Clean Water Services

Annex H
Clean Water Services

Table of Contents

1. Introduction

1.1. Planning Process Contact

The point of contact during the Washington County Natural Hazard Mitigation Plan (NHMP) planning process for Clean Water Services[1] (CWS) was the Senior Water Resources Program Manager.

1.2. Annex Organization

This annex has six sections that satisfy mitigation requirements in the Code of Federal Regulations (CFR) Title 44, Part 201 (44 CFR §201):

- **Section 1:** Introduction
- **Section 2:** Planning Process
- **Section 3:** Hazard Identification and Risk Assessment
- **Section 4:** Capability Assessment
- **Section 5:** Mitigation Strategy
- **Section 6:** Action Items

This annex applies to maintaining the business continuity of CWS operations to provide wastewater and stormwater management services in the event of a natural hazard. The information provided in this annex is for CWS alone. All pertinent information that is not identified in this annex is identified in other sections of this NHMP or within the respective appendices.

1.3. NHMP Adoption Process

Once the Washington County NHMP receives the designation “Approvable Pending Local Adoption” from the Federal Emergency Management Agency (FEMA), CWS will present the plan to the Board of Directors for final public comment and adoption. A copy of the resolution will be inserted into the NHMP and held on file at CWS and Washington County.

2. Planning Process

(In compliance with 44 CFR §201.6(c)(1))

2.1. Development and Adoption Process

To apply for certain types of federal aid, technical assistance, and most post-disaster funding, local jurisdictions and special districts must comply with 44 CFR §201.3, which sets forth the requirement that

[1] Clean Water Services is an ORS 451 county service district that provides urban wastewater treatment, stormwater management, and related water resources management services in the Tualatin River Watershed.

communities develop a plan outlining their present and proposed efforts to mitigate risks from natural hazards.

CWS recognizes the benefits of having a long-term, all-hazards approach to mitigating natural hazards that could impact the provision of wastewater conveyance and treatment and stormwater management services. This approach has been implemented through the NHMP and five-year NHMP updates as required by law. This planning will improve the business continuity of CWS operations in the event of hazard-associated impacts by building on risk reduction measures in subsequent iterations of the NHMP. (In previous NHMP efforts, CWS did not participate as an independent jurisdiction with specific risk reduction measures.) The involvement of CWS in the Washington County NHMP represents the collective efforts of the NHMP Steering Committee members, Clean Water Services' Technical Committee members, the public, and stakeholders.

CWS developed this annex in accordance with 44 CFR §201.6(c)(5) as referenced in the Disaster Mitigation Act of 2000. The complete NHMP and this annex identify hazards and mechanisms to minimize damages associated with these hazards as they occur in the CWS service area.

2.2. Organizing the Planning Effort

A comprehensive approach was taken in developing this NHMP annex as part of the overall NHMP. An open involvement process was established for the public and all stakeholders through the Emergency Management Cooperative of Washington County as well as the Clean Water Services Advisory Commission, which provided an opportunity for those groups to be involved in the planning process and make their views known.

Two teams worked simultaneously throughout the development of this mitigation plan:

1. **Hazard Mitigation Steering Committee:** This committee consisted of points of contact from each plan participant. The group met to discuss countywide topics, including hazards and mitigation strategies. The points of contact were the leads of each local Technical Committee.
2. **Local Technical Committee:** Each plan participant had a Technical Committee that consisted of the Steering Committee representative for that jurisdiction or special district as well as designated representatives from within the organization. This team met to assess capabilities, hazards, and mitigation strategies within the planning area.

2.2.1. Clean Water Services Technical Committee

The CWS annex of the overall NHMP was developed by the CWS local Technical Committee with support from IEM, a consulting firm hired to support the planning process. The efforts of the committee were led by the CWS Senior Water Resources Program Manager throughout 2022 and 2023.

Table 1: Clean Water Services Technical Committee Members for the 2023 NHMP

Job Title and Department	Role in Committee and Planning Process
Senior Water Resources Program Manager, CWS Natural Systems Enhancement & Stewardship	General oversight, hazard identification, and plan development
Strategic Risk Manager, CWS Strategy Development & Enterprise Performance Management	Leadership oversight; hazard identification and plan development
Field Operations Division Manager, CWS Utility Operations & Services	Hazard identification and plan development
Development Services Division Manager, CWS Regional Utility Services	Hazard identification and plan development
GIS Analyst, CWS Regional Utility Services	Hazard identification and plan development
Plant Superintendent 3, CWS Utility Operations & Services	Hazard identification and plan development
Business Practice Leader 1 Integrated Planning, CWS Strategy Development & Enterprise Performance Management	Hazard identification and plan development
Water Resources Analyst, CWS Water Resource Recovery Operations & Services	Hazard identification and plan development
Public Involvement Coordinator, CWS Communications and Community Engagement	Hazard identification and plan development
Systems Planning Division Manager, CWS Regional Utility Services	Hazard identification and plan development

IEM also supported or led the following activities associated with the development, approval, and adoption of the plan:

1. Facilitated the NHMP update process.
2. Based on committee direction and stakeholder and community input, prepared the first draft of the plan and provided technical writing assistance for plan review, editing, and formatting.
3. Submitting the proposed plan to the State of Oregon Department of Emergency Management (OEM) and FEMA for review and approval and completed edits or revisions requested by these organizations.
4. Coordinating the plan adoption processes with OEM and FEMA.

2.3. Public Participation

Public participation is an important component of the NHMP and also a required element as outlined in 44 CFR §201.6(c)(5), FEMA's mitigation planning guidance. In addition to FEMA's public participation requirement, Oregon's land use system addresses the need for public participation in Statewide Land Use Planning Goal 1, Citizen Involvement, which ensures the opportunity for the community to be involved in the planning process.

As described in the base report, plan participants used a survey to collect information about community perceptions of natural hazards and priorities. The Steering and Technical Committees used the results to inform their risk assessments and mitigation strategies. Community members were also provided an

opportunity to comment on a draft of the NHMP through the Emergency Management Cooperative of Washington County's website. These NHMP sections were further reviewed by the Clean Water Services Advisory Commission (CWAC) representing environmental, business, agricultural, and service area representatives. CWAC provides specific policy, programs, and budget input to CWS and the Clean Water Services Board of Directors. The plan was also reviewed by the Clean Water Services Board of Directors, whose members also serve as the Washington County Board of Commissioners. A public notice was issued via multiple social media accounts for a two-week open public comment period coordinated through the Emergency Management Cooperative of Washington County. Appendix B in the base plan contains notices and additional information about the survey and opportunities for public comment. CWS will take the NHMP to its Board for adoption after FEMA approval.

As CWS implements the mitigation actions identified in this annex, there will be additional opportunities for public participation.

3. Hazard Identification and Risk Assessment

(In compliance with 44 CFR §201.6(c)(2)(i), §201.6(c)(2)(ii), §201.6(c)(2)(ii)(A), §201.6(c)(2)(ii)(B), §201.6(c)(2)(ii)(C), §201.6(c)(2)(iii), and §201.6(c)(3)(ii))

The following information serves to assist CWS in determining and prioritizing appropriate mitigation action items to reduce losses from identified hazards to maintain business continuity in the provision of wastewater and stormwater management services in urbanized Washington County and other adjacent urban areas served.

3.1. Clean Water Services Profile

This section provides information on CWS-specific characteristics. Additional community characteristics of the planning area are in Appendix A.

The Unified Sewerage Agency (USA) was formed in 1970 by public vote to consolidate into one agency the responsibility to correct the significant pollution problems in local area creeks caused by multiple poorly operating wastewater treatment plants discharging partially treated sewage. USA formed a surface water utility in 1990 to provide stormwater management services to meet new regulatory compliance requirements. In 2001, the organization's name was changed to Clean Water Services (CWS).

CWS is an ORS 451 county service district that provides wastewater conveyance and treatment and stormwater management services to urbanized Washington County. CWS provides innovative wastewater and stormwater management services with a watershed-based approach to regulatory compliance by investing in nature-based solutions with partners to meet the regulatory requirements for the utility while providing improved environmental and ecological outcomes with its project investments.

Clean Water Services provides regional services for wastewater and stormwater management for all customers in the service area (Figure 1). CWS works with the cities of Hillsboro, Beaverton, Forest Grove, Cornelius, Tualatin, Tigard, and Sherwood, which provide the local sewer and storm drainage services to their communities. Within its service area, CWS also provides the local sewer and storm drainage services for unincorporated Washington County and the cities of Banks, North Plains, Durham, Gaston (wastewater only), and King City. Finally, Clean Water Services provides regional wastewater services to small portions of Lake Oswego, Portland, and portions of unincorporated Clackamas and Multnomah counties. CWS cleans an average of 66 million gallons of wastewater each day from residents of these communities.

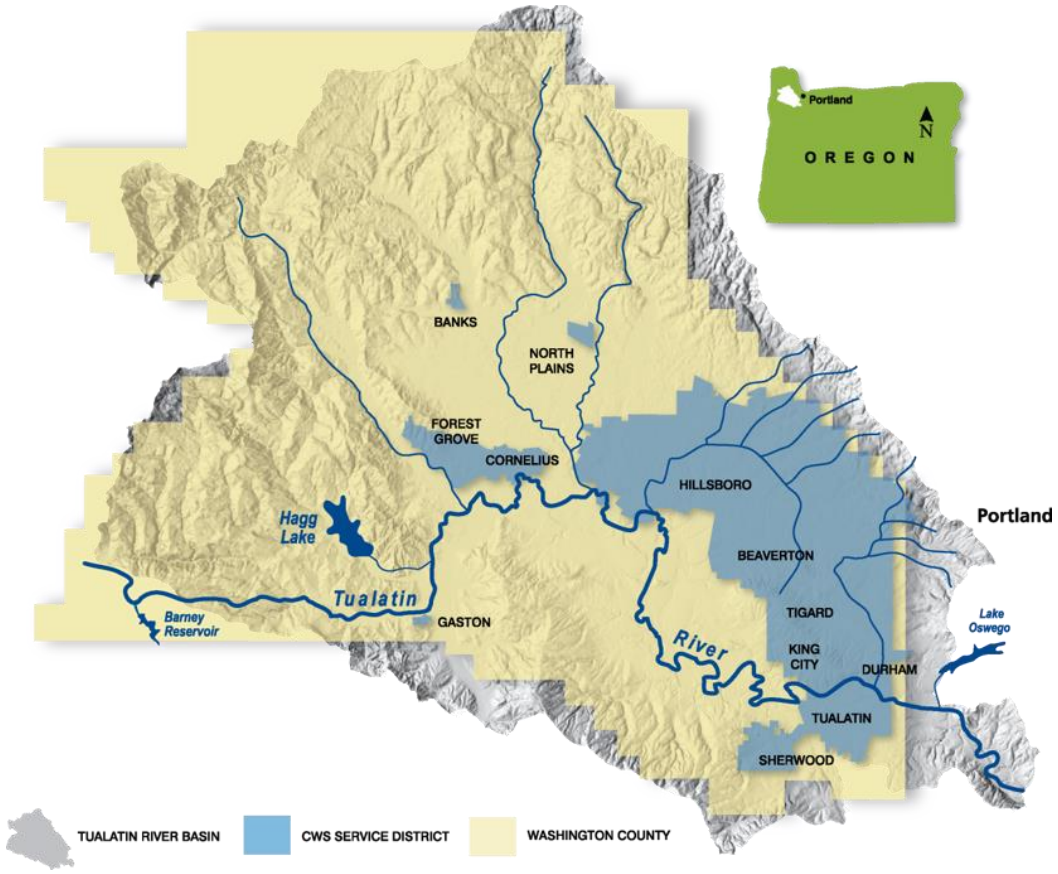

Figure 1: Clean Water Services Service Area

During fiscal year 2021–2022, CWS transformed the region's wastewater into nearly 15 million kilowatts of renewable energy and more than 24 billion gallons of clean water.[2] Additionally, CWS contributed about 75% of the Tualatin River's summer flow by releasing clean water from reservoirs and treatment facilities and released 83% of the Hagg Lake water and 100% of the Barney Reservoir water allocated for stream and river flow restoration.[3]

CWS is responsible for 875 miles of the nearly 1,900 miles of public sewer pipes within the CWS service area and 44 pump stations routed to one of its four water resource recovery/wastewater treatment facilities at Durham (located in Tigard), Rock Creek (located in Hillsboro), Hillsboro, and Forest Grove. These pipelines are divided into the "Regional" system of larger diameter lines, pump stations and associated force mains, and siphons under the Tualatin River, and the "Local" system of smaller diameter lines and related infrastructure outside of the larger cities as described above.[4] CWS also owns and manages a Field Operations office, research and laboratory facility, materials handling yard, and Administrative Building Complex.[5]

CWS holds the National Pollutant Discharge Elimination System (NPDES) stormwater permit for urban Washington County, with Washington County and city partners as co-implementers. As part of the

[2] Clean Water Services. (2022, September). At a Glance. https://cleanwaterservices.org/wp-content/uploads/2022/09/clean-water-services-at-a-glance.pdf
[3] Clean Water Services. (2022 September). At a Glance. https://cleanwaterservices.org/wp-content/uploads/2022/09/clean-water-services-at-a-glance.pdf
[4] Clean Water Services. (2022). Locations. https://cleanwaterservices.org/a(bout/locations/
[5] Clean Water Services. (2022). Locations. https://cleanwaterservices.org/about/locations/

requirements of this permit, CWS owns and is responsible for maintenance of at least 536 miles of public drainage pipelines, 18,284 catch basins, and nearly 2,000 public stormwater detention and water quality facilities for unincorporated Washington County and the cities of Banks, North Plains, Durham, and King City.[6]

CWS nature-based solutions as part of the watershed-based approach to regulatory compliance include nearly 100 miles of revegetated riparian corridors that provide stream shade to meet regulatory compliance requirements to offset thermal loads from the water resource recovery facilities, over 7,000 acres of wetland and stream corridor enhancement and floodplain reconnection project investments to improve the function of streams receiving urban runoff, the Fernhill Natural Treatment System, and portions of the Jackson Bottom Wetlands site in conjunction with the City of Hillsboro, Oregon. CWS also partners with the U.S. Fish & Wildlife Service to support the restoration of large complexes like the Wapato and Chicken Creek sites on the Tualatin River National Wildlife Refuge to improve water quality and stream function. These nature-based solutions can help mitigate several natural hazards. For instance, they moderate flooding impacts by providing flood storage or slowing runoff, reduce extreme heat impacts by providing shade, and locally stabilize steep slopes to reduce the risk of landslides.

Many of the characteristics of CWS investments in built and natural infrastructure can affect how natural hazards impact the CWS service area, facilities, underground infrastructure and project investments. It is important for CWS to plan for natural hazard mitigation to reduce the risk of damage that impacts the operations and business continuity of providing wastewater and stormwater management services. Considering these specific assets during the planning process can assist in identifying appropriate measures for natural hazard mitigation.

The critical and vulnerable facilities listed below in Tables 2 and 3, noncritical facilities such as local wastewater conveyance and stormwater management facilities, and the nature-based solutions described above are in hazard areas for all or some of the hazards identified in the CWS service area. Table 2 includes infrastructure or facilities other than pump stations. Pump stations are listed in Table 3. A complete and current inventory of all CWS facilities is maintained in our enterprise GIS system. More detail regarding specific CWS-maintained engineered assets is maintained in our Lucity-based asset management system, while information on nature-based investments is maintained in our TerraTrak system.

[6] Other cities within the CWS service area own and are responsible for similar stormwater infrastructure within their jurisdictions, although CWS performs basin-scale public education and outreach, water quality monitoring, compliance services and other actions across the service district as required by the permit. This infrastructure is not considered “critical,” but may be locally important in specific events.

Table 2: Critical Facility and Asset Inventory, Not Including Pump Stations

Name of Infrastructure, Facility, or Resource	Type of Asset	Address	Comments
Forest Grove Water Resource Recovery Facility	Infrastructure or Facility	1345 SW Fern Hill Road, Forest Grove	Not vulnerable to drought, landslide, or wildfire.
Hillsboro Water Resource Recovery Facility	Infrastructure or Facility	770 S First Avenue, Hillsboro	Not vulnerable to drought, landslide, or wildfire
Rock Creek Water Resource Recovery Facility	Infrastructure or Facility	3235 SE River Road, Hillsboro	Not vulnerable to drought, landslide, or wildfire.
Durham Water Resource Recovery Facility	Infrastructure or Facility	16060 SW 85th Avenue, Tigard	Not vulnerable to dam failure, drought, or wildfire.
Fernhill Natural Treatment System	Infrastructure or Facility and natural and cultural resource	1399 Fern Hill Road, Forest Grove	Not vulnerable to landslide or wildfire.
Wastewater lines (interceptors, trunk lines, force mains, gravity mains) greater than or equal to 24 inches in diameter	Infrastructure or Facility	Various locations	Not vulnerable to dam failure (except adjacent to Tualatin River upstream of Highway 99W), drought, extreme heat, flooding (except in stream corridors), volcanic ash, or wildfire. Includes related wastewater infrastructure (e.g., manholes, flow meters) and buried infrastructure (e.g., fiber optic lines).
Wastewater siphons	Infrastructure or Facility	45.396, -122.777; 45.396, -122.790; 45.393, -122.804	Not vulnerable to drought, extreme heat, volcanic ash, or wildfire. May be susceptible to streambank erosion during floods or dam failure, though the assets are protected and set back through emplacement with horizontal directional drilling.
Wastewater lines less than 24 inches in diameter that comprise the “Local” system in unincorporated Washington County and the cities of Banks, North Plains, Durham, Gaston, and King City	Infrastructure or Facility	Various locations	Not vulnerable to dam failure (except adjacent to Tualatin River upstream of Highway 99W), drought, extreme heat, flooding (except in stream corridors), volcanic ash, or wildfire. Includes related infrastructure (e.g., manholes, flow meters).

