed. The combination of shallow water, high levels of nutrients and primary productivity is ideal for the development of organisms that form the base of the food web and feed many species of fish, amphibians, shellfish and insects. Many species of birds and mammals rely on wetlands for food, water and shelter, especially during migration and breeding.

Application for Tool in Watershed:

Water Storage: By storing water and slowly releasing it, wetlands decelerate water's momentum and erosive potential, reduce flood heights, and allow for ground water recharge. These actions contribute to base flow to surface water systems during dry periods.

Water Filtration: Since flow is decreased upon entering a wetland, suspended sediments are allowed to drop out and settle to the wetland floor. Nutrients from fertilizer application, manure, leaking septic tanks, and municipal sewage that are dissolved in the water are often absorbed by plant roots and microorganisms in the soil. In many cases, this filtration process removes much of the water's nutrient and pollutant load by the time it leaves a wetland. Some wetlands are artificially engineered to enhance effluent water quality from various sources such as municipal wastewater or as a primary treatment for stormwater.

Biological Productivity: Wetlands are some of the most biologically productive natural ecosystems in the world. Abundant vegetation and shallow water provide diverse habitats for fish and wildlife. Aquatic plant life flourishes in the nutrient-rich environment, and energy converted by the plants is passed up the food chain to fish, waterfowl, and other wildlife and to us as well.

DATA & METRICS

Evaluation Metrics:
Primary Quantifiable Benefits:

- Improved water security
- Improved water quality
- Habitat creation
- Enhanced instream flows
- Reduced potential flood damages
- Biological species counts

Secondary Benefits:
Data Gaps:

- Carbon sequestration by wetland plant
- Bio-assessments and functional assessments when compared to a set of reference wetlands

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors:

- Constructed treatment wetlands use natural processes involving wetland vegetation, soils and their associated microbial life to improve water quality
- Constructed treatment wetlands are less expensive to build than traditional stormwater treatments options
- Wetlands contribute to the national and local economies by producing resources, enabling recreational activities and providing other benefits, such as pollution control and flood protection.
- While it can be difficult to calculate the economic value provided by a single wetland, it is possible to evaluate the range of services provided by the wetland and assign a dollar value.

Constraints:

Permitting & Coordination:

- Water quality standards for wetlands and riparian zones can provide a strong foundation for protecting and enhancing state or tribal wetland resources.
- Federal, State, Tribal and local agencies are all involved in wetland and riparian restoration.
- Federal agencies with key roles include EPA, USACE, NOAA, USFWS, USDA, US DOD, DOI, USFS and USDOT.
- Local players include conservation groups, corporations, lawyers, citizens' groups. Ongoing monitoring and assessment are important to understanding the success of restoration.

Associated Thresholds:

Considerations & Impacts:

- Ecological integrity, understanding ecosystem processes within the watershed
- Restoration of native species and habitat
- Drinking Water Quality
- By improving the water quality in nearby rivers and streams, wetlands provide a natural biological filter for future drinking water downstream reducing impact of water purification plants.
- Flood Control
- Wetlands can play a role in reducing the frequency and intensity of floods by acting as natural buffers, soaking up and storing a significant amount of flood water, typically about three acre-feet of water (1-million gallons).
- Wastewater Effluent Quality
- Municipalities have turned to more cost-effective constructed wetlands for cleaning discharged water instead of costly upgrades to existing infrastructure.
- Fisheries
- Wetlands provide an essential link to the life cycle of 75 percent of the fish and shellfish commercially harvested in the U.S., and up to 90 percent of the recreational fish catch.
- Recreation
- Recreation in protected wetlands including hiking, fishing, bird watching, photography, and hunting contributed more than $108 billion in 2001 (Source: USFWS, Ducks Unlimited).
- Intangible Values
- In addition to the many ways wetland provides economic benefits, they offer numerous less tangible benefits as well. These include providing aesthetic value to residential communities, reducing stream bank erosion, and providing educational opportunities as an ideal outdoor classroom.

Community Engagement:

- Public support and coordination can help ensure long-term protection of the restored area.
- Partnerships with stakeholders can add resources ranging from monetary to technical expertise and implementation.
- Wetland Program Development Grants (WPDGs) assist state, tribal, local government agencies, and interstate/inter tribal entities in building programs to protect, manage and restore wetlands.
- Voluntary restoration and protection refers to activities not required by statutes or regulations. Examples include land trusts purchasing titles or easements to wetland areas, community groups removing invasive species and planting native vegetation, and conservation programs that pay landowners to change practices such as cultivation or grazing that alter wetland areas.
- Partnerships with stakeholders can add resources ranging from monetary to technical expertise and implementation.
- The Ojai Valley Land Conservancy has extensive experience working with the community, the county, and other organizations to restore riparian corridors of the Ventura River and San Antonio Creek. OVLC can leverage this experience to assist landowners in the watershed who are interested in riparian and wetland restoration.

