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Brown AND Caldwell

West Linn Pipelines Land Use Application

Submittal Section 9

Safe Operations Plan for Raw Water and Finished Water Pipelines in West Linn

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1.0 Introduction

The purpose of this Safe Operations Plan is to document how the Lake Oswego-Tigard Water Partnership (Partnership) will assure the long-term integrity of its proposed Raw Water Pipeline (RWP) and Finished Water Pipeline (FWP). Safety during construction is addressed in the accompanying Construction Management Plan.

The cities of Lake Oswego and Tigard are committed to the safe operation of all elements of the proposed Partnership facilities, including the pipelines. In fact, the basic mission of the Partnership is to design, build, and maintain a safe, reliable, long-term water supply system that is resilient to multiple potential hazards, consistent with the critical importance of the system to public health and safety.

The citizens of Lake Oswego and Tigard will depend on the new water supply system at all times, but perhaps no more so than during and following an emergency or natural disaster. And the citizens of West Linn, in the event of damage to or malfunction of any key element of its water system or the South Fork Water Board supply facilities, will also rely on the Partnership's facilities, including the RWP and FWP for its backup source of supply. The Partnership's facilities will create the opportunity to access all four major sources of water in the region.

Given the importance of the proposed pipelines as key links in the local and regional water supply system, as well as the substantial investment to be made by Lake Oswego and Tigard water customers, a strong commitment to maintenance through asset management is warranted. This commitment is reflected in the Intergovernmental Agreement (IGA) that formed the Partnership. The IGA commits Lake Oswego and Tigard to an asset management program intended to maximize the service life of the system by performing timely monitoring, assessment, maintenance, and upgrades.

Safety during ongoing operations is focused on ensuring the continuous structural integrity of the pipelines. As with any pressurized pipeline, the issues to be addressed through design, construction, inspection, and maintenance include resilience against seismic events and protection from corrosion, internal pressure, and external loading. As an extra safeguard in the unlikely event that damage to either pipeline occurs, measures to tightly control the potential volume of water released are included. Key strategies are summarized below:

- **Conservative design.** A conservative engineering design process resulted in selection of robust pipeline materials and features able to protect the pipe against the full range of potential hazards, including the industry's highest seismic standard, during its 75- to 100-year design service life.

- **Thorough inspection and testing.** Careful construction inspection and a wide range of performance testing will validate that the pipelines are constructed as intended by the design engineers.

- **Proactive maintenance.** Routine ongoing monitoring and maintenance of the corrosion control system and isolation (shut-off) valves will ensure these components remain in good working order.

- **Regular condition assessment.** Pipeline condition assessment at regular intervals will confirm the condition of internal linings and external coatings to guide future decisions about timing for rehabilitation or replacement.
- **Attentive pumping oversight.** Pumping of water will be done only when operations staff are on duty at the Water Treatment Plant (WTP) to monitor the process so that the River Intake Pumping Station (RIPS) and the Finished Water Pumping Station (FWPS) at the WTP can be shut down immediately in the event of a problem with either pipeline.
- **Closely-spaced isolation valves.** In addition to the above safeguards, isolation (shutoff) valves will be installed at regular intervals along the pipelines to facilitate testing and maintenance and to limit the rate and volume of any water released in the unlikely event of a catastrophic pipeline failure.

Each of these items is described in more detail in the sections that follow.

2.0 Conservative Design Determines Robust Pipeline Materials and Features

A thorough, conservative, peer-reviewed design process, in accordance with the high standards of professional engineering care for the potable water industry, is being employed for all projects proposed by the Partnership. For the pipelines, this process led to selection of a system of pipe material, wall thickness, jointing method, and corrosion protection to positively address the full range of hazards to buried pipelines, including seismic events, corrosion, internal pressure, and external loading.

2.1 Seismic Hazards Mitigated by Welded Steel Pipe

Steel pipe with welded joints, regarded as the highest performing pipeline system available for resisting forces due to earthquakes, will be used for both the RWP and FWP. The joints will be secured with double lap welds, i.e., both inside and outside the pipe at each joint, in accordance with American Water Works Association (AWWA) Standard C206. Agencies such as the San Francisco Public Utility Commission and the Los Angeles Department of Water and Power routinely use this material for their new, critically important pipelines in seismically hazardous areas.

Though there are no recognized seismic design standards for pipelines, the Partnership has adopted the approach recommended by the American Society of Civil Engineers and the International Building Code for very important structures. This approach mitigates the hazards of an earthquake with a 2 percent chance of exceedance in 50 years (2,475-year return interval), the highest level accepted worldwide. This is the standard applicable to life sustaining structures such as hospitals and emergency response facilities. This return interval includes consideration of the magnitude 9.0 Cascadia Subduction Zone megathrust event. Compared to the push-on joints of the existing steel RWP and FWP, the new welded joint system will provide much greater seismic resilience.

Further discussion of the extensive investigations and analyses leading to selection of the applicable seismic design criteria and piping system is presented in the accompanying Seismic Design Memorandum in Section 9 of this land use application.

2.2 Corrosion Potential Controlled Using Multiple Barriers

Corrosion protection of the RWP and FWP will be accomplished by several barriers:

- **Cement mortar**, in accordance with American Water Works Association (AWWA) Standard C205, will likely be used to line the interior of the pipelines, thereby placing the inner steel surface in an alkaline, high pH environment to control this potential corrosion pathway. High-performance urethanes or epoxies may be approved alternatives to provide comparable interior corrosion protection.
- A **tape-coating system**, in accordance with AWWA Standard C214, will be used to wrap the exterior of the pipelines. The tape-coating system includes an adhesive and a two-part tape wrap: corrosion-preventive inner layer and mechanical-protective outer layer.
- An impressed current **cathodic protection system**, designed in accordance with National Association of Corrosion Engineers guidance, will provide an additional barrier to corrosion.
- Control of key **water quality parameters**, such as pH and alkalinity, at the WTP prevent the water chemistry from being suitable for corroding the interior of the pipeline.