Name of Infrastructure, Facility, or Resource	Type of Asset	Address	Comments
Administrative Building Complex	Infrastructure or Facility	2550 SW Hillsboro Highway, Hillsboro	Not vulnerable to drought, extreme heat, or landslide. Primary emergency operations center.
Field Operations Center	Infrastructure or Facility	2025 SW Merlo Court, Beaverton	Not vulnerable to dam failure, drought, extreme heat, flooding, landslide, or wildfire. Backup location of emergency operations center.
Springer Facility	Infrastructure or Facility	3395 NE Springer Street, Hillsboro	Not vulnerable to dam failure, drought, extreme heat, flooding, landslide, or wildfire. Potential location of a future emergency operations center.
Material Handling Yard	Infrastructure or Facility	3990 & 3910 NE 33rd, Hillsboro	Not vulnerable to dam failure, drought, extreme heat, flooding, landslide, or wildfire. Repository for debris.
ripl (Research + Innovation + Partnerships + Laboratory)	Infrastructure or Facility	1585 Poplar Street, Forest Grove	Not vulnerable to drought, extreme heat, flooding, landslide, or wildfire. Site of future water quality laboratory facilities.
CWS Water Quality Laboratory at ABC	Infrastructure or Facility	2550 Hillsboro Highway, Hillsboro	Not vulnerable to drought, extreme heat, flooding, landslide, or wildfire. Increased vulnerability to winter storms due to the lack of a backup power source.
Scoggins Dam and Hagg Lake	Infrastructure or Facility	45.471, -123.200	Not vulnerable to extreme heat, landslide, volcanic ash, windstorms, or winter storms. Provides water supply for water quality flows. Bureau of Reclamation facility with CWS water rights.
Barney Dam and Reservoir	Infrastructure or Facility	45°26'34.59", -123°22'50.70"	Not vulnerable to extreme heat, landslide, volcanic ash, windstorms, or winter storms. Provides water supply for water quality flows. CWS has a minor ownership interest to assure water rights.
Tualatin River Farm	Infrastructure or Facility and Natural Resource	4490 SW Minter Bridge Road, Hillsboro	Not vulnerable to flooding or wildfire.
Emergency communications facilities	Infrastructure or Facility	4475 SW Fern Hill Road, Forest Grove 45.438 -122.723	Not vulnerable to dam failure or flood (Nansen summit facility only), landslide.

Table 3: Critical Facility and Asset Inventory – Pump Stations

Name of Pump Station (No.)	Type of Asset	Address	Comments
Alderbrook (8397)	Infrastructure or Facility	1601 NW 9th Avenue, Hillsboro	Not vulnerable to dam failure, drought, extreme heat, landslide, or wildfire.
Aloha 3 (1561)	Infrastructure or Facility	4850 SW 209th Avenue, Beaverton	Not vulnerable to dam failure, drought, extreme heat, landslide, or wildfire.
B Street (1229)	Infrastructure or Facility	1527 B Street, Forest Grove	Not vulnerable to dam failure, drought, extreme heat, landslide, or wildfire.
Banks (1881)	Infrastructure or Facility	42660 NW Cedar Canyon Road, Banks	Not vulnerable to dam failure, drought, extreme heat, landslide, volcanic ash, or wildfire.
Beaverton (185)	Infrastructure or Facility	4150 SW Watson Avenue, Beaverton	Not vulnerable to dam failure, drought, extreme heat, landslide, or wildfire.
Borland (1867)	Infrastructure or Facility	4600 SW Borland Road, Tualatin	Not vulnerable to dam failure, drought, extreme heat, flooding, or wildfire.
Brighton (1208)	Infrastructure or Facility	14802 NW Cornell Road, Portland	Not vulnerable to dam failure, drought, extreme heat, flooding, or wildfire.
Broad Oak (134)	Infrastructure or Facility	6313 SW Broad Oak Drive, Beaverton	Not vulnerable to dam failure, drought, extreme heat, flooding, landslide, or wildfire.
Bull Mtn. (1151)	Infrastructure or Facility	14385 SW Beef Bend Road, Tigard	Not vulnerable to dam failure, drought, extreme heat, or wildfire.
Butternut (6554)	Infrastructure or Facility	4622 SW 229th Avenue, Hillsboro	Not vulnerable to dam failure, drought, extreme heat, flooding, landslide, or wildfire.
Cedar Street (4521)	Infrastructure or Facility	1065 Cedar Street, Forest Grove	Not vulnerable to dam failure drought, extreme heat, landslide, or wildfire.
Childs (6387)	Infrastructure or Facility	6500 Childs Road, Lake Oswego	Not vulnerable to drought, extreme heat, landslide, or wildfire.
Cipole (1868)	Infrastructure or Facility	19400 SW Cipole Road, Tualatin	Not vulnerable to drought, extreme heat, landslide, or wildfire.
Cornelius (6054)	Infrastructure or Facility	788 S. Linden Street, Cornelius	Not vulnerable to drought, extreme heat, flooding, landslide, or wildfire.

Name of Pump Station (No.)	Type of Asset	Address	Comments
Country Haven (1499)	Infrastructure or Facility	23585 NW Jacobson Road, Hillsboro	Not vulnerable to dam failure, drought, extreme heat, flooding, landslide, or wildfire.
Cross Creek (4890)	Infrastructure or Facility	6400 SW 209th Avenue, Beaverton	Not vulnerable to dam failure, drought, extreme heat, flooding, landslide, or wildfire. To be decommissioned.
Dawson Creek (6389)	Infrastructure or Facility	1199 NE Brookwood Parkway, Hillsboro	Not vulnerable to dam failure, drought, extreme heat, flooding, or wildfire.
Fir Grove (8650)	Infrastructure or Facility	1505 SE Duke Drive, Hillsboro	Not vulnerable to dam failure, drought, extreme heat, landslide, or wildfire.
Fox Hill (1869)	Infrastructure or Facility	5698 SW Nyberg Lane, Tualatin	Not vulnerable to dam failure, drought, extreme heat, or wildfire.
Gaston (994)	Infrastructure or Facility	44329 East Gaston Road, Gaston	Not vulnerable to drought, extreme heat, landslide, or wildfire.
Laurel Woods (9864)	Infrastructure or Facility	2525 South Jasper Drive, Cornelius	Not vulnerable to dam failure, drought, extreme heat, flooding, landslide, or wildfire.
Lower Tualatin (6187)	Infrastructure or Facility	8549 SW Tualatin Road, Tualatin	Not vulnerable to drought, extreme heat, landslide, or wildfire.
Meyers Farm (8435)	Infrastructure or Facility	16399 SW Bray Lane, Tigard	Not vulnerable to dam failure, drought, extreme heat, flooding, or wildfire.
North Hillsboro Industrial	Infrastructure or Facility	5832 NE Sewell Avenue, Hillsboro	Not vulnerable to dam failure, drought, extreme heat, flooding, landslide, or wildfire.
North Plains (6387)	Infrastructure or Facility	9835 NW 307th Avenue, North Plains	Not vulnerable to dam failure, drought, extreme heat, flooding, landslide, or wildfire.
Nyberg (6070)	Infrastructure or Facility	6500 SW Nyberg Lane, Tualatin	Not vulnerable to drought, extreme heat, landslide, or wildfire.
Oak Village (4753)	Infrastructure or Facility	42230 NW Oak Way, Banks	Not vulnerable to dam failure, drought, extreme heat, flooding, or wildfire.
Orchard Hills (1873)	Infrastructure or Facility	4561 SW Natchez Court, Tualatin	Not vulnerable to drought, extreme heat, or wildfire.

Name of Pump Station (No.)	Type of Asset	Address	Comments
Pine Lodge (876)	Infrastructure or Facility	4450 Pacific Avenue, Forest Grove	Not vulnerable to dam failure, drought, extreme heat, flooding, landslide, or wildfire.
Pleasant View (1885)	Infrastructure or Facility	4450 Pacific Avenue, Forest Grove	Not vulnerable to dam failure, drought, extreme heat, flooding, or wildfire.
Polygon (8848)	Infrastructure or Facility	800 NW 185th Avenue, Beaverton	Not vulnerable to dam failure, drought, extreme heat, flooding, or wildfire.
River Road (6060)	Infrastructure or Facility	4195 SW Davis Road, Hillsboro	Not vulnerable to dam failure, drought, extreme heat, flooding, or wildfire.
River Terrace North (6631)	Infrastructure or Facility	17480 SW Clementine Street, Tigard	Not vulnerable to dam failure, drought, extreme heat, flooding, or wildfire.
River Terrace South (6827)	Infrastructure or Facility	17158 SW Roy Rogers Road, Sherwood	Not vulnerable to dam failure, drought, extreme heat, flooding, landslide, or wildfire.
Rock Creek Ranch (239)	Infrastructure or Facility	4960 NW Salishan Drive, Portland	Not vulnerable to dam failure, drought, extreme heat, flooding, landslide, or wildfire.
Rock Creek Ranch #3 (1356)	Infrastructure or Facility	20410 NW West Union Road, Portland	Not vulnerable to dam failure, drought, extreme heat, flooding, or wildfire.
Saum Creek (1874)	Infrastructure or Facility	20455 SW 65th Avenue, Tualatin	Not vulnerable to dam failure, drought, extreme heat, flooding, or wildfire.
Scholls Country (4165)	Infrastructure or Facility	16381 SW Gearin Court, Tigard	Not vulnerable to dam failure, drought, extreme heat, flooding, landslide, or wildfire.
Sherwood (26)	Infrastructure or Facility	19035 SW Pacific Highway, Sherwood	Not vulnerable to drought, extreme heat, landslide, or wildfire.
Sunset Terrace (6689)	Infrastructure or Facility	32435 NW Wascoe Street, North Plains	Not vulnerable to dam failure, drought, extreme heat, flooding, landslide, or wildfire.
Tektronix (8294)	Infrastructure or Facility	3555 SW Hocken Avenue, Beaverton	Not vulnerable to dam failure, drought, extreme heat, or wildfire.

Name of Pump Station (No.)	Type of Asset	Address	Comments
Victoria Woods (4424)	Infrastructure or Facility	22960 SW Miami Place, Tualatin	Not vulnerable to dam failure, drought, extreme heat, flooding, or wildfire.
Westmark (8493)	Infrastructure or Facility	22650 NW West Union Road, Hillsboro	Not vulnerable to dam failure, drought, extreme heat, landslide, or wildfire.

3.2. Natural Hazard Profiles

The Technical Committee for CWS utilized the OEM's hazard analysis methodology to examine hazard vulnerability and probability by collecting information about history, probability, vulnerability, and maximum threat for each hazard that impacts CWS. The Technical Committee focused on evaluating the hazards and potential vulnerabilities relative to staff, facilities, and the ability to recover the level of service to those within the CWS service area. This methodology does not compare hazards to each other or rank hazards against each other. Instead, this process provides a sense of hazard priorities or relative risk and allows comparison of the same hazard across participants.

Each of the hazards examined by this analysis was scored using a formula that incorporates the four rating criteria, a weight factor, and three levels of severity: low, medium, and high. The score range for this methodology is 24 (lowest possible) to 240 (highest possible). For additional detail about the OEM risk and hazard analysis methodology, see Section 2 of the base plan.

All natural hazards included in the NHMP have the potential to impact CWS. The scores for each hazard that impacts CWS are presented below.

Table 4: Natural Hazard Risk Scores

Natural Hazard	History	Vulnerability	Maximum Threat	Probability	Score
Dam failure	Low	Low	Medium	Low	98
Drought	Medium	Medium	Medium	High	165
Earthquake: Cascadia (3–5-minute event)	Low	Medium	High	Low	148
Earthquake: Crustal (1-minute event)	Low	High	High	Low	155
Extreme heat	High	Medium	Medium	High	152
Flooding, including channel migration and streambed erosion	High	Medium	High	High	189
Landslide	Medium	Low	Low	Medium	96
Volcanic ash	Low	Low	Medium	Low	86
Wildland fire	Medium	Medium	Medium	Medium	127
Windstorm, including tornado	High	Low	Medium	High	147
Winter storm	High	Low	Medium	High	142

Full descriptions of each hazard are provided in Section 2 of the base plan. The potential effects of climate change on the magnitude and frequency of natural hazard events are described in each hazard description in this annex and in Section 2 of the base plan.

The time frame of data collected during the planning process for CWS was from as far back as available to February 22, 2022. Hazard events that occurred during this period and were deemed significant by the CWS Technical Committee are included in this annex's hazard profiles.

The following hazard profiles are in alphabetical order and include a brief hazard description, significant events, if applicable, and potential impacts and vulnerabilities. Potential impacts and vulnerabilities are focused on those directly related to CWS-owned or managed gray and green infrastructure; nature-based solution investments, on CWS staff, contractors and visitors that may be on premises; and on customers affected loss of CWS-provided services. For impacts to residents and businesses of urban Washington County, see the annexes provided by the County and by individual participating cities in this NHMP. (Note that the City of Tualatin has participated in the Clackamas County NHMP.)

3.2.1. Dam Failure

CWS could be directly impacted by dam failure. The Bureau of Reclamation owns Scoggins Dam and Hagg Lake, which provide water supply for agricultural irrigation, municipal drinking water supply, and water quality flows for the Tualatin River. CWS has an allocation of 16,900 acre-feet that can be used to maintain water quality in the main stem of the Tualatin or to supplement flows in select tributaries. Barney Reservoir is owned and operated by the Barney Joint Ownership Commission, organized under ORS 225.050. CWS' share of this venture is 10%, granting it access to 1,654 acre-feet of stored water from the reservoir every summer. Potential impacts of and vulnerabilities to dam failure are identified below.

3.2.1.1. Potential Impacts

The potential impacts of a dam failure event are identified below. The type, magnitude, and extent of impacts can vary based on the scale of the event.

- Water quality infrastructure—both green and gray—adjacent to the Tualatin River upstream of Highway 99W could be inundated or subject to flood-related erosion. This includes the Forest Grove Water Resource Recovery Facility and adjacent Fernhill Natural Treatment System wetlands and parts of the Hillsboro Water Resource Recovery Facility. Portions of the Durham Water Resource Recovery Facility campus may also be inundated. Finally, several pump stations could be inundated.
- Should the Barney Dam and Reservoir or Scoggins Dam and Hagg Lake fail, it would impact the ability of CWS to meet instream water quality targets, as this area and the Scoggins Dam area provide water quality flows to augment summer low water flows, mitigating water quality impacts of discharges from the CWS water resource recovery facilities.

3.2.1.2. Vulnerabilities

Public wastewater and stormwater infrastructure and CWS investments in nature-based solutions can have vulnerabilities to a dam failure event from Scoggins Dam that may include:

- The CWS Forest Grove and Hillsboro treatment facilities are in the potential dam failure impact area. These facilities provide wastewater treatment for the cities of Gaston, North Plains, Banks, Cornelius, Forest Grove, and the western region of Hillsboro. The facilities together clean approximately 8.5 million gallons of wastewater on an average winter day; the Hillsboro facility typically operates only during the winter months.[7]

[7] Clean Water Services. (2022). Locations. https://cleanwaterservices.org/about/locations/

- While it is likely that there would be adequate warning of dam failure to allow evacuation of staffed CWS facilities, workers in those facilities would be at risk until the evacuation is complete. Field staff, particularly those working in the vicinity of Gaston, Forest Grove, and Cornelius, are less likely to receive timely alerts and may have more difficulty moving to higher ground; consequently, they are potentially more vulnerable.
- Interties between Forest Grove, Hillsboro, and Rock Creek mean that there might be little economic loss from damage to the Forest Grove and Hillsboro water resource recovery facilities other than that associated with direct damage to CWS infrastructure in those facilities. Damage to storm sewer outfalls for these facilities could occur from erosion during the flood wave. If the dam failure occurs during a moderate or heavier rainstorm, localized flooding beyond the area of direct inundation could occur if stormwater outfalls are submerged deeply enough or long enough to restrict upland drainage.
- Multiple pump stations (see Table 3) could be inundated and therefore temporarily compromised to move sewage from specific neighborhoods to the interceptor lines feeding the water resource recovery facilities. Damage to storm sewer outfalls that discharge directly to the main stem of the Tualatin River could occur from streambank erosion.
- Fernhill and Wapato Lake areas would likely be inundated with the flood wave. While this should not damage the vegetation as long as the inundated areas are allowed to drain, incidental damage from inundation or erosion could occur. Riparian plantings along the main stem of the Tualatin River and the lower reaches of major tributaries upstream of Rock Creek (including those acting as offsets for thermal loads from the water resource recovery facilities) could be inundated for several days. Again, while this is not likely to cause widespread vegetation loss, some may occur. The most likely damage to these areas would be from streambank erosion.

With respect to CWS facilities and operations, failure of Barney Dam would reduce the availability of supplemental summer flows that would otherwise be diverted to the Tualatin River. The CWS flow allocation from Barney Reservoir represents about 10% of the water available to CWS for this purpose.

3.2.2. Drought

Drought typically occurs as a regional event and often affects more than one jurisdiction simultaneously. Potential impacts of and vulnerabilities to public wastewater and storm drainage infrastructure and CWS investments in nature-based solutions from drought events are identified below.

3.2.2.1. Potential Impacts

The type, magnitude, and extent of impacts can vary based on the scale of the event. Potential impacts from a drought may include:

- Inadequate reservoir rainfall fill volume could reduce the CWS water supply available for stream flow augmentation to meet regulatory permit requirements.
- Vegetation used in the CWS nature-based solution investments in natural areas could be so affected as to require replanting.
- High potential would exist for concurrent hazards, including extreme heat, wildfire, when under severe and prolonged drought conditions.
- Inadequate drinking water supply could reduce water usage and result in secondary impacts to CWS by reducing sewage flows that require conveyance and treatment. This could reduce rate revenues.

- Loss of power or reduced availability of electricity due to concurrent hazards such as wildfire and extreme heat that require electrical grid pre-emptive shutdowns could impact CWS operations.
- CWS property and infrastructure could be damaged in areas with expansive soils, which are clay-based soils that expand and contract based on the amount of moisture in the soil.