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring:

Volunteer monitoring programs run by the EPA creates informed and knowledgeable citizens who become better stewards and advocates for more sustainable approaches to land use and water management. Examples of monitoring data include dominant vegetation type, adjacent impervious surfaces, hydrology, exotic plant species encroachment, amphibian migration counts, macro invertebrate tax richness, physical and chemical baseline parameters, bird sightings, and wetland appearance/footprint.

The California Wetland Monitoring Group focused its efforts on developing and implementing the CA Rapid Assessment Method (CRAM) and a wetland and stream database called EcoStlas. This data based provides data in graphic and report formats on the extent and conditions of wetland in CA along with other water quality and habitat data derived from multiple databases that it accesses.

Forecasting & Outcomes:

Wetlands/ microbes, plants and wildlife are part of global cycles for water, nitrogen and sulfur. Furthermore, scientists are beginning to realize that atmospheric maintenance may be an additional wetlands function. Wetlands store carbon within their plant communities and soil instead of releasing it to the atmosphere as carbon dioxide. Thus, wetlands help to moderate global climate conditions.

Image 2a, 2b: Before (TOP) of an existing wetland site and; After (BTM) rendering of site restoration. (Source: Watershed Progressive)

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3. *Wetland and Riparian Restoration: Taking a Broader View. Edited by Keith B Macdonald and Fred Weinmann, U.S. Environmental Protection Agency, 1997*
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Image 1: A California Conservation Crew members removing invasive riparian species from the San Joaquin River in Fresno, CA. (Source: ccc.ca.gov)

Tool Profile: Riparian Invasive (Vegetative) Species Removal

TOOL SUMMARY

Toolkit Project Type(s): Reduced Consumptive Use, Water Quality Improvements
Related Tools: Wetland & Riparian Restoration, Giant Reed *Arundo donax* Removal, Upland Vegetation Management
Site Condition: Invasive vegetation within the riparian channel
Impacts to Stream Flow/Hydrology: Groundwater recharge, erosion control and bank protection, water quality improvement, reduced evapotranspiration.
Region:

DESCRIPTION

The removal of invasive plant species along riparian channels and restoration with native riparian plants and trees throughout the drainage channel. Invasive impact water quality, biodiversity, fish and wildlife habitat, tree cover, fire risk and land management costs. Restoration encourages regrowth of the natural plant palette, reduces evapotranspiration, provides wildlife habitat, stabilizes soils to minimize erosion, creates pathways for water infiltration through root channels, and increases water quality with oxygenation, sediment filtration, and contamination removal.

Invasive riparian species typically have dense, shallow root systems that consume large amounts of water, destabilize banks and increase bank erosion, and create competition with native species. Once removed, native species are planted to stabilize riparian soil, filter sentiment and contamination from natural water channels, and increase biodiversity.

Application for Tool in Watershed: Anywhere along riparian channels.

DATA & METRICS

Evaluation Metrics: Acres or stream kilometers (km) of invasive vegetation removed.
Primary Quantifiable Benefits:

- Increased water quantity
- Increased water quality

Secondary Benefits:

- Increased native riparian flora
- Recreational benefits for human users

Data Gaps: Vegetation mapping throughout the watershed needed to understand where invasive species are located.

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors:

Constraints:

- Inundation of channel at site, density of beds, incision of channel
- Removal includes maintenance and restoration plan
- Limited access for removal, restoration and ongoing maintenance due to regulatory restrictions

Permitting & Coordination:

Associated Thresholds:

- Slope, width and incision of channel
- Access

Considerations & Impacts:

- Potential flooding due to debris from uncontained canes downstream
- Removal through chemical control. (Most practitioners are moving away from this method to protect habitat quality.)

Community Engagement: The Ojai Valley Land Conservancy has extensive experience removing invasive riparian species such as giant reed and tamarisk. OVLC is working with partners at the local, county, and state level to develop a strategic, watershed-wide approach to giant reed eradication, and community engagement and support will be critical to this effort. Riparian landowners with invasive species on their property are welcome to reach out to OVLC for guidance. Ojai Valley Land Conservancy and Ventura Land Trust hosts public volunteer events, community film festivals, other outreach events that can be utilized.

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring:

- Ojai Valley Land Conservation
- Ventura Land Trust

Forecasting & Outcomes:

REFERENCES

1. State of California. (n.d.). Invasive Species Removal. California Conservation Corps. Retrieved November 15, 2021, from https://ccc.ca.gov/what-we-do/natural-resource-management/invasive-species-removal/.