3.2.2.2. Vulnerabilities

All populations, economies, structures, improved property, critical facilities and infrastructure, historical properties and cultural resources, and natural environments in Washington County are vulnerable to drought. Vulnerabilities specific to CWS operations are identified below.

- CWS may incur additional costs (e.g., for chemicals, energy, or staff) associated with operational changes needed to manage drought conditions.
- Need to increase revegetation efforts at CWS nature-based solution sites including riparian zones and floodplain restoration sites to increase riparian shading of streams and respond to plant mortality.
- Landscaping in and around CWS facilities (e.g., the green roof on the Field Operations building) may be damaged and require additional maintenance or replanting.
- Streams and vegetation in riparian corridors in the Tualatin River Watershed are vulnerable to dewatering (with related water quality impacts for temperature and dissolved oxygen) and drought stress.

3.2.3. Earthquake

CWS facilities could experience earthquakes that originate from the Cascadia Subduction Zone (CSZ), or crustal earthquakes originating in the Portland Hills Fault Zone, the Gales Creek Fault Zone, or other faults within or near the Tualatin Basin. (Regionally, the 1993 Scotts Mill or 2001 Nisqually events are examples of crustal earthquakes.) CWS facilities could also be affected by liquefaction and co-seismic landslides as the result of an earthquake. The risk score assigned to earthquake by the CWS Technical Committee was 148 for a CSZ earthquake and 155 for a crustal earthquake. These scores are not significantly different but reflect the fact that there are many possible faults that could be activated during a crustal zone earthquake and that shaking locally could be more severe than would occur with a CSZ earthquake. Potential impacts of and vulnerabilities to earthquake are identified below.

3.2.3.1. Potential Impacts

The type, magnitude, and extent of impacts can vary based on the scale of the event. Impacts from an earthquake event may include:

- Injuries, deaths, or access impacting availability of the workforce.
- Mental health impacts, including post-traumatic stress disorder, impacting capability of workforce.
- Public health hazards resulting from disruption of drinking water and wastewater systems.
- Need for CWS resources to support countywide debris removal operations.
- Displaced residents in need of shelter may require temporary sewage and drainage infrastructure solutions.
- Delayed emergency response times due to debris, blocked transportation routes, and damaged infrastructure and vehicles impacting operations.

- Economic impacts, including reduced future revenues from changes in number of customers, housing patterns, population, or business activity; increased costs resulting from response activities; and increased future costs resulting from recovery and reconstruction activities.
- Industries can experience commerce losses from power interruptions, damaged buildings and assets, and road closures. Industries can also sustain direct losses to buildings, personnel, and other vital equipment, reducing the need for CWS services.
- Personal and household economic impacts of loss of income, increased medical costs, and property damage that may not be covered by insurance could make it difficult to pay utility bills.
- Damage to aboveground and underground utilities and transportation systems causing operational problems.
- Disruption of essential infrastructure systems such as power systems, public utilities, and telecommunications causing operational problems.
- Blocked roads and rail transportation routes due to debris from trees and damaged property, ground deformation, and liquefaction, causing operational problems.
- Downed or damaged power lines that can lead to wildfires.
- Power outages and natural gas leaks.
- Hazardous material releases due to facility damage.
- Loss of habitat and vegetation, impacting CWS nature-based solution investments.
- Change in water flows, including paths of rivers and streams.
- Concurrent hazards initiated by an earthquake, including flooding resulting from dam failure, wildland fire, and landslides.

3.2.3.2. Vulnerabilities

All populations, economies, structures, improved property, critical facilities and infrastructure, historical properties and cultural resources, and natural environments in the CWS service area are vulnerable to earthquakes. Vulnerabilities specific to CWS are identified below.

- Areas near the epicenter of an earthquake event are likely to incur a significant amount of damage to all buildings, infrastructure, facilities, and property. Such damage is reduced with distance from an earthquake epicenter. Structures and facilities in the western half of the CWS service area are more vulnerable in the event of a CSZ earthquake than those in the eastern half of the CWS service area. Less dependent on distance to an epicenter, floodplain areas or other areas of high soil moisture could experience liquefaction.
- Buildings with very high or high collapse potential include buildings constructed prior to 1990 that have not been retrofitted to improve seismic resilience (e.g., Hillsboro Water Resource Recovery Facility).
- CWS employees, contractors, and visitors could be vulnerable in an earthquake should structures collapse. In the event that CWS cannot provide sanitation services from one or more of the wastewater treatment facilities, affected residents would need to provide personal sanitation.
- Economic losses to CWS would be substantial (hundreds of millions) if wastewater treatment facilities suffered significant damage. Damage to collection pipes from liquefaction or other ground movement could also be costly. Finally, damage to riparian and wetland enhancement projects could occur if those areas become living space for residents whose living quarters are rendered unsuitable.

- All CWS structures could be damaged by a sufficiently large or proximal earthquake. Recent retrofits, such as those currently ongoing at the Forest Grove Water Resource Recovery Facility, and improved seismic resilience of new construction, such as that occurring at the Durham Water Resource Recovery Facility, incrementally reduce the vulnerability of CWS facilities. Buildings such as the Administrative Building Complex, Field Operations and associated structures (Springer facility and Material Handling Yard), and the Research+Innovation+Partners+Labs (ripl) facility would also be vulnerable. Vulnerability of green infrastructure facilities—planted stormwater treatment or flow management facilities, such as stream corridor or wetland enhancement projects—is expected to be low. A substantial portion of the underground pipes in the wastewater collection system and stormwater drainage system is expected to be subject to liquefaction in moderate to large earthquakes, potentially leading to line breakage. In steep portions of the CWS service area, these pipes could also be affected by co-seismic landslides.
- Ecosystem disturbance is an inherent process, particularly in geologically active ecoregions such as those in Washington County. Ground movement in areas of steep topography or liquefaction could disrupt vegetation with attendant modifications to wildlife use patterns. The extent of damage to ecosystem functions and values would depend on the amount of area disrupted and whether the disruption reduces ecosystem connectivity. CWS-owned property or natural resource restoration investments could be damaged as county residents seek to set up temporary shelter in these areas.

3.2.4. Extreme Heat

Due to a recent rise in frequency, severity, and impacts of extreme heat events, the NHMP Steering Committee chose to include this hazard for the first time in the Washington County NHMP. Potential impacts of and vulnerabilities to extreme heat are identified below.

3.2.4.1. Potential Impacts

The type, magnitude, and extent of impacts can vary based on the scale of the event. Potential impacts of an extreme heat event may include:

- Injuries or deaths impacting workforce availability.
- Heat illnesses, including heat rashes, heat cramps, heat exhaustion, heat stroke, and death impacting workforce.
- Disruption of biologically-mediated processes requiring modifications of operations at CWS' water resource recovery facilities.
- Impact on industries resulting in reduction in use of services and associated revenue loss to CWS.
- Economic losses from decreased worker efficiency and effectiveness and time lost on the job when workers take more frequent or longer breaks to avoid overheating.
- Property damage, such as roof expansions, leading to warped, cracked, and leaking shingles; dry, cracked, and leaking caulking around flashing and joints; cracked foundations; excessive drying of wood structures; and melted siding.
- Disruption of essential infrastructure systems from overheated and damaged utilities.
- Damage to vegetation, such as scorch and sunscald of new foliage, branches or tops of trees dying, and significant stress and die-off of native trees, particularly Douglas-fir and Western red cedar. These impacts are intensified if drought is also occurring.
- Concurrent hazards include drought and wildland fire.

3.2.4.2. Vulnerabilities

All populations, economies, structures, improved property, critical facilities and infrastructure, historical properties and cultural resources, and natural environments in the CWS service area are vulnerable to extreme heat.

Populations substantially vulnerable to extreme heat include:

- Staff and contractors who work or spend a sufficient amount of time outdoors, including those in construction, inspection, landscaping, and field data collection.
- Staff, contractors, and visitors who work in buildings without air conditioning or cooling equipment.

Additional vulnerabilities to extreme heat include:

- Costs associated with:
  - Setting up and providing cooling centers in CWS facilities for the workforce.
  - Additional energy and maintenance staff costs to sustain air conditioning.
  - Replacement of heat-damaged plants in green infrastructure maintained by CWS.

3.2.5. Flooding, Including Channel Migration and Erosion

Some degree of flooding is not uncommon in Washington County, and riverine flooding events typically occur from October through April. Potential impacts of and vulnerabilities to flooding are identified below.

3.2.5.1. Potential Impacts

The type, magnitude, and extent of impacts can vary based on the scale of the event. Potential impacts of a flooding event include:

- Injuries or deaths impacting available workforce.
- Public health concerns, such as the spread of infectious diseases, exposure to hazardous materials and debris, and water quality issues.
- Displaced residents in need of shelter and temporary sewer and drainage services.
- Delayed emergency response times and disruption of traffic due to high water, debris, blocked transportation routes, and damaged infrastructure and vehicles.
- Economic impacts, including reduced future revenues, increased costs resulting from response activities, and increased future costs resulting from recovery and reconstruction activities.
- Industries can experience commerce losses from power interruptions, damaged buildings and assets, and road closures. Industries can also sustain direct losses to buildings, personnel, and other vital equipment, reducing the need for CWS services and associated revenue loss.
- Damage and destruction of aboveground and underground infrastructure.
- Disruption of essential infrastructure systems, such as power systems, public utilities, telecommunications, and transportation routes.
- Loss of habitat and vegetation, impacting CWS nature-based solution investments.

3.2.5.2. Vulnerabilities

Population, economic, built environment, critical facility, infrastructure, and natural environment vulnerabilities to changes in CWS services resulting from a flooding event, or changes in these features that influence the ability of CWS to perform services, include:

- Staff and contractors unable to report for work or visitors unable to access CWS services due to flood-related access limitations (e.g., closure of Highway 219, limiting access to the CWS Administration Building Complex).
- Costs of repair for damages to CWS facilities, and revenue lost due to service interruptions.
- Inundation of water resource recovery facilities and associated facilities (e.g., Fernhill Natural Treatment System) or pump stations, and damage to outfall structures as a result of stream erosion.
- Stream channel (bed and/or bank) erosion resulting in damage, including potentially broken wastewater lines or damage to stormwater outfalls.
- Flooding and stream channel (bed and/or bank) erosion or channel migration resulting in damage to CWS investments in nature-based solutions.

3.2.6. Landslide

CWS operations could be directly impacted by landslides, though the likelihood of geographically widespread impacts is low because landslides themselves are geographically limited and major CWS facilities are not located in zones of high or very high landslide susceptibility. Potential impacts of and vulnerabilities to landslides are identified below.

3.2.6.1. Potential Impacts and Vulnerabilities

The potential impacts of and vulnerabilities to a landslide event are identified below. The type, magnitude, and extent of these can vary based on the scale of the event.

- Most large CWS facilities are not at substantial risk of landslides. However, several—including Durham and Rock Creek water resource recovery facilities and the Tualatin River Farm, as well as multiple pump stations—are located at the top of locally steep slopes. If landslides develop on these slopes, individual components of these larger facilities could be damaged if the headscarp migrates upward before the land is stabilized.
- In the event of a severe or intense and widespread rainfall event that produces a large number of landslides (e.g., such as occurred during the February 1996 storms), the potential for landslide impact locations in the CWS service area could be numerous. Blocked roads could hamper access to its facilities. Landslides could potentially damage the wastewater collection pipes or storm drainage pipes, outfalls, and adjacent water quality or quantity facilities. The geographic extent of individual landslides and related service impairment is expected to be limited; however, a few pump stations are at the top of slopes that could experience landslides.
- Areas at high or very high risk of landslides are ubiquitous in a notable percentage of under-developed land, particularly where slopes are steep (greater than 20% to 25%) and may present challenges for future planning and mitigation efforts. Awareness of nearby areas vulnerable to landslides is beneficial for reducing risk for every community in Washington County.
- Populations affected by landslide hazards related to CWS facilities and activities include residents with service “up-system” of damaged pipes that may be asked to moderate water use during an initial period of repair, or staff, contractors, or visitors unable to reach CWS facilities due to access limitations.

- Economic impacts are primarily the cost of repair of damaged facilities but could include the provision of alternative sanitary facilities (e.g., porta-potties) to affected residents immediately after damage and during the initial stages of repair.
- Landslides following wildfire in the drainages upstream of Hagg Lake and Barney Reservoir could mobilize sufficient sediment to reduce capacity of these reservoirs. This could have long-term implications for the ability to use CWS' allocated water to support water quality needs.
- Landslides are an inherent element of ecosystems developed on steeper slopes in the Pacific Northwest, although urban land use can alter the frequency, size, or geographic distribution of occurrence. Landslides may result in temporary loss of vegetation and associated habitat in the affected area. If landslide debris reaches watercourses, it would likely result in elevated dominantly suspended sediment loads and could temporarily block passage of aquatic organisms (e.g., fish). Landslides are not likely to be extensive enough to result in loss of species from urban Washington County, however, and may facilitate habitat improvement by adding complexity to instream and floodplain habitat through the introduction of large wood or rock and gravel.

3.2.7. Volcanic Ash

Volcanic activity is possible from mountains near Washington County. Based on late Holocene eruptive history, the most likely eruptions would originate from Mount St. Helens, Mount Hood, and Mount Rainier. It is anticipated that ashfall from a volcanic eruption has the potential to impact CWS, although the scale and types of impacts and vulnerabilities may differ depending on which volcano erupts, the level of eruption, and the wind direction during and after eruption. Potential impacts of and vulnerabilities to volcanic ash are identified below.

3.2.7.1. Potential Impacts

Though unlikely, the impacts of a significant ashfall can be substantial, including:

- Short-term health effects, including respiratory effects, impacting the workforce.
- The need to shelter the workforce to protect them from poor air quality.
- Delayed emergency response times due to decreased visibility and increased traffic hazards.
- Extended operational hours for staff and resources needed for response to the event.
- Economic impacts, including reduced future revenues, increased costs resulting from response activities, and increased future costs resulting from recovery and cleanup activities.
- Industries can experience commerce losses from power interruptions, damaged buildings and assets, and road closures. Industries can also sustain direct losses to buildings, personnel, and other vital equipment, reducing the need for CWS services.
- Personal and household economic impacts of loss of income, increased medical costs, and property damage that may not be covered by insurance could make it difficult to pay utility bills.
- Damage to aboveground and underground infrastructure from interference with mechanical systems.
- Damage to stormwater infrastructure and creek water quality due to increased fine sediment load.
- Disruption of essential infrastructure systems, such as power systems, public utilities, drainage systems, telecommunications, and transportation routes.
- Downed or damaged power lines can lead to wildfires.
- Damage to nature-based solution investments.

3.2.7.2. Vulnerabilities

All populations, economies, structures, improved property, critical facilities and infrastructure, historical properties and cultural resources, and natural environments in the CWS service area are vulnerable to volcanic ash. This includes:

- Staff, contractors, and visitors with chronic lung problems and other preexisting health conditions, children, pregnant women, and older adults.
- Staff, contractors, and visitors without access to effective dust masks, eye protection, and drinking water and food uncontaminated by ash.
- Economic impacts to CWS could result from damages to mechanical, airflow, and electrical systems at CWS water resource recovery facilities, pump stations, and buildings. While not likely an issue, loading of volcanic ash on the roofs of CWS buildings, including pump stations, could cause structural damage.
- Ash could damage outlet structures of stormwater detention ponds, particularly those fitted with real-time controls.

3.2.8. Wildland Fire

CWS could be affected by fire at the wildland-urban interface, an area where urban and ex-urban development occurs in close proximity to wildland vegetation, due to the extent of its service area. However, it is more likely to be affected by smoke and poor air quality due to wildland fires outside its boundaries. Potential impacts of and vulnerabilities to wildland fire are identified below.

3.2.8.1. Significant Events

In September 2020, wildfires within Washington County and nearby Cascade and Coastal ranges produced hazardous air quality resulting in the closure of all CWS offices, minimum staffing of water resource recovery facilities, and the suspension of outdoor work (e.g., revegetation planting, construction inspection, stormwater facility maintenance).

3.2.8.2. Potential Impacts

The potential impacts of a wildfire event are identified below. The type, magnitude, and extent of impacts can vary based on the scale and location of the event. Nearly all of the CWS service area is well away from the wildland–urban interface. This reduces the probability of an urban wildfire. Therefore, regional smoke impacts dominate those that CWS would respond to.

- Injuries or deaths resulting in reduction of available workforce.
- Exposure to wildfire smoke, which can lead to eye, nose, and throat irritation and the worsening of chronic heart and lung diseases impacting the workforce
- Public health issues stemming from failing or damaged infrastructure, such as lack of sanitation, should fire encroach on and damage CWS infrastructure.
- Delayed emergency response times due to blocked transportation routes and debris, congested transportation routes due to evacuations, and damaged infrastructure and vehicles.
- Extended operational hours of CWS staff and resources needed for response to the event.
- Strain on or loss of water supply that impacts operations and use of services.
- Economic impacts including loss of local revenue due to decline in use of service.

- Industries can experience commerce losses from power interruptions, damaged buildings and assets, and road closures. Industries can also sustain direct losses to buildings, personnel, and other vital equipment, reducing the need for CWS services.
- Personal and household economic impacts of loss of income, increased medical costs, and property damage that may not be covered by insurance could make it difficult to pay utility bills.
- Damage and destruction to the built environment, including aboveground and underground infrastructure.
- Disruption of essential infrastructure systems, such as power systems, public utilities, telecommunications, and transportation routes impacting CWS operations
- Debris from trees and damaged property, causing blocked road and rail transportation routes and impacting operations.
- Downed or damaged power lines. This impact may be compounded since power line failures can lead to additional wildfires.
- Power outages and natural gas leaks.
- Hazardous material releases due to infrastructure and facility damage.
- Loss of habitat and vegetation, impacting CWS nature-based solution investments.
- Concurrent hazards, including air and water quality issues. Landslide and erosion issues are common following a wildland fire.

3.2.8.3. Vulnerabilities

Given the dynamic nature of wildland fires, all populations, economies, structures, improved property, critical facilities and infrastructure, historical properties and cultural resources, and natural environments in the CWS service area are vulnerable to this hazard. This may include:

- Staff, contractors, and visitors with chronic lung problems and other preexisting health conditions, who are not otherwise able to shelter in a place that allows them to remain safe and continue to perform assigned duties.
- The primary economic impact to CWS from wildfires is related to disruption of work activities due to limitations placed on staff to limit exposure to excessive smoke and air particulates.
- Longer term accelerated erosion of the watersheds upstream of Hagg Lake and Barney Reservoir as a result of fire-related vegetation loss could further reduce the volume of water available for downstream releases to support attainment of instream water quality targets. These impacts would be compounded by drought or extreme heat conditions.
- Facilities (including shallow buried plastic piping) at the western edge of the CWS service area, including those associated with Hagg Lake, Barney Reservoir, and portions of the Tualatin River National Wildlife Refuge, are located within the wildland–urban interface and may be at direct risk of wildfire damage.
- Impacts to wildlife could arise as animals move into urban environments as a strategy during wildland fires; these could include increased mortality due to stress or vehicle collisions. Impacts from smoke on wildlife are not well understood but can also be significant. Impacts to plants are not likely to be detectable unless conditions persist for an entire season, in which case reduced growth and vigor due to reduced photosynthetic activity could occur.

- Ash and erosion from wildfires can impair water quality. Observations following recent wildland fires in Oregon found short-term elevated temperatures, turbidity, specific conductance, and dissolved organic matter.[8] These parameters may periodically be elevated due to vegetation loss.
- Vegetation associated with nature-based solutions infrastructure, particularly west of the CWS service area, are directly vulnerable to wildfire impacts, including direct combustion or damage from post-fire landslides or stream dynamics.

3.2.9. Windstorm, Including Tornado

CWS has multiple facilities that can be affected by windstorms. Potential impacts of and vulnerabilities to windstorms are identified below.

3.2.9.1. Potential Impacts

The type, magnitude, and extent of windstorm impacts can vary based on the scale of the event.

- Injuries or deaths impacting workforce.
- Delayed emergency response times due to debris, blocked transportation routes, and damaged infrastructure and vehicles impacting operations.
- Extended operational hours of CWS staff and resources needed for response to the event.
- Economic impacts, including reduced future revenues, increased costs resulting from response activities, and increased future costs resulting from recovery and reconstruction activities.
- Industries can experience commerce losses from power interruptions, damaged buildings and assets, and road closures. Industries can also sustain direct losses to buildings, personnel, and other vital equipment, reducing the need for CWS services.
- Personal and household economic impacts of loss of income, increased medical costs, and property damage that may not be covered by insurance could make it difficult to pay utility bills.
- Damage and destruction to the built environment, including aboveground utility lines; residential, public, and private buildings; and transportation systems. Significant damage could lead to the complete loss of structures or totaled vehicles.
- Disruption of essential infrastructure systems, such as power systems, public utilities, telecommunications, and transportation routes.
- Debris from trees and damaged property causing blocked road and rail transportation routes.
- Downed or damaged power lines can lead to wildfires.
- Power outages.
- Loss of habitat and vegetation, impacting CWS nature-based solution investments.

[8] U.S. Geological Survey. (2021, January 5). USGS Measures the Effect of Recent Wildfires on Water Quality in Oregon. https://www.usgs.gov/news/usgs-measures-effect-recent-wildfires-water-quality-oregon

3.2.9.2. Vulnerabilities

All populations, economies, structures, improved property, critical facilities and infrastructure, and historical properties and cultural resources in the CWS service area are vulnerable to windstorms, including tornadoes. Because windstorms are a natural part of the ecosystem disturbance regime in the Pacific Northwest, natural environments are not considered vulnerable to harm from windstorms. Vulnerabilities specific to CWS include:

- Older buildings and infrastructure not built to withstand high winds.
- Aboveground utility and power lines impacting operations.
- Staff, contractors, and visitors working outside (particularly in forested areas) or affected by toppled trees.
- CWS economic impacts from extensive windstorms are likely to be restricted to damage to CWS buildings and related facilities (e.g., communications facility on Nansen Summit, Lake Oswego), particularly from downed trees. Less likely, CWS would incur costs to replant trees that were uprooted in riparian forests located within enhancement project areas.

3.2.10. Winter Storm

CWS has facilities at various elevations throughout its service area and can be affected by winter storms. Potential impacts of and vulnerabilities to winter storms are identified below.

3.2.10.1. Potential Impacts

The type, magnitude, and extent of impacts can vary based on the scale of the event. Potential impacts of a winter storm event may include:

- Injuries or deaths, including from carbon monoxide poisoning, falls from slick or icy conditions, frostbite, and hypothermia impacting the workforce.
- Delayed emergency response times due to debris, blocked transportation routes, damaged infrastructure and vehicles, and difficulty using fire hydrants because of frozen or damaged water system components impacting operations.
- Employees stranded due to ice, snow, and transportation impacts.
- Extended operational hours of staff and resources needed to respond to the event.
- Economic impacts, including reduced future revenues, increased costs resulting from response activities, and increased future costs resulting from recovery and reconstruction activities.
- Industries can experience commerce losses from power interruptions, damaged buildings and assets, and road closures. Industries can also sustain direct losses to buildings, personnel, and other vital equipment, reducing the need for CWS services.
- Personal and household economic impacts of loss of income, increased medical costs, and property damage that may not be covered by insurance could make it difficult to pay utility bills.
- Damage and destruction to the aboveground infrastructure.
- Significant property damage and loss of water due to frozen or damaged pipes or the thawing of frozen pipes.
- Disruption of essential infrastructure systems, such as power systems, public utilities, telecommunications, and transportation routes, impacting operations.

- Debris from trees and damaged property causing blocked road and rail transportation routes impacting operations.
- Downed or damaged power lines can lead to wildfires, and tree debris can create fuel load for wildfire.
- Power outages disrupting operations.
- Loss of habitat and vegetation, impacting CWS nature-based solution investments.
- Concurrent hazards, including flooding.

3.2.10.2. Vulnerabilities

All populations, economies, structures, improved property, critical facilities and infrastructure, historical properties and cultural resources, and natural environments in the CWS service area are vulnerable to winter storms. Vulnerabilities specific to CWS include:

- Buildings and infrastructure not built to withstand the weight and impacts of the storm-related amounts of snow and ice.
- Outdoor workers who are unable to return to shelter and who do not have enough heating, sufficiently insulated clothing, or dry conditions available to them in the moment.
- Economic damages are expected to be those associated with repairs to buildings or surface infrastructure, such as stormwater treatment facilities and additional staff resources needed to manage storm impacts. It is unlikely that the storm would prevent adequate staff from being able to operate the wastewater treatment facilities, though should that happen there may be losses associated with lack of service revenue.
- Winter storms are part of the disturbance regime in the Pacific Northwest. While damage to vegetation occurs, it is not likely to fundamentally alter ecosystems in the short run. More frequent periods of low temperatures could impair vigor of native broad-leafed evergreens, over time altering plant communities and changing the mix of wildlife.

3.3. Historical Events

Hazard events that have affected the entire planning area are detailed in Section 2 of the base plan. CWS has experienced impacts of drought, extreme heat, flood, landslide, windstorm, winter storm, and wildfire smoke events. Specific impacts to CWS from the 1980 eruption of Mount St. Helens, if any, were not recorded.

3.4. Overall Vulnerability

Based on the analysis completed by the Technical Committee, flooding, drought, crustal earthquake, extreme heat, and windstorm, including tornado, present the highest relative and recurring risks to CWS operations. These hazards can create widespread events, and all populations, economies, structures, improved property, critical facilities and infrastructure, and natural environments in the CWS service area can be vulnerable. Areas of greatest vulnerability to these hazards for CWS include:

- Staff and contractors unable to report for work or visitors unable to access CWS services due to flood-related access limitations (e.g., closure of Highway 219, limiting access to the CWS Administration Building Complex).
- Costs of repair for damages to CWS facilities, and revenue lost due to service interruptions.
- Inundation of water resource recovery facilities and associated facilities (e.g., Fernhill Natural Treatment System) or pump stations from flooding, and damage to outfall structures as a result of stream erosion.

- Stream channel (bed and/or bank) erosion resulting in damage to the collection system, including broken wastewater lines or damage to stormwater outfalls.
- Stream channel erosion that damages or eliminates riparian vegetation, beyond that normal for dynamic stream processes and impacts CWS investments in restoration.
- CWS may incur additional costs (e.g., for chemicals, energy, or staff) associated with operational changes needed to manage drought conditions, including reduced releases from Hagg Lake and/or Barney Reservoir. CWS also may need to increase revegetation efforts at publicly maintained stormwater treatment facilities or riparian plantings to maintain project functionality. Customers of the CWS water reuse program could incur losses if CWS is unable to supply expected water volumes at expected times in the year.
- Landscaping in and around CWS facilities (e.g., the green roof on the Field Operations building) may be damaged and require additional maintenance or replanting in the event of drought or extreme heat.
- Streams and vegetation in vegetated corridors regulated by CWS or within areas of CWS nature-based investments are vulnerable to dewatering from stream channel erosion and drought stress.
- Damage to all buildings, infrastructure, facilities, and property as a result of a moderate to severe earthquake. Such damage is reduced with distance from an earthquake epicenter. Structures and facilities in the western half of the CWS service area are more vulnerable in the event of a CSZ earthquake than those in the eastern half of the service area. Less dependent on distance to an epicenter, floodplain areas or other areas of high soil moisture could experience liquefaction.
- Buildings with very high or high collapse potential include buildings constructed prior to 1990 that have not been retrofitted to improve seismic resilience (e.g., Hillsboro Water Resource Recovery Facility).
- CWS employees, contractors, and visitors could be vulnerable in an earthquake should structures collapse. If CWS cannot provide sanitation services from one or more of the water resource recovery facilities, affected residents would need to provide personal sanitation.
- Economic losses to CWS would be substantial (hundreds of millions) should water resource recovery facilities suffer significant damage. Damage to sewer pipes from liquefaction or other ground movement could also be costly. Finally, damage to riparian and wetland enhancement projects could occur should those areas become living space for residents whose living quarters are rendered unsuitable.
- All CWS structures could be damaged by a sufficiently large or proximal earthquake. Recent retrofits, such as those ongoing at the Forest Grove Water Resource Recovery Facility, and improved seismic resilience of new construction, such as that occurring at the Durham Water Resource Recovery Facility, incrementally reduce the vulnerability of CWS facilities. Buildings such as the Administrative Building Complex, Field Operations, and associated structures (Springer facility and Material Handling Yard), and the Research+Innovation+Partners+Labs (ripl) facility would also be vulnerable. Vulnerability of green infrastructure facilities—planted stormwater treatment or flow management facilities, such as stream corridor or wetland enhancement projects—is expected to be low. A substantial portion of the underground pipes in the wastewater collection system and stormwater drainage system is expected to be subject to liquefaction in moderate to large earthquakes, potentially leading to line breakage. In steep portions of the CWS service area, these pipes could also be affected by co-seismic landslides.
- Ecosystem disturbance is an inherent process, particularly in geologically active ecoregions such as those in Washington County. Ground movement in areas of steep topography or liquefaction could disrupt vegetation with attendant modifications to wildlife use patterns. The extent of damage to ecosystem functions and values would depend on the amount of area disrupted and whether the disruption reduces ecosystem connectivity. This could impact the CWS investment in nature-based solutions.

- Populations substantially vulnerable to extreme heat include:
  - Staff and contractors who work or spend a significant amount of time outdoors, including those in construction, inspection, facility maintenance, vegetation management, and field data collection.
  - Staff, contractors, and visitors who work in buildings without air conditioning or cooling equipment.
- Additional vulnerabilities to extreme heat include costs associated with:
  - Setting up and providing cooling centers in CWS facilities for the workforce.
  - Additional energy and maintenance staff costs to sustain air conditioning.
  - Replacement of heat-damaged plants in green infrastructure maintained by CWS.
  - Accelerated aging of CWS buildings.
  - Damage to vegetation in green infrastructure.
- CWS economic impacts from extensive windstorms are likely to be restricted to damage to CWS buildings and related facilities (e.g., communications facility on Nansen Summit, Lake Oswego), particularly from downed trees. CWS operations could be indirectly affected by damage to aboveground utility and power lines. Staff, contractors, and visitors working outside (particularly in forested areas) may be affected by toppled trees. Less likely, CWS would incur costs to replant trees that were uprooted in riparian forests located within enhancement project areas.

4. Capability Assessment

(In compliance with 44 CFR §201.6(c)(3))

The following capability assessment examines the ability of CWS to implement and manage a comprehensive mitigation strategy. Strengths, opportunities, and resources of the CWS service area are identified to develop an effective hazard mitigation action plan. The capabilities identified in this assessment were evaluated collectively to develop feasible recommendations, which support the implementation of effective mitigation activities.

A capability questionnaire was distributed to the CWS Technical Committee to initiate this assessment. The survey included questions regarding existing plans, policies, and regulations that contribute to or hinder the ability to implement hazard mitigation activities, including legal and regulatory capabilities, administrative and technical capabilities, education and outreach capabilities, and fiscal capabilities.

4.1. Planning and Regulatory Assessment

Planning and regulatory capabilities include plans, policies, codes, and ordinances within the CWS service area that can prevent and reduce the impacts of hazards.

CWS operates under a watershed-based NPDES and Municipal Separate Storm Sewer Systems (MS4) permit that regulates discharges to surface water from water resource recovery facilities and the network of stormwater drainage pipes and stormwater management facilities within urban Washington County. Regulatory compliance is predicated on the continuity of operations of these facilities within permit requirements.

Master plans for the wastewater collection system, operational documents for the water resource recovery facilities (e.g., Temperature Management Plan, Mercury Minimization Plan, Total Maximum Daily Load Implementation Plan), and a Stormwater Management Plan aid in documenting the actions necessary to guide facility management. CWS has Design and Construction Standards and Performance Standards (adopted as a Resolution and Order [R&O] by the CWS Board of Directors) that address a range of topics, including the design, construction, and maintenance of public wastewater and stormwater management systems, erosion control methods, and natural resources protection.[9]

Within the past several years, CWS has conducted the following as examples of hazard mitigation actions:

- Performed seismic retrofits at the Rock Creek Water Resource Recovery Facility (completed) and Forest Grove Water Resource Recovery Facility (in progress).
- Supported the Tualatin Watershed Enhancement Collaborative pilot effort in the Cedar Mill–North Johnson watershed to evaluate potential flood risk reduction capital and outreach projects with advanced hydrologic and hydraulic modeling. This was recently completed through the efforts of CWS, Washington County Department of Land Use and Transportation, the cities of Beaverton and Portland, Tualatin Hills Park & Recreation District, the Tualatin Soil and Water Conservation District, and several nonprofit partners.
- Developed the Watershed Navigator website with the Tualatin Soil and Water Conservation District to connect Washington County communities to place-based resources, learning opportunities, and natural resource information. Applied for a FEMA grant with the Tualatin Soil and Water Conservation District and Tualatin River Watershed Council to support hiring a Watershed Navigator staff position for the watershed council.
- Began development of a CWS Climate Action Roadmap. Evaluated changes in plant species to use for “climate ready” riparian habitat enhancements. Facilitated the development of a Wildfire Protection Plan and work with the Joint Water Commission (Hillsboro), Tualatin Soil and Water Conservation District, and Tualatin River Watershed Council to evaluate wildfire risk in watersheds upstream of Hagg Lake and Barney Reservoir and propose suitable mitigation actions.

4.2. Administrative and Technical Assessment

This portion of the assessment includes staff and their skills and tools that can be used for mitigation planning and to implement specific mitigation actions.

The CWS Technical Committee will become a mitigation planning committee that includes members from many sections of the organization.

Field Operations personnel perform Local Maintenance Program activities on the public storm drainage and wastewater systems serving the unincorporated area and the cities of Banks, Durham, Gaston (wastewater only), King City, and North Plains. These activities include emergency response, cleaning and performing CCTV inspection of public storm and wastewater pipes, cleaning catch basins and water quality maintenance holes, sweeping streets, maintaining water quality facilities, repairing damaged or deteriorated infrastructure, constructing short line replacements, installing catch basins and inlets, and enhancing stream corridors. This program also includes handling debris collected from catch basins and street sweeping functions. The group also maintains ditches and performs limited culvert repairs on roads within the Urban Road Maintenance District under an annual contract with Washington County.

The Field Operations staff members also perform Regional Maintenance Program activities throughout the entire service area and large cities for regional wastewater and stormwater infrastructure. These

[9] Clean Water Services. (2022). Design & Construction Standards. https://cleanwaterservices.org/development/dnc/view-the-standards/

activities include managing and maintaining the systemwide flow monitoring and rain gauge network, chemical root control, rehabilitating maintenance holes to reduce inflow and infiltration, maintaining and replacing the large diameter (24-inch and larger) wastewater system, and maintaining and reconstructing regional water quality facilities serving multiple lots.[10]

CWS has a robust staff that includes the following personnel across many departments:

- Planners and engineers with knowledge of land development and land management practices.
- Engineers and professionals trained in construction practices related to CWS infrastructure.
- Planners and engineers with an understanding of natural hazards.
- Scientists and engineers with an understanding of natural area management.
- Staff with education and expertise to assess vulnerability to hazards.
- Geographic information system (GIS) coordinators.

Additionally, CWS has many technical capabilities that have been used to assess or mitigate risk and could be used in future efforts. Warning systems include Everbridge and OR-Alert in partnership with Washington County and the Barney Reservoir earthquake monitoring system. Grant writing is completed by staff in individual departments as needed. A strong GIS program is available to create mapping products for specific projects and needs, and hazard data and information can be pulled from a variety of sources, including historical records and the Oregon Department of Geology and Mineral Industries (DOGAMI).