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Figure 1a: Arundo donax - AFTER removal rendering (Source: Watershed Progressive)

Figure 1b: Arundo donax - BEFORE removal rendering (Source: Watershed Progressive)

Tool Profile: Giant Reed *Arundo donax* Removal

TOOL SUMMARY

Toolkit Project Type(s): Reduced Consumptive Use, Water Quality Improvements
Related Tools: Wetland & Riparian Restoration, Giant Reed *Arundo donax* Removal, Upland Vegetation Management
Site Condition: Arundo donax within riparian channel.

Impacts to Stream Flow/Hydrology: Groundwater recharge, erosion control and bank protection, water quality improvement, reduced evapotranspiration. Giant reed alters hydrological regimes and reduces groundwater availability by transpiring large amounts of water from semi-arid aquifers (Dudley).

Giant reed impacts channel morphology by retaining sediments and constricting flows, and in some cases may reduce stream navigability (Lake, pers. comm., TNC 1996).

Region:

DESCRIPTION

Loose Arundo strands in the creeks and rivers may cause blockages in the system that eventually become fish passage barriers or result in flooded areas. Arundo promotes fire ignitions and the spread of wildfire. Arundo depletes groundwater, inhibits native plant recruitment, provides poor habitat for riparian dependent wildlife, reduces the abundance and diversity of arthropods, and leads to sensitive species decline when it dominates a region. According to the California Invasive Plant Council, since its foliage provides little shade, creek water temperatures soar where Arundo is found, making life uninhabitable for species like the endangered Arroyo toad, red-legged frog, western pond turtle, Santa Ana sucker, arroyo chub, unarmored three-spined stickleback, tidewater goby, and southern steelhead trout—a long endangered fish that used to ply the waters of the Santa Clara and Ventura Rivers and their upstream tributaries. Higher water temperatures also mean water evaporates faster, compounding dehydration in our streams and critical subsurface water supplies.

Dense stands trap and clog native silts in critical fish-rearing habitat, creating a creek bottom of near-impenetrable barrier of silts. Prime graveled bottoms become fouled by algae, depleting oxygen available for aquatic species while potentially preventing infiltration and recharge to subsurface aquifers.

Water demand from invasive Arundo donax is highly variable based on inundation period, access to surface flows and dormancy periods. Previous scientific studies have estimated stand-based transpiration to be very high (~40 mm / day), although this may exceed actual physiological transpiration limits (Cal IPC 2017).

Application for Tool in Watershed: Anywhere along riparian channels.

DATA & METRICS

Evaluation Metrics: Acres or stream kilometers (km) of Arundo removed.
Primary Quantifiable Benefits:

- Increased water quantity
- Reduction in floodplain fire risk
- Increased water quality.

Secondary Benefits:

- Reduction in localized flood and fire damage
- Increased native riparian flora
- Recreational benefits for human users

Data Gaps: New scientific studies are needed to corroborate and refine stand-based transpiration estimations for the Ventura County region. Capturing these data will allow for a more accurate estimation of the water use benefits associated with removing Arundo donax in Ventura County and, more broadly, Southern California.

Vegetation mapping throughout the watershed needed to understand where Arundo is located. A prioritization tool is needed to strategically remove Arundo throughout the watershed.

Primary Benefits	Unit, Parameter	Where/Validation
Enhanced Stream Flow	cfs, hourly (if detectable over 0.5 cfs or greater)	*Above/below project site; At site, pre and post monitoring*
Habitat Enhancement	Acres restored	*Photo and Drone UAV Monitoring*
Water Quality: Temperature	Air, surface water	*At site, pre and post monitoring*
Water Quality: Dissolved Oxygen	Surface water	*Above/below project site; pre and post monitoring.*
Fire Resilience	Acres restored	*Photo and Drone UAV Monitoring*
Groundwater Recharge	TBD	*Highly conditional, seasonal*
Secondary Benefits	**Unit, Parameter**	**Notation**
Flood Mitigation		
Healthy Communities		*Avoidance of fire, flooding risk; Reduced channel incision, lowering of groundwater table.*

Figure 2: Primary Quantifiable Benefits and Evaluation Metrics (direct benefits at project site)

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors: Needs to be strategically removed and maintained with follow-up treatments/native restoration to reduce the risk of repopulation.

Constraints:

- Inundation of channel at site, density of beds, incision of channel
- Removal includes maintenance and restoration plan
- Limited access for removal, restoration and ongoing maintenance due to regulatory restrictions
- Difficult to garner support from private land owners

Permitting & Coordination:

Associated Thresholds:

- Slope, width and incision of channel
- Access

Considerations & Impacts:

- Potential flooding due to debris from uncontained canes downstream
- Removal through chemical control.