4.3. Education and Outreach Assessment

Education and outreach programs and methods already in place that could be used to implement mitigation activities and communicate hazard-related information were assessed to determine CWS capabilities. CWS has a comprehensive social footprint and uses it to educate the public. This includes the organization's Communications & Community Engagement section, which enables CWS to reach its strategic outcomes by amplifying its values and nurturing positive behaviors including promoting and advocating for mitigation efforts.[11]

4.4. Financial Assessment

The Finance & Accounting section of CWS manages budget planning, development, and administration, capital improvement program development and project accounting, and bond issuance and debt management. Finance & Accounting works closely with the Strategy Development team on cost of services analysis, rate and fee setting, and financial forecasting.[12]

4.5. Capability Expansion and Improvement

Actions that can expand and improve existing authorities, plans, policies, and resources for mitigation include continuing to update organizational plans as necessary to ensure they are current and reflect the needs of CWS, its partners, and customers; further development of warning systems and messaging; increasing dedicated grant writing staff; creating and implementing additional public education and

[10] Clean Water Services. (2022). Utility Operations & Services. https://cleanwaterservices.org/about/leadership-departments/uops/
[11] Clean Water Services. (2022). Business Services. https://cleanwaterservices.org/about/leadership-departments/business-services/
[12] Clean Water Services. (2022). Business Services. https://cleanwaterservices.org/about/leadership-departments/business-services/

outreach offerings and increasing the volume of translated materials; and ensuring grant opportunities are capitalized upon to meet CWS goals.

5. Mitigation Strategy

(In compliance with 44 CFR §201.6(c)(3)(i), §201.6(c)(3)(ii), §201.6(c)(3)(iii), §201.6(c)(3)(iv), and §201.6(c)(4)(ii))

The mitigation strategy serves as the long-term blueprint for reducing the potential losses identified in the risk assessment. The Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act) directs local mitigation plans to describe hazard mitigation actions and establish a strategy to implement those actions. Therefore, all other requirements for a local mitigation plan lead to and support the mitigation strategy.

5.1. Mitigation Goals

The Steering Committee reviewed and evaluated goals from the 2017 Washington County NHMP, 2020 City of Beaverton NHMP, 2011 Cities of Cornelius and Forest Grove NHMPs, and 2020 State of Oregon NHMP. The goals from each plan were grouped by topic and then synthesized to create the seven goals detailed in Section 3.4 of the base plan. These goals are the basis of this plan and summarize what the Steering Committee will accomplish by implementing this plan.

5.2. Plan Incorporation and Integration into Existing Planning Mechanisms

Based on mitigation plan requirement 44 CFR §201.6(c)(4)(ii), the vulnerabilities and capabilities assessment for CWS were carefully reviewed and considered when developing the mitigation actions for this plan. The CWS Technical Committee will establish a process in which the mitigation strategy, goals, objectives, and actions outlined in this plan will be incorporated into the existing local planning strategies.

Once the plan is adopted, the committee will coordinate implementation with the responsible parties in the CWS service area and with external stakeholders as needed. The primary means for integrating mitigation strategies will be through the revision, update, and implementation of plans and regulations, such as comprehensive plans, capital improvement plans, and land development regulations, as feasible.

The members of the CWS Technical Committee will remain charged with ensuring the goals and strategies of new and updated local planning documents for their jurisdictions and special districts are consistent with the goals and actions in the NHMP and will not contribute to increased hazard vulnerability.

5.2.1. Public Engagement, Education, and Outreach

CWS will work with community partners, including building and strengthening community partnerships that engage the public. Staff will direct particular attention with respect to natural hazard mitigation targeted at supporting the value of nature-based solution investments to help in the mitigation of natural hazard events.

5.2.2. Day-to-Day CWS Functions

CWS will continue to perform Local and Regional Maintenance Program activities and update them as required to fit the needs of CWS, its partner cities, and its customers.

5.2.3. Stormwater Management Plans and Procedures

CWS is a Phase 1 Municipal Separate Storm Sewer System (MS4) permittee, with cities and Washington County as co-implementers. These provisions are included as part of the CWS watershed-wide NPDES permit. As such, CWS provides the local stormwater management program that includes sweeping public streets, responding to flooding from the stormwater drainage system and water pollution, and water quality investigation and spill response in unincorporated Washington County and the cities of Banks, North Plains, Durham, and King City. In addition, CWS addresses stormwater management in its Stormwater Management Plan, Design and Construction Standards, and Performance Standards.[13]

5.2.4. Enforcement of Existing Policies

CWS will continue to operate the water resource recovery facilities as required by the NPDES permit. In addition, CWS will enforce the Design and Construction Standards, Performance Standards, and Stormwater Management Plan used by the organization and update them as needed to fit requirements of CWS, its partner cities, and its customers.

5.2.5. Funding Opportunities

CWS will continue to review annual, post-disaster, and stand-alone grant openings for potential mitigation project funding opportunities.

[13] Clean Water Services. (2022). Design & Construction Standards. https://cleanwaterservices.org/development/dnc/view-the-standards/

6. Action Items

Action items for the 2023 NHMP were determined by the Technical Committee of CWS based on the review of its risk assessment and its existing capabilities. This comprehensive range of actions includes modifications to local plans and regulations, structure and infrastructure projects, natural systems protections, and education and awareness programs. A summary of these actions and full action item planning worksheets are provided in Sections 6.1 and 6.2 below. Additional information about how these actions were developed, evaluated, and prioritized is in Section 3 of the base plan.

6.1. Clean Water Services Action Items: 2023 Washington County NHMP

Table 5: Clean Water Services Action Items

Action Item Number	Action Item Description	Hazard(s) Addressed	Priority
WN1	With regional partners, CWS would facilitate the establishment of a Watershed Navigator to assist (primarily urban) basin residents with strategies for living in a floodplain or other area with urban drainage and related erosion issues.	• Drought • Extreme heat • Flooding	High
WF1	CWS would support the Tualatin Soil and Water Conservation District forestry plan for forest thinning, debris flow mitigation, and Tualatin River Watershed Council efforts on stream corridor and floodplain enhancement. Provide CWS staff expertise at a minimum, along with potential support for grant applications.	• Drought • Flooding • Landslide • Wildland fire	High
WF2	CWS would continue to support current efforts for joint wildfire planning to protect sites where CWS has invested in natural assets for temperature management	• Drought • Flooding • Wildland fire	High
WF4	CWS facilities located near the Wildland–Urban Interface (particularly the Banks pump station) don't have alternative power sources that can be easily reconfigured to provide electricity in the event of a planned shutoff. This action item would develop a strategy for the management of PGE shutoffs for wildfire at Banks pump station.	• Wildland fire	High
WF6	Develop management strategy for planning, constructing, and maintaining capital projects and other enhancement projects within stream corridors and wetlands in the face of elevated wildfire risk.	• Drought • Flooding • Wildland fire	Medium
WF7	Support Washington County, Tualatin Valley Water District, Tualatin Valley Irrigation District, Tualatin River Watershed Council, and the Tualatin Soil and Water Conservation District to develop a risk assessment for and best practices to mitigate the risk of or from post-wildfire debris flows.	• Drought • Flooding • Landslide • Wildland fire	Medium

Action Item Number	Action Item Description	Hazard(s) Addressed	Priority
C4	Develop a strategy to improve the climate resiliency opportunities of real-time controls for detention pond outlets. Move beyond the current approach for managing winter flows to one also managing summer or nonpeak flows to increase resilience of riparian vegetation.	• Dam failure • Flooding	Medium
D1	Improve CWS resilience to harm from dam failure during period of implementation of the Bureau of Reclamation's Safety of Dams project at Scoggins Dam through staff training and development of temporary floodproofing strategies.	• Dam failure • Flooding	Medium
D3	Federal funding for the project design and construction is anticipated to come with programmatic funding available under the Bureau of Reclamation Safety of Dams Program. This action item relates to efforts to ensure the project receives necessary federal funding under the Safety of Dams Program, including federal dollars to support the Endangered Species Act and other fish and wildlife benefits.	• Dam failure • Earthquake	High
F2	Identify and further prioritize sites of wastewater mains and public laterals at high-risk due to potential stream erosion into Capital Improvement Program and begin work to confirm and secure access for risk-reduction activities.	• Flooding • Landslide	Medium
F4	Pluvial flooding, with or without adjacent riverine flooding, presents the most frequent flooding risk to most CWS ratepayers. This action item would increase outreach (e.g., organizing a neighborhood "clean-up" day) to particularly flood-prone neighborhoods, leveraging the existing "rake the grate" outreach and leaf collection events that occur across the CWS service area annually.	• Flooding	Medium
G1	Support Washington County and other partner jurisdictions in managing cross-entity education and response activities undertaken by the Emergency Management Cooperative of Washington County to the extent that they are relevant to CWS facilities or staff safety or actions.	• Dam failure • Drought • Earthquake • Extreme heat • Flooding • Landslide • Volcanic ash • Wildland fire • Windstorm, inc. tornado • Winter storm	Medium
V1	Evaluate critical wet, dry ash loading values for CWS-owned facilities; develop response plans based on ashfall depth. Evaluate potential for interference in mechanical systems from suspended ash particles. Develop appropriate procedures for staff to reduce impacts to health.	• Volcanic Ash	Medium

Action Item Number	Action Item Description	Hazard(s) Addressed	Priority
H3	Evaluate participation in PGE dispatchable generation program - pump station power (i.e., at Dawson Creek and North Plains pump stations). Look at additional incorporation of renewables, and need for participation in this program at other sites (e.g., Durham, Rock Creek facilities).	• Extreme heat	High
H4	Develop strategy to assess and repair heat damage to green infrastructure (including vegetated stormwater facilities) from extreme heat events.	• Extreme heat • Wildland fire	Medium
E1	Refine the strategy for earthquake preparedness training for CWS staff into a program that is repeated frequently.	• Earthquake	Medium
E2	Participate in regional strategies for cooperative sharing of trained and capable staff across Portland metro region based on staff mobility and access (e.g., considering that staff ability to travel from home to work may be limited) in the event of a natural disaster.	• Earthquake	Medium
E3	More widely distribute emergency toilet information to be used in the event of earthquake or other major interruption of wastewater service. Develop strategy with other partners to distribute or make available at reasonable cost the supplies (e.g., two 5-gallon buckets, seats) needed to provide for emergency sanitation.	• Earthquake	Low
E5	Incorporate into wastewater conveyance system design the "safe fail" strategy to manage the large geographic area of elevated liquification risk with a dominantly gravity sewer system. A strategy of “safe fail” has been incorporated into the recent West Basin Master Plan master plan design concept whereby weaker portions of pipe that would be the locus of failure are placed in areas where a pipe fracture can be easily managed, contained, and repaired.	• Earthquake	Medium
E8	Incorporate recommended seismic upgrades during budgeted facility improvements at the CWS Field Operations Merlo Road facility. This will help ensure Utility Operations & Services can meet CWS’ desired level of service during emergencies and disaster situations and improve facility resiliency.	• Earthquake	High
E12	Develop strategy for easement acquisitions for CWS collection system projects implementing “safe-fail” design approach to managing liquefaction hazard. Increase operational resilience of collection system, recognizing that it is impossible to avoid all areas of moderate or high liquefaction or ground motion risk in upgrading or building the collection system.	• Earthquake	Medium

6.2. Mitigation Action Information Worksheets

Table 6: Watershed Navigator Program

Mitigation Action Information			
Title of action	WN-1: Facilitate Establishment of a Watershed Navigator Program		
Type of action	Plans/regulations ☐	Natural systems protection ☐	
	Structure and infrastructure project ☐	Public education/awareness ☒	
Action description	With regional partners Tualatin River Watershed Council and Tualatin Soil and Water Conservation District, CWS would facilitate the establishment of a Watershed Navigator program to assist (primarily urban) basin residents with strategies for living in a floodplain or other area with urban drainage and related erosion issues. This program would consider the expected conditions of climate change: increased summer drought and more intense winter rains. Strategies could include vegetation selection and management related to flooding and wildfires, beaver management, approaches for maintaining stable stream banks, response in the event of a dam break, and community engagement and education. The program would include staff resources (e.g., a position) to extend the reach of the existing web resource. Staff could also work with HOAs to address hazard response in natural areas, including wildfire risk reduction, storm debris management, and vegetation response to drought or extreme heat. In addition, prior work has found that members of under-represented communities are relatively unlikely to call for information or assistance on these issues; outreach coordinated by the Watershed Navigator would help reduce the disparities in service.		
Hazard(s) addressed	Dam failure ☐	Flood ☒	Windstorm, incl. tornado ☐
	Drought ☒	Landslide ☐	Winter storm ☐
	Earthquake ☐	Volcanic ash ☐	
	Extreme heat ☒	Wildland fire ☐	
How does the action address identified current or future risks and vulnerabilities?	Questions from basin residents are frequently addressed to multiple organizations and jurisdictions with specific and often limited authorities or missions and complex boundaries and regulatory environments. As a result, residents often don't get the "best" answer. In addition, organizational/agency staff are required to spend a great deal of time coordinating a response.		
Area of action impact	Throughout the CWS service area at a minimum, with potential for outreach to the remainder of Washington County.		
Is the action related to a critical facility or facilities?	Yes ☐ No ☒ If yes, what facility(ies)?		
Mitigation Action Integration			
Alignment with NHMP goals	Goal 1 ☒	Goal 4 ☐	Goal 7 ☐
	Goal 2 ☐	Goal 5 ☒	
	Goal 3 ☒	Goal 6 ☐	
Integration into other initiatives	CWS Climate Action Roadmap; Washington County Climate Change Adaptation Plan; Oregon Natural Hazard Mitigation Plan		

Alignment with existing plans and policies	NPDES permit (public education and outreach requirements) Stormwater management, floodplain management, and transportation components of comprehensive plans of partner jurisdictions.
Mitigation Action Implementation Plan	
Priority	Low ☐ Medium ☐ High ☒
Lead position, office, department, or division responsible for implementation	Stewardship division in Natural Systems Enhancement & Stewardship department

Supporting Partners	
Internal Partners	**External Partners, Including Community Partners**
Communications & Community Engagement	Tualatin River Watershed Council, Tualatin Soil and Water Conservation District, Washington County and cities with floodplain management and stormwater management responsibilities

Potential Funding Sources	
Non-Federal Funding Sources	**Federal Funding Sources**
CWS, Tualatin Soil and Water Conservation District operating budgets	FEMA (grant application submitted to Oregon Office of Emergency Management)
Estimated Cost	$150,000/year for staff, benefits (CWS share)

Estimated Benefit		
Primary Benefit(s)	**Secondary Benefit(s)**	**Financial Benefit(s)**
One central source for residents in the CWS service area to connect them with resources and provide them with information.	• Awareness by residents and commercial interests. • Support for developing capital projects (public and private) that maintain systemwide resilience in drainage management.	Unknown

Project Timeline		
Expected Timeline for Completion	**Potential Start Date**	**Potential Completion Date**
Short-term ☒ Mid-term ☐ Long-term ☐ Ongoing ☐	July 2023	After July 2026

Implementation Benchmarks: How Will Success Be Measured?

- Securing funding for initial grant period.
- Developing stable long-term funding source.
- Hiring and training staff.
- Identification of outreach strategies to underserved communities and neighborhoods
- Number of education and outreach events
- Number of field visits, follow-up contacts in proportion to initial inquiries

Potential Challenges to Implementation
• Securing ongoing funding for maintenance of communications networks, response to issues arising from community.
Resources and References, if Applicable
• Watershed Navigator Website, https://watershednavigator.org/

Three Alternatives Considered, Including No Action			
	Action Description	**Estimated Cost**	**Evaluation**
Alternative #1	No action	$0	Continued challenging coordination between organizations operating in the County around communicating with residents and businesses.
Alternative #2	Standing coordinating council with community partners	At least $20,000/year in staff time	Hard to prioritize given current staffing levels in the absence of a new disaster. Some ability to respond will remain with partners even as CWS focuses on stormwater management.
Alternative #3	Increase content detail on Watershed Navigator website only	Ongoing – $5,000–$10,000	Doesn't provide site-specific information, awareness, or options. Also, not able to respond in real-time to specific disasters.

Implementation Progress Report for Plan Maintenance	
Date	
What progress in implementation has been made to date?	
What challenges in implementation have been experienced?	
What are the next steps in implementation?	

Table 7: Support Tualatin Soil and Water Conservation District Forestry Plan and Tualatin River Watershed Council Stream Corridor Conservation

Mitigation Action Information	
Title of action	WF1: Support Tualatin Soil and Water Conservation District Forestry Plan and Tualatin River Watershed Council Stream Corridor Conservation
Type of action	Plans/regulations ☐ Natural systems protection ☒ Structure and infrastructure project ☐ Public education/awareness ☐
Action description	CWS would support the Tualatin Soil and Water Conservation District forestry plan for forest thinning, debris flow mitigation, and Tualatin River Watershed Council efforts on stream corridor and floodplain enhancement. Provide CWS staff expertise at a minimum, along with potential support for grant applications.
Hazard(s) addressed	Dam failure ☐ Flood ☒ Windstorm, incl. tornado ☐ Drought ☒ Landslide ☒ Winter storm ☐ Earthquake ☐ Volcanic ash ☐ Extreme heat ☐ Wildland fire ☒
How does the action address identified current or future risks and vulnerabilities?	Risk of wildfire is expected to increase with projected temperature trends, while overall vegetation vigor may decline. Precipitation events are expected to be more extreme, increasing flooding risks. This action item affirms the need to coordinate and support the efforts of these partners with respect to watershed management activities that will make uplands and stream corridors more resilient to expected changes in temperature and moisture regime.
Mitigation Action Integration	
Alignment with NHMP goals	Goal 1 ☒ Goal 4 ☐ Goal 7 ☐ Goal 2 ☐ Goal 5 ☒ Goal 3 ☐ Goal 6 ☐
Integration into other initiatives	Specifically, integration with Tualatin Soil and Water Conservation District outreach to small woodlot owners (particularly tributary to Hagg Lake and Barney Reservoir) and with urban conservation program. Actions undertaken to support Action Item WF-2 Strategic Climate Action Roadmap and Natural Systems Enhancement & Stewardship department Roadmap
Alignment with existing plans and policies	Asset management for water supply within these reservoirs and for stream corridors, including those enrolled in the CWS thermal mitigation (aka “shade”) program.
Mitigation Action Implementation Plan	
Priority	Low ☐ Medium ☐ High ☒
Lead position, office, department, or division responsible for implementation	Stewardship division in Natural Systems Enhancement & Stewardship department

Potential Funding Sources	
Non-Federal Funding Sources	**Federal Funding Sources**
CWS Operating budget, OWEB	USDA, FEMA pre-disaster mitigation
Estimated Cost	$10,000/year
Estimated Benefit	
Primary Benefit(s)	**Financial Benefit(s)**
Over long term, reduced wildfire risk in portions of the watershed is key to meeting water quality requirements under NPDES permit and TMDLs	Unknown
Project Timeline	
Expected Timeline for Completion	
Short-term ☐ Mid-term ☐ Long-term ☐ Ongoing ☒	

Table 8: WF2: Joint Wildfire Planning with Joint Water Commission and Tualatin Soil and Water Conservation District

Mitigation Action Information			
Title of action	WF2: Joint Wildfire Planning with Joint Water Commission, Tualatin Soil and Water Conservation District, and Tualatin Valley Irrigation District to protect CWS temperature management assets		
Type of action	Plans/regulations ☒	Natural systems protection ☐	
	Structure and infrastructure project ☐	Public education/awareness ☐	
Action description	CWS would continue to support current efforts for joint wildfire planning to protect sites where CWS has invested in natural assets for temperature management. Facilitate wildfire planning to protect other water infrastructure in partnership with others (e.g., Joint Water Commission and Tualatin Soil and Water Conservation District). Provide staff support for joint planning and implementation, including procuring grant funding.		
Hazard(s) addressed	Dam failure ☐	Flood ☒	Windstorm, incl. tornado ☐
	Drought ☒	Landslide ☐	Winter storm ☐
	Earthquake ☐	Volcanic ash ☐	
	Extreme heat ☐	Wildland fire ☒	
How does the action address identified current or future risks and vulnerabilities?	Risk of wildfire is expected to increase with projected temperature trends, while overall vegetation vigor may decline. Precipitation events are expected to be more extreme, increasing flooding risks and placing riparian vegetation—which provides needed shade—at risk. This action item affirms the need to coordinate and support efforts of these partners with respect to watershed management activities that will enhance resiliency in light of expected changes in temperature and moisture regime.		
Mitigation Action Integration			
Alignment with NHMP goals	Goal 1 ☒	Goal 4 ☐	Goal 7 ☐
	Goal 2 ☒	Goal 5 ☒	
	Goal 3 ☐	Goal 6 ☐	
Integration into other initiatives	State of Oregon NHMP Actions undertaken to support Action Item WF-1 Watershed Navigator Upcoming update to County's Wildfire Protection Plan CWS Climate Action Roadmap		
Alignment with existing plans and policies	NPDES permit Tualatin Basin Quantitative Wildfire Risk Assessment and Recommendations (2021)		

Mitigation Action Implementation Plan		
Priority	Low ☐ Medium ☐ High ☒	
Lead position, office, department, or division responsible for implementation	Stewardship division in Natural Systems Enhancement & Stewardship department	
Potential Funding Sources		
Non-Federal Funding Sources		**Federal Funding Sources**
CWS Operating budget OWEB grant program for implementation actions		USDA, FEMA pre-disaster mitigation
Estimated Cost	$5,000–10,000/year	
Estimated Benefit		
Primary Benefit(s)		**Financial Benefit(s)**
Over long term, reduced wildfire risk in portions of the watershed is key to meeting water quality requirements under NPDES permit and TMDLs.		Unknown
Project Timeline		
Expected Timeline for Completion		
Short-term ☒ Mid-term ☐ Long-term ☐ Ongoing ☒		

Table 9: Alternatives to Electrical Grid for Pump Stations

Mitigation Action Information			
Title of action	WF4: Alternatives to Electrical Grid for Pump Stations		
Type of action	Plans/regulations ☒	Natural systems protection ☐	
	Structure and infrastructure project ☒	Public education/awareness ☐	
Action description	In 2022, PGE de-powered a portion of the Washington County grid for the first time as a wildfire prevention measure, following the experience of the California and Oregon Labor Day 2020 fires. CWS facilities located near the Wildland–Urban Interface (particularly the Banks pump station) don't have alternative power sources that can be easily reconfigured to provide electricity. This action item would develop a strategy for management of PGE shutoffs for wildfire at Banks pump station. CWS would coordinate planning and alerts with PGE and would integrate alert information into the provision of both fuel and non-fuel (e.g., solar with battery) alternative electricity sources. CWS and PGE could also evaluate the applicability of this strategy to other pump stations and with respect to other hazards (e.g., windstorm or winter storm). The action item would include developing an agreement document and documenting any changes in CWS operational guidance.		
Hazard(s) addressed	Dam failure ☐	Flood ☐	Windstorm, incl. tornado ☐
	Drought ☐	Landslide ☐	Winter storm ☐
	Earthquake ☐	Volcanic ash ☐	
	Extreme heat ☐	Wildland fire ☒	
How does the action address identified current or future risks and vulnerabilities?	Loss of pump stations from unplanned power interruptions could result in wastewater overflows. This action item would develop a coordinated alerting process from PGE (potentially ahead of the general public, particularly with respect to the actual power shutoff) as well as provide a process for coordinated action by CWS staff (e.g., to ascertain that backup system is functioning as needed).		
Mitigation Action Integration			
Alignment with NHMP goals	Goal 1 ☒	Goal 4 ☐	Goal 7 ☒
	Goal 2 ☐	Goal 5 ☒	
	Goal 3 ☒	Goal 6 ☒	
Integration into other initiatives	Any Wildfire Prevention Plan updates		
Alignment with existing plans and policies	NPDES permit (facility performance, prevention/reporting of wastewater overflows, pump station operational guidance)		
Mitigation Action Implementation Plan			
Priority	Low ☐	Medium ☐	High ☒
Lead position, office, department, or division responsible for implementation	Water Resource Recovery Operations & Services department		

Potential Funding Sources	
Non-Federal Funding Sources	**Federal Funding Sources**
CWS Operating budget	N/A
Estimated Cost	$5,000–10,000
Estimated Benefit	
Primary Benefit(s)	**Financial Benefit(s)**
Improve operational resilience of CWS pump station facilities during wildfire emergencies	Unknown; at a minimum, avoided cost of one wastewater overflow complex cleanup (one two-person crew for 8 hours, plus vehicles, and subsequent reporting; approx. $3,000)
Project Timeline	
Expected Timeline for Completion	
Short-term ☒ Mid-term ☐ Long-term ☐ Ongoing ☐	

Table 10: Develop Wildfire-Risk Aware Strategy for Capital Projects Within Stream Corridors and Wetlands

Mitigation Action Information	
Title of action	WF6: Develop Wildfire-Risk Aware Strategy for Capital Projects Within Stream Corridors and Wetlands
Type of action	Plans/regulations ☐ Natural systems protection ☒ Structure and infrastructure project ☐ Public education/awareness ☒
Action description	Develop management strategy for planning, constructing, and maintaining capital projects and other enhancement projects within stream corridors and wetlands in the face of elevated wildfire risk. Evaluate design approaches that address site access, approach to maintaining soil moisture, plant selection and planting design strategies, and implementation and maintenance best practices. Goal is to reduce wildfire risk to any adjacent infrastructure while providing the intended ancillary benefits (e.g., increased flood storage, water quality improvement, habitat values) of revegetation scheme. Action item would include elements of public education and outreach.
Hazard(s) addressed	Dam failure ☐ Flood ☒ Windstorm, incl. tornado ☐ Drought ☒ Landslide ☐ Winter storm ☐ Earthquake ☐ Volcanic ash ☐ Extreme heat ☐ Wildland fire ☒
How does the action address identified current or future risks and vulnerabilities?	Vegetation is an important component of green infrastructure (water quality facilities, stream corridor enhancement of thermal load mitigation riparian planting sites) and site stabilization for traditional gray infrastructure projects (e.g., conveyance pipes). Healthy riparian zones are more resistant to wildfires than uplands. Adding a “hazard reduction” lens to project implementation would potentially reduce harm and would explicitly address potential conflicts between this and other project goals.
Mitigation Action Integration	
Alignment with NHMP goals	Goal 1 ☒ Goal 4 ☐ Goal 7 ☒ Goal 2 ☒ Goal 5 ☒ Goal 3 ☒ Goal 6 ☐
Integration into other initiatives	Any Wildfire Prevention Plan updates Climate-ready planting (CWS internal initiative) and CWS Climate Action Roadmap
Alignment with existing plans and policies	Integrated Project Delivery policies and procedures NPDES permit and project-specific natural resource and land use permits
Mitigation Action Implementation Plan	
Priority	Low ☐ Medium ☒ High ☐
Lead position, office, department, or division responsible for implementation	Field Operations division in Utility Operations & Services department Stewardship division in Natural Systems Enhancement & Stewardship department

Potential Funding Sources	
Non-Federal Funding Sources	**Federal Funding Sources**
CWS Operating budget Partner contributions (e.g., Metro, Tualatin Soil and Water Conservation District)	N/A
Estimated Cost	$20,000–40,000
Estimated Benefit	
Primary Benefit(s)	**Financial Benefit(s)**
Projects would be more resilient to future climate conditions.	Unknown
Project Timeline	
Expected Timeline for Completion	
Short-term ☐ Mid-term ☒ Long-term ☐ Ongoing ☐	

Table 11: Support Development of Strategy to Respond to, and Mitigate Risk From, Post-Wildfire Debris Flows

Mitigation Action Information	
Title of action	WF7: Support development of a strategy to respond to, and mitigate risk from, post-wildfire debris flows
Type of action	Plans/regulations ☐ Natural systems protection ☒ Structure and infrastructure project ☐ Public education/awareness ☒
Action description	Support Washington County, Tualatin Valley Water District, Tualatin Valley Irrigation District, Tualatin River Watershed Council, and Tualatin Soil and Water Conservation District to develop a risk assessment for and best practices to mitigate risk of or from post-wildfire debris flows. Contribute staff expertise, grant management, and/or convening services. Support development of a management strategy for planning, constructing, and maintaining capital projects undertaken in response to debris flow potential. Evaluate design approaches that address site access, approach to maintaining soil moisture, plant selection and planting design strategies, implementation and maintenance best practices. The goals are to retain sediment within the stream corridor, promote revegetation of runout and source areas by others, protect adjacent infrastructure, and provide the intended ancillary benefits (e.g., increased flood storage, water quality improvement, habitat values) of revegetation scheme. Action item should include an element of public education and outreach.
Hazard(s) addressed	Dam failure ☐ Flood ☒ Windstorm, inc. tornado ☐ Drought ☒ Landslide ☒ Winter storm ☐ Earthquake ☐ Volcanic ash ☐ Extreme heat ☐ Wildland fire ☒
How does the action address identified current or future risks and vulnerabilities?	Debris flows resulting from landslides associated with post-wildfire processes are an anticipated risk. Excess sediment from these debris flows has the potential to reduce reservoir capacity in Hagg Lake or Barney Reservoir, potentially reducing available water for water quality flows needed for CWS to support permit and TMDL compliance. Greater variability in future water supply suggests maintaining existing water storage capacity is regionally important. Elsewhere in the Tualatin Basin, debris flows following wildfire have the potential to degrade water quality and destabilize streams, thus endangering CWS' plantings for instream temperature management.
Mitigation Action Integration	
Alignment with NHMP goals	Goal 1 ☒ Goal 4 ☐ Goal 7 ☒ Goal 2 ☒ Goal 5 ☒ Goal 3 ☒ Goal 6 ☒
Integration into other initiatives	Any Wildfire Prevention Plan updates Climate-ready planting (CWS internal initiative) Washington County Climate Adaptation Plan CWS Climate Action Roadmap

Alignment with existing plans and policies	CWS Integrated Project Delivery policies and procedures NPDES permit, TMDL Implementation Plan, and project-specific natural resource and land use permits
Mitigation Action Implementation Plan	
Priority	Low ☐ Medium ☒ High ☐
Lead position, office, department, or division responsible for implementation	Field Operations division in Utility Operations & Services department Stewardship division in Natural Systems Enhancement and Stewardship department
Potential Funding Sources	
Non-Federal Funding Sources	**Federal Funding Sources**
CWS Operating budget CWS Capital Budget (if tied to a specific project) Partner contributions (e.g., Metro, Tualatin Soil and Water Conservation District)	N/A
Estimated cost	$30,000-50,000
Estimated Benefit	
Primary Benefit(s)	**Financial Benefit(s)**
Projects would be more resilient specifically to wildfires, which are expected to be more frequent in the Coast Range until forest stand replacement has occurred. This action item would promote long-term climate resiliency as a result.	Unknown
Project Timeline	
Expected Timeline for Completion	
Short term ☐ Mid term ☒ Long term ☐ Ongoing ☐	

Table 12: Develop Approach to Using Real-Time Controls on Detention Ponds as a Climate Adaptation Tool

Mitigation Action Information	
Title of action	C4: Develop approach to using real-time controls on detention ponds as a climate adaptation tool
Type of action	Plans/regulations ☒ Natural systems protection ☐ Structure and infrastructure project ☐ Public education/awareness ☐
Action description	Develop strategy to improve the climate resiliency opportunities of real-time controls for detention pond outlets. Move beyond current approach for managing winter flows to one managing summer or non-peak flows to increase resilience of riparian vegetation.
Hazard(s) addressed	Dam failure ☐ Flood ☒ Windstorm, inc. tornado ☐ Drought ☒ Landslide ☐ Winter storm ☐ Earthquake ☐ Volcanic ash ☐ Extreme heat ☐ Wildland fire ☐
How does the action address identified current or future risks and vulnerabilities?	Real-time controls represent a potentially significant tool for managing urban runoff volumes that can lead to channel erosion and flood inundation on a somewhat smaller footprint than detention that would provide the same flow-duration matching performance. The use of real-time controls is expected to be more significant in the future as storm intensity increases and urban environments become more impervious. Real-time controls have not yet been evaluated as a mechanism for maintaining streamflow during the summer dry season; such flows can be locally crucial to maintaining riparian vegetation that in turn supports stream channel stability and provides shade to improve instream temperature conditions.
Mitigation Action Integration	
Alignment with NHMP goals	Goal 1 ☒ Goal 4 ☒ Goal 7 ☐ Goal 2 ☒ Goal 5 ☐ Goal 3 ☐ Goal 6 ☒
Integration into other initiatives	CWS Climate Action Roadmap, Resilient Stream Corridors
Alignment with existing plans and policies	NPDES permit, local comprehensive plans

Mitigation Action Implementation Plan			
Priority	Low ☐ Medium ☒ High ☐		
Lead position, office, department, or division responsible for implementation	Utility Operations & Services department Engineering Technical Services		
Potential Funding Sources			
Non-Federal Funding Sources		**Federal Funding Sources**	
CWS Operating, Capital budgets			
Estimated cost	$30,000 - $50,000		
Estimated Benefit			
Primary Benefit(s)		**Financial Benefit(s)**	
Building on analysis of business case for real-time controls, this would provide pathway for taking this tool to scale in support of new development or redevelopment.		Unknown, but could free developable land	
Project Timeline			
Expected Timeline for Completion			
Short term ☐ Mid term ☒ Long term ☐ Ongoing ☐			

Table 73: Implement Measures to Improve Resilience of CWS Staff and Infrastructure in the Event of Dam Failure

Mitigation Action Information	
Title of action	D1: Implement measures to improve resilience of CWS staff and infrastructure in the event of dam failure
Type of action	Plans/regulations ☐ Natural systems protection ☐ Structure and infrastructure project ☐ Public education/awareness ☒
Action description	Improve CWS resilience to harm from dam failure during period of implementation of the Bureau of Reclamation Safety of Dams project at Scoggins Dam through staff training and development of temporary floodproofing strategies. Deliver to CWS staff information on dam failure drills and exercises as identified in the recent update to Bureau of Reclamation's Emergency Action Plan. Train staff on procedures that would be used to notify them of impending dam failure, and when to act without receiving such notification. Provide them with information on escape routes and strategies, along with procedures for check-in. Coordinate activities with the Emergency Management Cooperative of Washington County and Bureau of Reclamation. Along with staff training, develop interim strategies for floodproofing (based on predicted dam break flood elevation) at Forest Grove Water Resource Recovery Facility and Gaston force main and pump station until the Safety of Dams project is complete. Include actions needed to prepare for initial recovery following flooding.
Hazard(s) addressed	Dam failure ☒ Flood ☒ Windstorm, inc. tornado ☐ Drought ☐ Landslide ☐ Winter storm ☐ Earthquake ☐ Volcanic ash ☐ Extreme heat ☐ Wildland fire ☐
How does the action address identified current or future risks and vulnerabilities?	The upper basin facilities where staff are most vulnerable are located at or below the predicted inundation depth in the event of dam failure at Scoggins Dam. Risk of dam failure is expected to be much reduced after the Bureau of Reclamation's Safety of Dams upgrades to Scoggins Dam, which are in initial stages of implementation, are complete. For this reason, some floodproofing may be more temporary or deployable in the event of observed failure or failure precursors. CWS staff could be working within the predicted inundation zone for failure of Scoggins Dam, or need to respond to damage to CWS facilities within this zone. Including this element, while unlikely, would increase employee safety until the Scoggins Dam Safety of Dams project is completed.
Mitigation Action Integration	
Alignment with NHMP goals	Goal 1 ☒ Goal 4 ☐ Goal 7 ☒ Goal 2 ☒ Goal 5 ☒ Goal 3 ☒ Goal 6 ☒
Integration into other initiatives	Onboarding education for new employees regarding health and safety policies Emergency Management Cooperative of Washington County emergency response planning