Community Engagement:

- Public perception/community understanding as value.
- VRW council website interactive map "Arundo free watershed", five year goal
- VRW Community Outreach
- VRWPD
- UPVGSA: GPS Stakeholder engagement (DWR), Vegetation Monitoring (WCB 2020 pending)

Image 1: Arundo donax

- VRIF Water View for Watersheds interactive map, three year goal
- Pilot projects; working with landowners to debunk herbicide myths and develop alternate visual screens on their property
- Ojai Valley Land Conservancy and Ventura Land Trust hosts public volunteer events, community film festivals, other outreach events that can be utilized

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring:

- UPVGSA: GPS Stakeholder engagement (DWR), Vegetation Monitoring (WCB 2020 pending)
- OVLC: (WCB 2020 pending)
- VCRCD: Ojai Valley Inn Water Strategies for Ventura River Instream Flow Enhancement (Phase 1) (WCB 2020 pending)

Forecasting & Outcomes:

- Arundo donax can recolonize quickly, and with climate change can quickly invade or re-invade stressed riparian habitats.
- Regional collaboration and coordination on permitting, maintenance and monitoring strategies.
- VRW council website interactive map “Arundo free watershed”, give year goal.
- Identification Mapping and Quantification Analysis
- Environmental Water
- Clear Tie to Community and Intrinsic Ecological Values
- Benefits and Impacts to Ventura River Watershed Cultural heritage
- Localized Conditions Transpiration Quantification
- Collaboration of net benefit(s)

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Image 1: Fish Passage Improvements can include fish screens, intake channgels and pumping plants. This example is along the Sacramento River. (Source: WaterEducation.org)

Tool Profile: Fish Passage Improvements

TOOL SUMMARY

Toolkit Project Type(s): Water Quality Improvements

Related Tools: Wetland & Riparian Restoration, Vegetation Management, Riparian Invasive Species Removal, In-Channel Pond Structures, Regenerative Stormwater Conveyance

Site Condition: The depletion of flows necessary for the migration, spawning, and rearing of Southern California Steelhead in the Ventura River Watershed have resulted in changes to fish community structures, increased water temperatures, and reduced gravel recruitment.

Impacts to Stream Flow/Hydrology: Instream flow enhancement has the potential to increase fish passage, increase habitat area, and improve habitat conditions. Fish Passage Improvements are often an outcome of enhanced instream flows rather than a tool to enhance stream flows. However, there are certainly cases where improving fish passage can alter stream flow. For example, removal of a dam would result in less water retention above the dam and potentially different downstream flows if water releases from the dam are managed. The primary application of Fish Passage Improvements is to help identify/prioritize locations where enhanced instream flow would be beneficial for passage and habitat.

In addition, fish passage improvements will help reduce habitat fragmentation within the watershed, provide access to more habitat, provide additional habitat, improve overall habitat quality. These will aid all native fish in the watershed. Also, removal of barriers could reduce the presence of invasive fish that associate with habitats created by barriers. Finally, removal of barriers could influence sediment transport within the watershed.

Region:

DESCRIPTION

California's salmon, steelhead and other aquatic life depend on healthy coastal rivers and streams that provide cool water and habitat features that support life history needs of aquatic species including the ability to access different habitats within a watershed. Fish passage improvements work to identify barriers that alter instream flows, water temperatures and habitat diversity needed for fish to survive, and work to re-open streams and rivers to migratory fishes.

Application for Tool in Watershed: When streamflow drops below the sensitive period indicator, fish and benthic macro-invertebrates are particularly sensitive to additional water reductions and other stressors.

Fish Passage Improvements can be used as a decision making tool for project implementation/prioritization.

DATA & METRICS

Evaluation Metrics:
Primary Quantifiable Benefits:

- Improved water quality
- Habitat creation
- Enhanced instream flows

Secondary Benefits:

Data Gaps:

- Identification and characterization of fish migration barriers
- While most Watershed Criteria Reports only provide data on passage flows for juvenile species, the Watershed Report provides passage flows for juvenile and adult species by drainage area.
- Passage requirements for native, non-salmonid species

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors:
Constraints:

Permitting & Coordination:

- Recovering salmon and steelhead on the California coast landowners, agencies and others to work together to identify and remove barriers to fish passages
- CDFW's California Salmonid Stream Habitat Restoration Manual provides guidance for fish passage requirements
- Coordination and streamlining of permits required for habitat restoration

Associated Thresholds:

- CDFW recognize low-flow thresholds, which can be identified through the wetted perimeter method or as a percentage of Mean Annual Discharge (MAD)
- Sensitive Period Indicator
- To determine adequate passage flows, depth, velocity, and wetted perimeter are modeled at a variety of discharge

Considerations & Impacts:

Community Engagement:

- The Fish Passage Forum is an association of public, private and governmental organizations developing programs to assist private landowners, communities and public agencies in efforts to remove migration barriers and restore currently inaccessible habitat
- Riparian landowners in the watershed have the potential to be partners in fish passage improvement projects. OVLC can support efforts to leverage private lands for fish passage improvements both by engaging in projects on OVLC's protected lands and by leveraging relationships with supporters in the community.
- Coastal Conservancy
- The Department of Fish and Game
- NOAA Fisheries Services

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring: CDFW has a Passage Assessment Database (PAD) that documents barriers. This is semi-regularly updated.