Alignment with existing plans and policies	Updated Emergency Action Plan, CWS health and safety training Bureau of Reclamation Safety of Dams / Scoggins Dam project
Mitigation Action Implementation Plan	
Priority	Low ☐ Medium ☒ High ☐
Lead position, office, department, or division responsible for implementation	Risk Management in Business Services department
Potential Funding Sources	
Non-Federal Funding Sources	**Federal Funding Sources**
CWS Operating budget CWS Operating, Capital budgets State Clean Water Revolving Loan fund	FEMA BRIC grant for floodproofing implementation
Estimated cost	$30,000-$40,000 if training is included in broader training/ notification of facility-specific and CWS Emergency Action Plan updates. Costs for floodproofing to be determined.
Estimated Benefit	
Primary Benefit(s)	**Financial Benefit(s)**
Increase workforce safety, facility resilience, and effectiveness of response to flooding in the event of dam failure	Unknown
Project Timeline	
Expected Timeline for Completion	
Short term ☒ Mid term ☐ Long term ☐ Ongoing ☐	

Table 84: Finalize Funding Strategy to Advance Bureau of Reclamation Scoggins Safety of Dams Project

Mitigation Action Information	
Title of action	D3: Finalize funding strategy to provide CWS' share of local match for Bureau of Reclamation's Scoggins Safety of Dams project
Type of action	Plans/regulations ☐ Natural systems protection ☐ Structure and infrastructure project ☒ Public education/awareness ☐
Action description	The Bureau of Reclamation's Scoggins Safety of Dams project is currently in design. Federal funding for the project design and construction is anticipated to come from programmatic funding available under the Bureau of Reclamation Safety of Dams Program. That programmatic funding was increased as a result of the Bipartisan Infrastructure Law. Local repayment partners, including Clean Water Services, will be responsible for 15% of the total project cost. Once the project design is complete, the total amount of the 15% local obligation and CWS' share of the local obligation will be determined. CWS' obligation will be finalized and payable through a long-term repayment contract once the project is substantially complete. This action item relates to efforts to ensure the project receives necessary federal funding under the Safety of Dams Program, including federal dollars to support the Endangered Species Act and other fish and wildlife benefits.
Hazard(s) addressed	Dam failure ☒ Flood ☐ Windstorm, inc. tornado ☐ Drought ☐ Landslide ☐ Winter storm ☐ Earthquake ☒ Volcanic ash ☐ Extreme heat ☐ Wildland fire ☐
How does the action address identified current or future risks and vulnerabilities?	Clean Water Services depends on releases from Hagg Lake and Barney Reservoir to meet instream permit conditions related to discharges from CWS water resource recovery facilities. Reducing the risk of dam failure provides additional resilience to the package of actions undertaken by CWS to maintain the option for releases from Hagg Lake to facilitate water quality improvements in the main stem of the Tualatin River.
Mitigation Action Integration	
Alignment with NHMP goals	Goal 1 ☐ Goal 4 ☐ Goal 7 ☐ Goal 2 ☐ Goal 5 ☐ Goal 3 ☐ Goal 6 ☐
Integration into other initiatives	Cooperation with local repayment partners (Joint Water Commission, Tualatin Valley Irrigation District)
Alignment with existing plans and policies	NPDES permit, water reuse program

Mitigation Action Implementation Plan		
Priority	Low ☐ Medium ☐ High ☒	
Lead position, office, department, or division responsible for implementation	Finance & Accounting in Business Services department	
Potential Funding Sources		
Non-Federal Funding Sources	**Federal Funding Sources**	
CWS Capital budget	Primarily a federal project funded by Bureau of Reclamation	
Estimated cost	To be determined	
Estimated Benefit		
Primary Benefit(s)		**Financial Benefit(s)**
Reduce risk of loss of source for water quality flows.		Unknown
Project Timeline		
Expected Timeline for Completion		
Short term ☐ Mid term ☒ Long term ☐ Ongoing ☐		

Table 9: Retrofit High-Risk Public Wastewater Line Locations

Mitigation Action Information	
Title of action	F2: Retrofit high-risk public wastewater line locations
Type of action	Plans/regulations ☐ Natural systems protection ☐ Structure and infrastructure project ☐ Public education/awareness ☐
Action description	Identify and further prioritize sites of wastewater mains and public laterals as high-risk due to potential stream erosion, incorporate their stabilization into the Capital Improvement Program, and begin work to confirm or secure access. Document risk conditions.
Hazard(s) addressed	Dam failure ☐ Flood ☒ Windstorm, inc. tornado ☐ Drought ☐ Landslide ☒ Winter storm ☐ Earthquake ☐ Volcanic ash ☐ Extreme heat ☐ Wildland fire ☐
How does the action address identified current or future risks and vulnerabilities?	CWS has repaired a number of sewer lines within stream corridors in recent years, usually as the line becomes exposed. This action would accelerate retrofits to occur for at-risk locations ahead of exposure so that line exposure, and related failure risk, would not occur.
Mitigation Action Integration	
Alignment with NHMP goals	Goal 1 ☒ Goal 4 ☐ Goal 7 ☒ Goal 2 ☒ Goal 5 ☒ Goal 3 ☐ Goal 6 ☐
Integration into other initiatives	Subbasin planning and stream corridor enhancement/ resilient stream corridors
Alignment with existing plans and policies	Capacity, Management, Operations and Maintenance (CMOM) asset management for collection system. CWS Integrated Plan.
Mitigation Action Implementation Plan	
Priority	Low ☐ Medium ☒ High ☐
Lead position, office, department, or division responsible for implementation	Regional Utility Services department Systems Planning division for CIP development Utility Operations & Services department for wastewater line work Project Delivery division in Natural Systems Enhancement & Stewardship department for stream corridor enhancement.

Potential Funding Sources	
Non-Federal Funding Sources	**Federal Funding Sources**
CWS Capital budget to develop projects State Clean Water Revolving Fund available for retrofit projects, capitalizing on additional green infrastructure add-on funding where suitable. This is a loan rather than grant program. Green infrastructure projects typically have favorable loan rates and repayment terms.	
Estimated cost	$150,000 to develop projects sufficient for inclusion in CIP. Costs to implement capital projects to be determined

Estimated Benefit	
Primary Benefit(s)	**Financial Benefit(s)**
Primary benefit would be protection of the existing wastewater collection system infrastructure, providing more reliable service to ratepayers. Secondarily could provide opportunities to improve stream corridor resilience, address capacity issues (if any).	Unknown

Project Timeline
Expected Timeline for Completion
Short term ☐ Mid term ☐ Long term ☒ Ongoing ☐

Table 10: Support Ratepayers to Reduce Flooding From Clogged Stormwater Drainage Within the Public Stormwater Drainage System

Mitigation Action Information	
Title of action	F4: Support ratepayers to reduce flooding from clogged stormwater drainage within the public stormwater drainage system
Type of action	Plans/regulations ☐ Natural systems protection ☐ Structure and infrastructure project ☐ Public education/awareness ☒
Action description	Help ratepayers fix storm drainage issues associated with the public stormwater drainage system and improve maintenance in adjacent public storm infrastructure.
Hazard(s) addressed	Dam failure ☐ Flood ☒ Windstorm, inc. tornado ☐ Drought ☐ Landslide ☐ Winter storm ☐ Earthquake ☐ Volcanic ash ☐ Extreme heat ☐ Wildland fire ☐
How does the action address identified current or future risks and vulnerabilities?	Pluvial flooding, with or without adjacent riverine flooding, presents the most frequent flooding risk to most CWS ratepayers. This is particularly an issue in low-lying parts of the urban Tualatin Basin that were developed in the 1970s or earlier. This flooding pattern arises most commonly in the fall when higher-intensity storms occur at the same time that leaves are falling. This leads to plugging of inlet grates or other parts of the public drainage infrastructure. This action item would increase outreach (e.g., organizing a neighborhood clean-up day) to particularly flood-prone neighborhoods, leveraging the existing “rake the grate” outreach and leaf collection events that occur annually throughout the CWS service area. With predicted increases in high-intensity rainfall events occurring earlier in the season, the need for this activity is expected to increase.
Mitigation Action Integration	
Alignment with NHMP goals	Goal 1 ☒ Goal 4 ☐ Goal 7 ☒ Goal 2 ☒ Goal 5 ☐ Goal 3 ☒ Goal 6 ☒
Integration into other initiatives	Integrate with Watershed Navigator program, leaf collection events, “rake the grate” social media posts CWS Climate Action Roadmap
Alignment with existing plans and policies	NPDES permit: Field Operations policy is to respond to flooding where the storm drainage system might be impaired.

Mitigation Action Implementation Plan		
Priority	Low ☐ Medium ☒ High ☐	
Lead position, office, department, or division responsible for implementation	Field Operations division in Utility Operations & Services department	
Potential Funding Sources		
Non-Federal Funding Sources		**Federal Funding Sources**
CWS Operating budget		
Estimated cost	$25,000 initial, $5,000/year	
Estimated Benefit		
Primary Benefit(s)		**Financial Benefit(s)**
Field Operations will respond during flood emergencies to situations arising from the public stormwater system. Prevention would allow Field Operations to concentrate on public infrastructure issues that are beyond the scope of individual residents.		Unknown
Project Timeline		
Expected Timeline for Completion		
Short term ☐ Mid term ☐ Long term ☐ Ongoing ☒		

Table 11: In Cooperation With Project Partners, Evaluate CWS Floodplain Facilities for Flood Storage Opportunities

Mitigation Action Information	
Title of action	F5: In cooperation with project partners, evaluate CWS floodplain facilities for flood storage opportunities
Type of action	Plans/regulations ☐ Natural systems protection ☒ Structure and infrastructure project ☐ Public education/awareness ☐
Action description	CWS owns multiple floodplain parcels that provide winter flood storage. As opportunities and need arise, under this action item CWS would help project partners acquire (or acquire easements to) floodplain parcels, continue building or preserving wetlands to maintain or improve flood storage in addition to providing other ecological benefits of interest to CWS. Flood storage benefit would be documented where suitable on riparian and wetland parcels managed or enhanced by CWS. For sites with flood storage opportunities, partners and CWS would assess feasibility of implementing any site modifications to protect CWS infrastructure and optimize flood storage.
Hazard(s) addressed	Dam failure ☒ Flood ☒ Windstorm, inc. tornado ☐ Drought ☐ Landslide ☐ Winter storm ☐ Earthquake ☐ Volcanic ash ☐ Extreme heat ☐ Wildland fire ☐
How does the action address identified current or future risks and vulnerabilities?	Particularly within the urban basin, where runoff is flashy and the time between peak rainfall and peak runoff is less than a few hours, preserving existing flood storage is currently important. Doing so will likely become more important in the future as storm intensity is predicted to increase. CWS actions can support non-encroachment into regulated floodplains and drainage hazard areas, and support the preservation of “pockets” of flood storage. This could reduce both inundation and erosion damage.
Mitigation Action Integration	
Alignment with NHMP goals	Goal 1 ☒ Goal 4 ☒ Goal 7 ☐ Goal 2 ☒ Goal 5 ☒ Goal 3 ☐ Goal 6 ☒
Integration into other initiatives	CWS Climate Action Roadmap. Also consider as part of regional conservation strategy.
Alignment with existing plans and policies	Integrate with vegetated corridor program, regulations and floodplain management requirements of individual jurisdictions; CWS integrated planning. CIP for collection system, shade program, and resilient stream corridors.

Mitigation Action Implementation Plan	
Priority	Low ☐ Medium ☒ High ☐
Lead position, office, department, or division responsible for implementation	Regional Utility Services and Natural Systems Enhancement & Services departments
Potential Funding Sources	
Non-Federal Funding Sources	**Federal Funding Sources**
CWS Operating budget Metro Nature In Neighborhoods grants Tualatin Soil and Water Conservation District TREE grants	FEMA BRIC program pre-disaster mitigation grant
Estimated cost	To be determined
Estimated Benefit	
Primary Benefit(s)	**Financial Benefit(s)**
Increase stream corridor resilience to erosion and potentially decrease risk of inundation either by direct flooding or by reducing the drainage efficiency of existing stormwater infrastructure.	Unknown
Project Timeline	
Expected Timeline for Completion	
Short term ☐ Mid term ☐ Long term ☐ Ongoing ☒	

Table 12: Support Activities of the Emergency Management Cooperative of Washington County That Are Relevant to CWS

Mitigation Action Information	
Title of action	G1: Support activities of the Emergency Management Cooperative of Washington County that are relevant to CWS.
Type of action	Plans/regulations ☒ Natural systems protection ☐ Structure and infrastructure project ☐ Public education/awareness ☒
Action description	Support Washington County and other partner jurisdictions in managing cross-entity education and response activities undertaken by the Emergency Management Cooperative of Washington County to the extent that they are relevant to CWS facilities or staff safety or actions. An example activity would be developing plans to coordinate re-establishing access to critical CWS facilities in the event of a natural disaster. This entity would also support implementation of warning systems (e.g., U.S. Geological Survey Shake Alert) disaster response drills, including dam failure, and hazard communication to residents and businesses.
Hazard(s) addressed	Dam failure ☒ Flood ☒ Windstorm, inc. tornado ☒ Drought ☒ Landslide ☒ Winter storm ☒ Earthquake ☒ Volcanic ash ☒ Extreme heat ☒ Wildland fire ☒
How does the action address identified current or future risks and vulnerabilities?	Clean Water Services depends on other jurisdictions to maintain road access to CWS facilities or other infrastructure on which these facilities depend; such access can be impaired in the event of flooding and storms. One element of this action would build on strategies developed for regional disasters (e.g., earthquakes) to provide operational response in the event of shorter term or more geographically limited disasters.
Mitigation Action Integration	
Alignment with NHMP goals	Goal 1 ☒ Goal 4 ☐ Goal 7 ☒ Goal 2 ☒ Goal 5 ☒ Goal 3 ☒ Goal 6 ☒
Integration into other initiatives	Jurisdiction-specific emergency management staff, infrastructure, and administrative structures; Oregon Climate Adaptation Plan; Washington County NHMP Action Item #20 (this plan)
Alignment with existing plans and policies	CWS facility-specific Emergency Response Plans; NPDES permit; Oregon Natural Hazard Mitigation Plan

Mitigation Action Implementation Plan			
Priority	Low ☐ Medium ☐ High ☒		
Lead position, office, department, or division responsible for implementation	Risk Management in Business Services department		
Potential Funding Sources			
Non-Federal Funding Sources		**Federal Funding Sources**	
CWS Operating budget			
Estimated cost	$20,000		
Estimated Benefit			
Primary Benefit(s)			**Financial Benefit(s)**
Increase coordination of emergency response between CWS and partner entities			Unknown
Project Timeline			
Expected Timeline for Completion			
Short term ☒ Mid term ☐ Long term ☐ Ongoing ☐			

Table 18: Assess Vulnerability to Volcanic Ash Loading at CWS Facilities and Develop Response Strategy

Mitigation Action Information	
Title of action	V1: Assess vulnerability to volcanic ash loading at CWS facilities and develop response strategy
Type of action	Plans/regulations ☒ Natural systems protection ☐ Structure and infrastructure project ☐ Public education/awareness ☐
Action description	Evaluate critical wet, dry ash loading values for CWS-owned facilities; develop response plans based on ashfall depth. Evaluate potential for interference in mechanical systems from suspended ash particles. Develop appropriate procedures for staff to reduce impacts to health.
Hazard(s) addressed	Dam failure ☐ Flood ☐ Windstorm, inc. tornado ☐ Drought ☐ Landslide ☐ Winter storm ☐ Earthquake ☐ Volcanic ash ☒ Extreme heat ☐ Wildland fire ☐
How does the action address identified current or future risks and vulnerabilities?	Vulnerability to volcanic ash loading for CWS buildings is not understood. Action item would evaluate as-built plans and basis-of-design reports for buildings and define wet and dry ash depth thresholds for maintenance actions as appropriate. Action item would also document procedures to be taken to reduce health risk to employees. Resulting strategies would be documented in facility-specific Emergency Response plans.
Mitigation Action Integration	
Alignment with NHMP goals	Goal 1 ☒ Goal 4 ☐ Goal 7 ☒ Goal 2 ☐ Goal 5 ☐ Goal 3 ☐ Goal 6 ☒
Integration into other initiatives	Emergency Management Cooperative of Washington County
Alignment with existing plans and policies	Facilities asset management, Emergency Response plans
Mitigation Action Implementation Plan	
Priority	Low ☐ Medium ☒ High ☐
Lead position, office, department, or division responsible for implementation	Facilities division in Enterprise Asset & Technical Services department

Potential Funding Sources	
Non-Federal Funding Sources	**Federal Funding Sources**
CWS Operating budget	
Estimated cost	$50,000 to assess vulnerability. Any retrofit costs are not included.
Estimated Benefit	
Primary Benefit(s)	**Financial Benefit(s)**
Understand and manage CWS vulnerability to volcanic ashfall	Unknown
Project Timeline	
Expected Timeline for Completion	
Short term ☐ Mid term ☒ Long term ☐ Ongoing ☐	