Forecasting & Outcomes:

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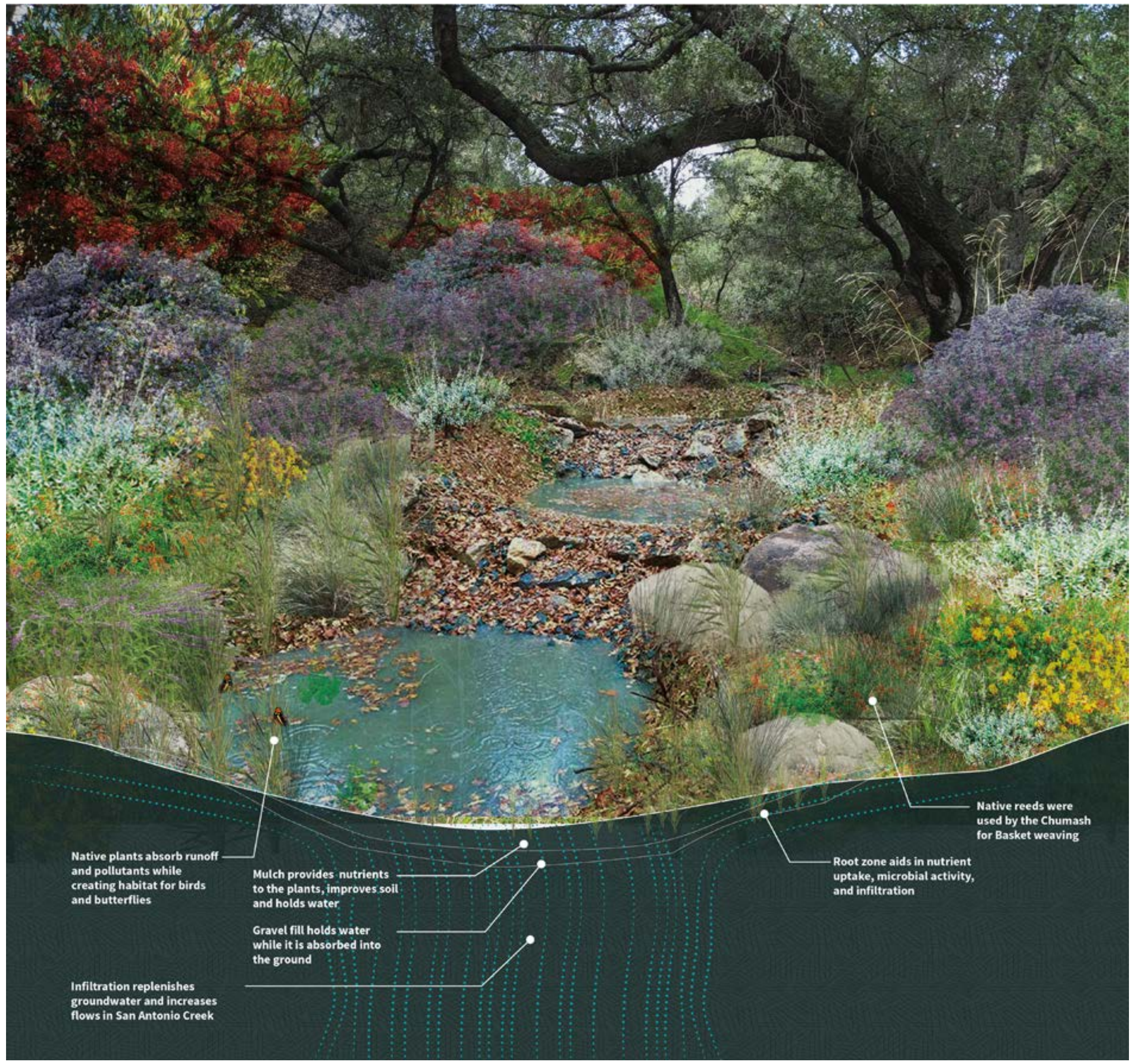

Image 1: Step pools and in-channel pond structures are a form of Regenerative Stormwater Conveyance. (Source: Watershed Progressive)

Tool Profile: In-Channel Pond Structures

TOOL SUMMARY

Toolkit Project Type(s): Time Management of Water

Related Tools: Regenerative Stormwater Conveyance, Wetland and Riparian Restoration

Site Condition:

Impacts to Stream Flow/Hydrology: By decelerating the momentum of water in streams, sediments and pollutants present are able to settle in the stream bed leaving cleaner water to move downstream. Water held in these ponds now have a chance to percolate and restore groundwater supplies and encourage riparian vegetative growth that stabilize banks and promote healthy soils.

Region: Appropriate in areas with suitable hydro-geology conditions.

DESCRIPTION

In-channel pond structures are a restoration strategy that promotes ponds in stream channels to provide wildlife habitat, boost vegetative growth, increase infiltration to groundwater reserves, and prevent bank erosion.

Application for Tool in Watershed: Along with Regenerative Stormwater Conveyance check dams, pond structures can be employed as a tool that recharges streamflow and water quantity along areas of a stream that are steep in grade. This reduces bank erosion and prohibits excess sediment from flowing downstream, which in turn promotes better water quality. In sections of steep grade, pond structures can disperse stream flows over a greater drainage area and benefit riparian growth.

DATA & METRICS

Evaluation Metrics:

- Acre-feet of water infiltration
- CFS benchmark versus post-construction CFS
- Vegetative species counts
- Wildlife species counts

Primary Quantifiable Benefits:

- Water quality inflows versus outflows
- Water quality testing

Secondary Benefits:
Data Gaps:

- Detailed topography (1-2 foot increments) for constructing dams along a single contour
- Knowledge of sub-watersheds and design storms for determining stream heights in drainage channels when experiencing flooding rains
- Correct ground covers in sub-watersheds (impervious, turf, native plantings)
- Creation of ponds within a stream section could also create additional passage barriers and provide habitat for invasive species (e.g., bass, bluegill, sunfish).

IMPLEMENTATION CONSIDERATIONS

Economic & other Feasibility Factors:
Constraints:

- Projection location in relation to coastal zones, red line streams, public land, U.S. Army Corps of Engineers (USACE) jurisdictional waters, and California Department of Fish and Game (CDFG) jurisdictional waters.
- A California Environmental Quality Act (CEQA) exemption exists for habitat restoration projects 5 acres or smaller.
- A state Water Resources Control Board (SWRCB) Construction General Permit/Stormwater Pollution Prevention Plan (SWPPP) is triggered when more than 1 acre of soil disturbance is associated with new construction projects.

Permitting & Coordination:

- If a project affects an area where water flows, ponds or is present even part of the year, it is likely to be regulated by one or more agencies.
- A representative from the regulatory agency or a qualified biologist can help you determine whether you have a regulated wetland, stream or associated resource on-site. Ultimately, it is the regulatory agency with jurisdiction, or regulatory control, that decides whether project activities require a permit.
- Several factors unique to your project may trigger requirements for wetland and stream permits. These include the proposed work, location, biology, and size of the project. *(2)*

Associated Thresholds:

- Increase infiltration
- Regulate water temperature
- Enhance riparian environments by restoring critical habitat
- Reduce erosion

Considerations & Impacts: Key factors to consider scaling, planning or implementing this tool. Related impacts of implementing this tool from realized community or watershed values, multiple benefits, or aggregated single metrics that can enhance stream flow quality or quantity.
Community Engagement: Community outreach methods, organizations and programs which can assist in scaling, funding, planning, implementing or monitoring of the tool or approach.

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring: Current or past regional monitoring efforts that can inform effectiveness of tool on streamflow enhancement and other watershed and community values, benefits.
Forecasting & Outcomes: Key applied targets or climatic factors forecasted to modify the tool or approach in the future.

Tributary Streams

Stream	Area (mi^2)	Optimum Flows (cfs)
10) Lion Canyon Creek	12.8	5
9) Coyote Creek 2	13.1	6
15) NF Matilija Creek	16.1	7
3) Cañada Larga Creek	19.3	5
11) San Antonio Creek 2	33.9	8

	Drainage Area (mi^2)	Number of Sites		Steelhead Passage Flows (cfs)	
		Juvenile	Adult	Juvenile	Adult
11) San Antonio Creek 2	33.9	4	2	7	24

Figure 1: Adult and Juvenile Steelhead Passage Flows (by drainage area).