Table 13: Participate in Dispatchable Generation Program for CWS Facilities

Mitigation Action Information	
Title of action	H3: Participate in dispatchable generation program for CWS facilities
Type of action	Plans/regulations ☒ Natural systems protection ☐ Structure and infrastructure project ☐ Public education/awareness ☐
Action description	Evaluate participation in PGE dispatchable generation program - pump station power (i.e., at Dawson Creek and North Plains pump stations). Look at additional incorporation of renewables and need for participation in this program at other sites (e.g., Durham, Rock Creek facilities).
Hazard(s) addressed	Dam failure ☐ Flood ☐ Windstorm, inc. tornado ☐ Drought ☐ Landslide ☐ Winter storm ☐ Earthquake ☐ Volcanic ash ☐ Extreme heat ☒ Wildland fire ☐
How does the action address identified current or future risks and vulnerabilities?	Because the power grid is vulnerable during extreme heat events due to increased usage for cooling, having alternative power sources available on short notice may be useful to maintain system function. One option to investigate is dispatchable generation, which is offered by PGE, the local power utility.
Mitigation Action Integration	
Alignment with NHMP goals	Goal 1 ☒ Goal 4 ☐ Goal 7 ☒ Goal 2 ☐ Goal 5 ☒ Goal 3 ☐ Goal 6 ☒
Integration into other initiatives	Emergency Management Cooperative of Washington County
Alignment with existing plans and policies	Facility-specific Emergency Response Plans; Oregon Natural Hazard Mitigation Plan
Mitigation Action Implementation Plan	
Priority	Low ☐ Medium ☐ High ☒
Lead position, office, department, or division responsible for implementation	Water Resource Recovery Operations & Services department

Potential Funding Sources	
Non-Federal Funding Sources	**Federal Funding Sources**
CWS Operating budget	
Estimated cost	<$10,000
Estimated Benefit	
Primary Benefit(s)	**Financial Benefit(s)**
Increase facility resilience in the face of extreme heat events	Unknown
Project Timeline	
Expected Timeline for Completion	
Short term ☒ Mid term ☐ Long term ☐ Ongoing ☐	

Table 20: Manage Impacts to Green Infrastructure From Extreme Heat Events

Mitigation Action Information	
Title of action	H4: Evaluate and manage impacts to green infrastructure from extreme heat events
Type of action	Plans/regulations ☒ Natural systems protection ☐ Structure and infrastructure project ☐ Public education/awareness ☐
Action description	Develop strategy to assess and repair heat damage to green infrastructure (including vegetated stormwater facilities) from extreme heat events. Develop assessment approach through use of drone surveys or other remote sensing resources. Develop methods for determining urgency of vegetation repair and contracting/ revegetation strategies for responding in a timely manner.
Hazard(s) addressed	Dam failure ☐ Flood ☐ Windstorm, inc. tornado ☐ Drought ☐ Landslide ☐ Winter storm ☐ Earthquake ☐ Volcanic ash ☐ Extreme heat ☒ Wildland fire ☒
How does the action address identified current or future risks and vulnerabilities?	Functionality of CWS' green infrastructure—whether its purpose is stormwater management, shade provision, or at natural resource enhancement—depends on appropriate vegetation and cover. Stormwater management facilities and natural resource enhancement sites require vegetation to maintain structural integrity through winter storms beginning in October, while summer is the critical season for sites in the shade program and other sites requiring healthy riparian vegetation. There is currently no mechanism for systematically assessing the impact of extreme heat events at these sites, which typically have no or limited irrigation infrastructure, and replacing vegetation in a timely manner as needed to maintain key functionality.
Mitigation Action Integration	
Alignment with NHMP goals	Goal 1 ☒ Goal 4 ☐ Goal 7 ☒ Goal 2 ☒ Goal 5 ☒ Goal 3 ☒ Goal 6 ☒
Integration into other initiatives	Regional conservation strategy; Metro Titles 3, 13; CWS Climate Action Roadmap
Alignment with existing plans and policies	NPDES permit

Mitigation Action Implementation Plan		
Priority	Low ☐ Medium ☒ High ☐	
Lead position, office, department, or division responsible for implementation	Natural Systems Enhancement & Stewardship department	
Potential Funding Sources		
Non-Federal Funding Sources	**Federal Funding Sources**	
CWS Operating budget		
Estimated cost	$25,000 - $35,000	
Estimated Benefit		
Primary Benefit(s)	**Financial Benefit(s)**	
Increase responsive revegetation in the event of heat-related vegetation loss	Unknown	
Project Timeline		
Expected Timeline for Completion		
Short term ☐ Mid term ☒ Long term ☐ Ongoing ☐		

Table 21: Refine Earthquake Preparedness Training for CWS Staff

Mitigation Action Information	
Title of action	E1: Refine earthquake preparedness training for CWS staff
Type of action	Plans/regulations ☐ Natural systems protection ☐ Structure and infrastructure project ☐ Public education/awareness ☒
Action description	Refine the strategy for earthquake preparedness training for CWS staff into a program that is repeated frequently. Program should include participation in the "Great American Shake Out" as an element of the CWS' employee health and safety plan. Develop a strategy to set repeat intervals (if not annually) as a part of recurring training of staff. Incorporate information about new seismic risk information, as available, and "Shake Alert" warning system. Document process to update internal leads and contact info for external emergency managers, and awareness for staff at the front desk and answering service. Provide guidelines for employees to return to work.
Hazard(s) addressed	Dam failure ☐ Flood ☐ Windstorm, inc. tornado ☐ Drought ☐ Landslide ☐ Winter storm ☐ Earthquake ☒ Volcanic ash ☐ Extreme heat ☐ Wildland fire ☐
How does the action address identified current or future risks and vulnerabilities?	"Disaster amnesia" affects nearly everyone. Consistent (every one to three years) participation in this event, along with others in the community, reinforces behaviors in the event of an earthquake and provides an opportunity for updated information and training on this and other related hazards that staff may experience in the workplace and at home, in the community, or recreating.
Mitigation Action Integration	
Alignment with NHMP goals	Goal 1 ☒ Goal 4 ☐ Goal 7 ☐ Goal 2 ☒ Goal 5 ☒ Goal 3 ☒ Goal 6 ☒
Integration into other initiatives	Emergency Management Cooperative of Washington County
Alignment with existing plans and policies	Employee health and safety plan
Mitigation Action Implementation Plan	
Priority	Low ☐ Medium ☒ High ☐
Lead position, office, department, or division responsible for implementation	Risk Management, with support from Communications & Community Engagement in Business Services department

Potential Funding Sources	
Non-Federal Funding Sources	**Federal Funding Sources**
CWS Operating budget	
Estimated cost	$5,000 - $10,000 for initial strategy development; additional cost to be determined

Estimated Benefit	
Primary Benefit(s)	**Financial Benefit(s)**
Increase staff awareness of earthquake hazards including immediate response. Decrease time to operational recovery for CWS-provided services.	Unknown

Project Timeline
Expected Timeline for Completion
Short term ☒ Mid term ☐ Long term ☐ Ongoing ☐

Table 22: Participate in Regional Staff Sharing and Exchange Program for Certified and Highly Trained Staff

Mitigation Action Information	
Title of action	E2: Participate in regional staff sharing and exchange program for certified and highly trained staff
Type of action	Plans/regulations ☒ Natural systems protection ☐ Structure and infrastructure project ☐ Public education/awareness ☐
Action description	Participate in regional strategies for cooperative sharing of trained and capable staff across Portland metro region based on staff mobility and access (e.g., considering that staff ability to travel from home to work may be limited) in the event of a natural disaster.
Hazard(s) addressed	Dam failure ☐ Flood ☐ Windstorm, inc. tornado ☐ Drought ☐ Landslide ☐ Winter storm ☐ Earthquake ☒ Volcanic ash ☐ Extreme heat ☐ Wildland fire ☐
How does the action address identified current or future risks and vulnerabilities?	In the event of a regional-scale emergency such as an earthquake, specifically trained personnel are needed to manage and staff many CWS facilities (e.g., water resource recovery facilities, water quality lab, digital infrastructure) or to staff emergency operations center(s). Similar situations occur at many jurisdictions across the Portland metro region. However, a major seismic event is expected to make bridges across the Willamette River impossible. A regional strategy for specialized staff sharing would have workers report to an available similar facility if they are unable to reach CWS (and vice versa).
Mitigation Action Integration	
Alignment with NHMP goals	Goal 1 ☒ Goal 4 ☐ Goal 7 ☒ Goal 2 ☒ Goal 5 ☒ Goal 3 ☐ Goal 6 ☒
Integration into other initiatives	Emergency Management Cooperative of Washington County; City of Portland Basic Earthquake Emergency Communication Nodes, Emergency mutual aid agreements.
Alignment with existing plans and policies	NPDES permit
Mitigation Action Implementation Plan	
Priority	Low ☐ Medium ☒ High ☐
Lead position, office, department, or division responsible for implementation	Risk Management in Business Services department

Potential Funding Sources		
Non-Federal Funding Sources		**Federal Funding Sources**
CWS Operating budget		
Estimated cost	To be determined	
Estimated Benefit		
Primary Benefit(s)		**Financial Benefit(s)**
Improve likelihood that service interruptions due to lack of trained workers will be minimized.		Unknown
Project Timeline		
Expected Timeline for Completion		
Short term ☐ Mid term ☒ Long term ☐ Ongoing ☐		

Table 23: Emergency Sanitation Outreach

Mitigation Action Information	
Title of action	E3: Emergency sanitation outreach
Type of action	Plans/regulations ☐ Natural systems protection ☐ Structure and infrastructure project ☐ Public education/awareness ☒
Action description	More widely distribute emergency toilet information to be used in the event of earthquake or other major interruption of wastewater service. Develop strategy with partners to distribute or make available at reasonable cost the supplies (e.g., two 5-gallon buckets, seats) needed to provide for emergency sanitation.
Hazard(s) addressed	Dam failure ☐ Flood ☐ Windstorm, inc. tornado ☐ Drought ☐ Landslide ☐ Winter storm ☐ Earthquake ☒ Volcanic ash ☐ Extreme heat ☐ Wildland fire ☐
How does the action address identified current or future risks and vulnerabilities?	Because the CWS wastewater collection system cannot avoid areas with moderate or greater liquefaction risk, and other facilities are vulnerable in the event of extensive loss of electrical power, it is likely that a major earthquake will result in service disruptions that are too geographically extensive to repair or provide a temporary work-around in the first several weeks post-event. This action would show residents how to provide for their sanitation needs.
Mitigation Action Integration	
Alignment with NHMP goals	Goal 1 ☒ Goal 4 ☐ Goal 7 ☒ Goal 2 ☒ Goal 5 ☒ Goal 3 ☒ Goal 6 ☒
Integration into other initiatives	Potential to integrate with Watershed Navigator
Alignment with existing plans and policies	Align with Washington County Emergency Management Cooperative efforts
Mitigation Action Implementation Plan	
Priority	Low ☒ Medium ☐ High ☐
Lead position, office, department, or division responsible for implementation	Communications & Community Engagement in Business Services department
Potential Funding Sources	
Non-Federal Funding Sources	**Federal Funding Sources**
CWS Operating budget	
Estimated cost	$10,000

Estimated Benefit	
Primary Benefit(s)	**Financial Benefit(s)**
Protect human health by providing community with 5-gallon buckets to use (with instructions) to prepare in case of emergency and lack of access to sewer services.	Unknown
Project Timeline	
Expected Timeline for Completion	
Short term ☐ Mid term ☐ Long term ☒ Ongoing ☐	

Table 24: Develop Strategy for Conveyance System Design in Response to Geographic Distribution of Liquefaction Hazard

Mitigation Action Information	
Title of action	E5: Develop strategy for conveyance system design in response to geographic distribution of liquefaction hazard
Type of action	Plans/regulations ☒ Natural systems protection ☐ Structure and infrastructure project ☐ Public education/awareness ☐
Action description	Incorporate into wastewater conveyance system design the "safe fail" strategy to manage the large geographic area of elevated liquification risk with a dominantly gravity sewer system. Applying construction methods to entire pipeline length that would withstand liquefaction is too expensive. This strategy has been incorporated into the recent West Basin Master Plan design concept whereby weaker portions of pipe that would be the locus of failure are placed in areas where a pipe fracture can be easily managed, contained, and repaired. This action item would seek to incorporate such a design strategy into subsequent conveyance pipe projects to the extent practicable.
Hazard(s) addressed	Dam failure ☐ Flood ☐ Windstorm, inc. tornado ☐ Drought ☐ Landslide ☐ Winter storm ☐ Earthquake ☒ Volcanic ash ☐ Extreme heat ☐ Wildland fire ☐
How does the action address identified current or future risks and vulnerabilities?	CWS will be upgrading many miles of wastewater conveyance pipes over the next decade. Across much of this length, liquefaction hazard is moderate or higher. High hazard areas cannot be avoided with a dominantly gravity system. Nor can pipes be made to be failure-proof at any reasonable costs. This action would employ a strategy of managed pipe failure.
Mitigation Action Integration	
Alignment with NHMP goals	Goal 1 ☒ Goal 4 ☒ Goal 7 ☒ Goal 2 ☒ Goal 5 ☒ Goal 3 ☐ Goal 6 ☒
Integration into other initiatives	Emergency Management Cooperative of Washington County
Alignment with existing plans and policies	NPDES permit (asset management); Oregon Natural Hazard Mitigation Plan
Mitigation Action Implementation Plan	
Priority	Low ☐ Medium ☒ High ☐
Lead position, office, department, or division responsible for implementation	Conveyance Engineering in Utility Operations & Services department

Potential Funding Sources	
Non-Federal Funding Sources	**Federal Funding Sources**
CWS Capital budget Clean Water State Revolving Fund	FEMA BRIC grant for mitigation actions
Estimated cost	To be determined; can be incorporated into collection system design relatively easily, but construction costs would be project-specific

Estimated Benefit	
Primary Benefit(s)	**Financial Benefit(s)**
Reduce risk of wastewater reaching surface waters in the event of a pipe break caused by liquefaction during a seismic event.	Unknown

Project Timeline
Expected Timeline for Completion
Short term ☐ Mid term ☒ Long term ☐ Ongoing ☐

Table 25: Perform Seismic Upgrades at Field Operations Merlo Road Facility

Mitigation Action Information	
Title of action	E8: Perform seismic upgrades at Field Operations Merlo Road facility
Type of action	Plans/regulations ☐ Natural systems protection ☐ Structure and infrastructure project ☒ Public education/awareness ☐
Action description	This action item would incorporate recommended seismic upgrades during budgeted facility improvements at the CWS Field Operations Merlo Road facility. This will help ensure Utility Operations & Services can meet CWS' desired level of service during emergencies and disaster situations and improve facility resiliency. A seismic evaluation of the building as well as other resiliency improvements are included in the scope of work.
Hazard(s) addressed	Dam failure ☐ Flood ☐ Windstorm, inc. tornado ☐ Drought ☐ Landslide ☐ Winter storm ☐ Earthquake ☒ Volcanic ash ☐ Extreme heat ☐ Wildland fire ☐
How does the action address identified current or future risks and	The Merlo Road facility is a major component of CWS' emergency response capability. Having it remain functional during a seismic event will aid in delivery of emergency services, including command center, throughout the CWS service area.
Mitigation Action Integration	
Alignment with NHMP goals	Goal 1 ☒ Goal 4 ☐ Goal 7 ☒ Goal 2 ☐ Goal 5 ☒ Goal 3 ☐ Goal 6 ☒
Integration into other initiatives	Emergency Management Cooperative of Washington County,
Alignment with existing plans and policies	Emergency Action Plan, Capital Improvement Plan; Oregon Natural Hazard Mitigation Plan
Mitigation Action Implementation Plan	
Priority	Low ☐ Medium ☒ High ☐
Lead position, office, department, or division responsible for implementation	Field Operations division in Utility Operations & Services department
Potential Funding Sources	
Non-Federal Funding Sources	**Federal Funding Sources**
CWS Capital budget	
Estimated cost	$6.1 million, included in 2022-2026 CIP for all upgrades. Seismic component not broken out separately.

Estimated Benefit	
Primary Benefit(s)	**Financial Benefit(s)**
Help ensure CWS can meet its desired level of service during emergencies and disaster situations and improve facility resiliency.	Unknown
Project Timeline	
Expected Timeline for Completion	
Short term ☐ Mid term ☒ Long term ☐ Ongoing ☐	

Table 26: Develop Strategy for Easement Acquisitions for CWS Collection System Projects Implementing "Safe-Fail" Design Approach

Mitigation Action Information	
Title of action	E12: Develop strategy for easement acquisitions for CWS collection system projects implementing "safe-fail" design approach
Type of action	Plans/regulations ☒ Natural systems protection ☐ Structure and infrastructure project ☐ Public education/awareness ☐
Action description	Develop strategy and begin to acquire easements to support "safe fail" design approach for wastewater collection system. Determine selection criteria for a location of allowable pipeline "failure"
Hazard(s) addressed	Dam failure ☐ Flood ☐ Windstorm, inc. tornado ☐ Drought ☐ Landslide ☐ Winter storm ☐ Earthquake ☒ Volcanic ash ☐ Extreme heat ☐ Wildland fire ☐
How does the action address identified current or future risks and vulnerabilities?	Increase operational resilience of collection system, recognizing that it is impossible to avoid all areas of moderate or high liquefaction or ground motion risk in upgrading or building the collection system. Because this design approach could require land in specific locations that would extend beyond the typical pipeline easement, acquiring easements prior to development would provide available land when needed prior to construction.
Mitigation Action Integration	
Alignment with NHMP goals	Goal 1 ☒ Goal 4 ☒ Goal 7 ☒ Goal 2 ☒ Goal 5 ☒ Goal 3 ☐ Goal 6 ☒
Integration into other initiatives	Emergency Management Cooperative of Washington County
Alignment with existing plans and policies	NPDES permit (asset management), capital improvement plan; Oregon Natural Hazards Mitigation Plan
Mitigation Action Implementation Plan	
Priority	Low ☐ Medium ☒ High ☐
Lead position, office, department, or division responsible for implementation	Conveyance Engineering in Utility Operations & Services department
Potential Funding Sources	
Non-Federal Funding Sources	**Federal Funding Sources**
CWS Capital budget	
Estimated cost	$25,000 for strategy development; easement acquisition costs to be determined

Estimated Benefit	
Primary Benefit(s)	**Financial Benefit(s)**
Ensure land availability for design approach to reduce risk of wastewater reaching surface waters in the event of a pipe break caused by seismic event.	Unknown
Project Timeline	
Expected Timeline for Completion	
Short term ☐ Mid term ☒ Long term ☐ Ongoing ☐	