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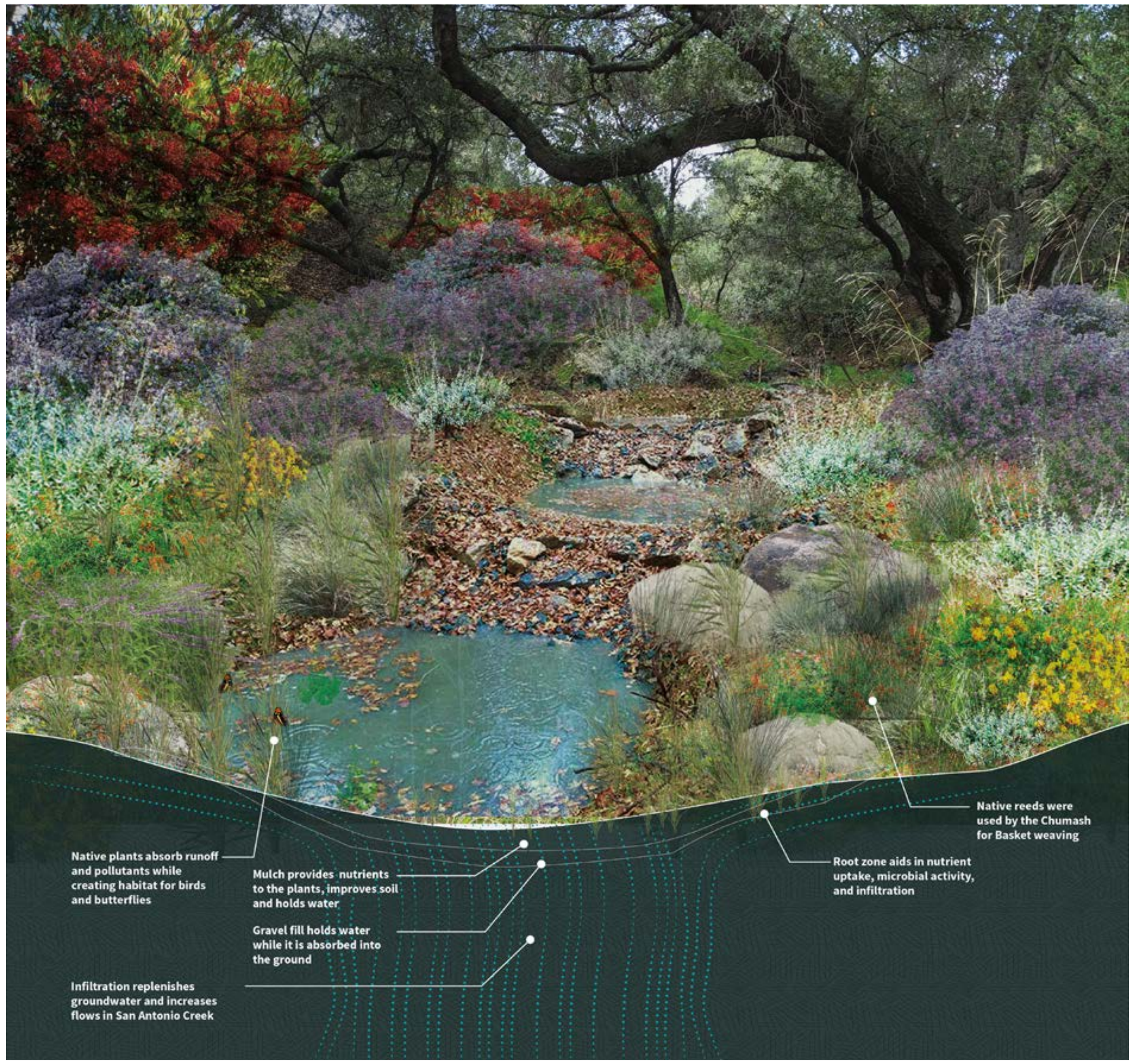

Image 1: Step pools and in-channel pond structures are a form of Regenerative Stormwater Conveyance. (Source: Watershed Progressive)

Tool Profile: Regenerative Stormwater Conveyance

TOOL SUMMARY

Toolkit Project Type(s): Reduced Consumptive Use, Flow Augmentation, Time Management of Water, Water Quality Improvements
Related Tools: Stormwater Reuse, Rainwater Reuse, Green Roofs, Climate Appropriate Plantings, Green Infrastructure
Site Condition: Regenerative Stormwater Conveyance may be applied to natural or created drainage channels and swales, and can replace traditional concrete and pipe stormwater infrastructure and prevent downstream impacts.
Impacts to Stream Flow/Hydrology: Slows stormwater; Infiltrates stormwater; Filters pollutants out of stormwater through settling in pools and flow through gravel/mulch/compost mix; Retains stormwater for in-stream flow and slower release
Region: Any

DESCRIPTION

Regenerative Stormwater Conveyance (RSC) uses boulder check dams to form step pools within eroding drainage channels to slow, sink, spread, and filter stormwater. The pools formed above and below the boulder check dams are lined with gravel/aggregate, mulch, and/or compost. Native riparian and aquatic vegetation around the check dams, within the channel, and on banks is also a critical piece of RSC design. Where feasible and when permitting allows, RSC design also involves raising the grade of eroding incised channels back to their original elevation. As opposed to other channel restoration methods which may lay back bank grades to reduce erosion or only plant to stabilize banks, RSC involves grading to raise and restore channel elevation. This grade raising has a unique long-term benefit of stabilizing the eroding channel, restoring historic water table levels and flood plains, and allowing layers of gravel, mulch, and/or compost to store, infiltrate and filter stormwater.

Application for Tool in Watershed: RSC can replace traditional development practices that harden surfaces with concrete channels, pips and storm sewers. RSC can mitigate soil erosion and polluted waterways by slowing and filtering stormwater runoff, thus protecting stream banks, native vegetation, invasive species and water quality.

DATA & METRICS

Evaluation Metrics:

Primary Quantifiable Benefits:

- Improved water quality
- Extreme heat reduction
- Flood mitigation
- Habitat creation
- Groundwater recharge
- Enhanced instream Flows

Secondary Benefits:
Data Gaps: Release of soluble reactive phosphorus from RSCs warrants further investigation

IMPLEMENTATION CONSIDERATIONS

Economic & Other Feasibility Factors:

- RSC best used to treat stormwater on moderate to steep slopes
- Ideally, design is applies to existing drainage features (ie ditches) with slopes of 10% or less
- Pools should drain down to their design (ponding) levels within 72 hours from a storm event

Constraints:

- Must be engineered property to avoid water flow shortcutting around check dam structure (may need bank stabilization around structure)
- May raise the water table around development that is encroaching on the channel
- RSC best used to restore ecological functions to an existing eroded ditch, outfall, channel or ephemeral/intermittent stream

Permitting & Coordination:

- Permitting for regrading incised channels to raise grade up, reestablish higher water table/floodplain, and stabilize further erosion
- Importation of non-local materials within recognized riparian zones/blue line creek channels in CA
- Hydraulic analysis, watershed and stream assessments, and sediment transport analysis used for preliminary design

Associated Thresholds:

- Slope/gradient affects spacing
- Necessary footprint on site to accommodate an RSC system with enough storage (need to calculate for drainage area)

Image 2: Regenerative step pools after the plantings and redesigns.

Considerations & Impacts: RSC Benefits include conveying stormwater while minimizing erosion, slowing and infiltrating stormwater, settling sediment, improving water quality, soil stabilization, and native vegetation restoration. RSC emphasizes and enhances natural stream channel design by maximizing sediment and nutrient processing, habitat creation, and aesthetic value.

Community Engagement: Ojai Valley Land Conservancy (OVLC) supports the implementation of regenerative stormwater conveyance projects to mitigate floodwaters, as these projects provide multiple benefits that contribute to community climate resilience. OVLC has successfully implemented two RSCs at its Ojai Meadows Preserve and plans to implement a large-scale RSC project to redirect floodwaters from the Casitas Springs neighborhood.

POST-IMPLEMENTATION CONSIDERATIONS

Related Regional Monitoring:
Forecasting & Outcomes:

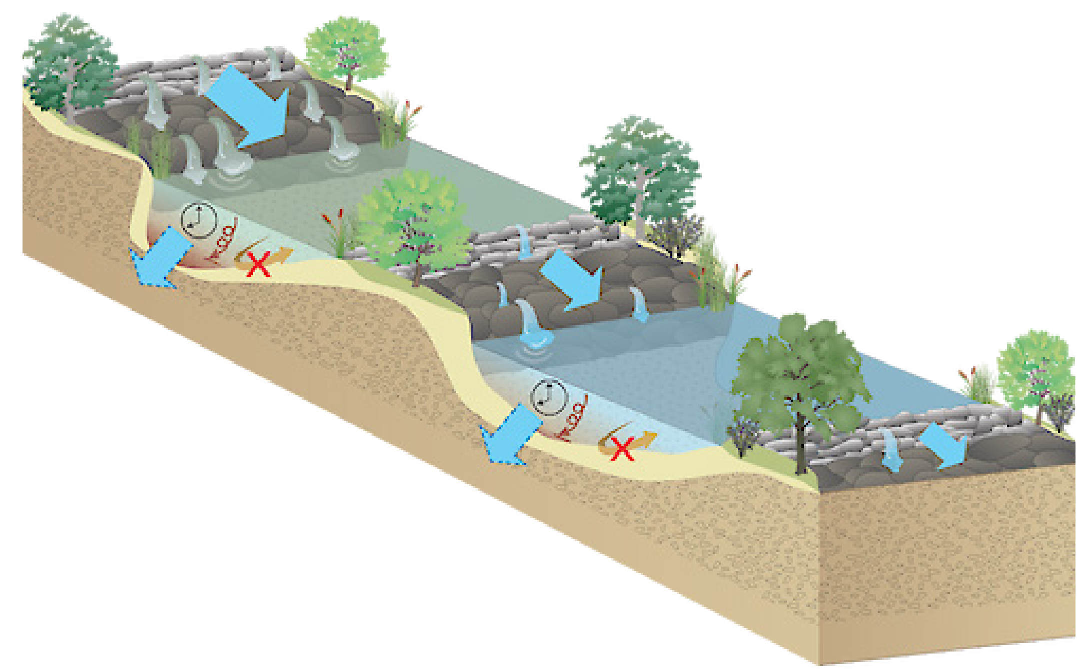

Figure 1: RSC systems are effective at reducing stormwater volume, preventing streambed erosion and increasing groundwater recharge. (Source: ian.umces.edu)

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