2.3 Design Standards Ensure External Loads and Internal Pressures are Accommodated

The minimum steel pipe wall thickness selected is ¼ inch to accommodate the loading conditions the pipe could experience. This minimum wall thickness was selected to resist the highest seismic design standard, as discussed above. It also provides more than adequate strength for external loads (weight of overlying backfill material, pavement, and groundwater, and live loads from heavy trucks) as well as for internal peak operating and test pressures, in accordance with good practice outlined in AWWA M11, *Steel Water Pipe: A Guide for Design and Installation.*

Transient pressure waves, caused by sudden pump stoppage such as in a power outage, will be handled by a combination of the pipe wall thickness, a reliable surge control device (likely an air-filled surge tank) at the RIPS and FWPS, and air/vacuum release valves along the pipelines to exhaust air out, or allow air in, as needed, to dampen these short-term pressure fluctuations.

3.0 Thorough Inspection and Testing Assures Pipelines Constructed As Designed

Engineering designs are an important start in the process to achieve a reliable, long-lived pipeline. The next step is careful construction inspection and a battery of performance tests that will be used to assure the finished product matches the design.

The process begins with verification that all materials provided by the contractor meet or exceed the project specifications for a variety of requirements including dimensions, uniformity, strength, composition, source, and other measures of quality. This process continues during installation where an experienced pipeline construction engineer/inspector will oversee the process for compliance with contract requirements. Relevant items include careful handling of the pipe, proper care in placing and compacting bedding and backfill material, and high quality joint welds, both interior and exterior.

Performance testing is the final step and includes checks on such items as bedding/backfill compaction, electrical continuity of the cathodic protection system, and water tightness of each individual joint followed by a pressure test of the entire pipeline at 150 percent of its peak operating pressure.

4.0 Asset Management Assures Pipeline Longevity

The objective of asset management is to care for valued assets properly so they can reliably meet the required level of service at the least cost over their useful lives. Definition of several of these terms helps put this objective in perspective:

- **Level of service.** These pipelines are vital to public health and safety, therefore, they must remain in service at virtually all times, even during emergencies and natural disasters. As noted above, the selected design seismic event the pipelines are designed to withstand has an extraordinary recurrence period of 2,475 years. This includes the Cascadia Subduction Zone megathrust event with magnitude 9.0.
- **Least cost.** The substantial initial capital investment required warrants the utmost in operations and maintenance (O&M) care to ensure full useful life is attained. Nothing is more costly for ratepayers than premature replacement of valuable infrastructure. Least cost for these pipelines can be realized only through longevity.
- **Useful life.** These pipelines are designed with features to enable them to perform safely for a minimum of 75 to 100 years.

Proactive maintenance and regular condition assessment are two practices that will help meet the Partners' asset management objective for the RWP and FWP and are discussed below.

4.1 Proactive Maintenance Keeps Pipeline Components in Good Working Order

The cathodic protection system will be checked monthly to be certain that it is providing the level of protection needed. And each year, a corrosion engineer/technician will inspect, test, and make any adjustments needed to optimize its long-term performance.

Air/vacuum release valves will be checked and maintained annually.

Isolation valves will be exercised annually to be certain they will be fully functional if ever needed.

All O&M procedures will be documented in a O&M manual to be sure best practices are standardized and available to future generations of O&M staff.

4.2 Regular Condition Assessment Identifies Timing of Future Upgrades

Pipeline condition assessment will be conducted at regular intervals, approximately every 10 years, to confirm the condition of the pipelines. As these assessments are tracked over time, any changes in the internal lining and coating will be noted which will help inform decisions about timing for rehabilitation or replacement.

Condition assessment will consist of measures including the following:

- internal remote TV or physical-entry inspection of various sample reaches to observe the cement mortar pipe lining
- spot excavations to observe the exterior tape-coating pipe wrap
- detailed check on level of corrosion protection provided by the cathodic protection system and any needed optimization
- leak detection testing using an acoustical system to listen for water flow during periods when all pumps are shut down

The most recent condition assessment was conducted by the Partnership on the existing RWP and FWP in 2010. The 40+ year-old system was shown to be in very good condition with little significant change to the condition of pipe linings and coatings. No leaks were detected.

5.0 Attentive Pumping Oversight Prevents Pumping Through Damaged Pipeline

In addition to preventing problems through sound engineering, quality construction, and proactive asset management, two added safeguards will reliably prevent the release of any significant volumes of water, even in the unlikely event of a catastrophic pipe failure.

The first of these is to monitor the pumping process. The RWP and FWP convey water only when electric pumps at the RIPS and FWPS, respectively, are running. Because WTP processes and reservoir storage levels must be carefully monitored and controlled by skilled operations personnel, pumping of water through the RWP and FWP will be done only when operators are on duty at the WTP. In the unlikely event that either pipeline has a serious problem, a pressure drop would be detected in the pipeline as it leaves the pumping station and an alarm would alert an operator to shut off the pumping station immediately.

Operators are certified by the State of Oregon to safely operate water supply and treatment systems.

6.0 Isolation Valves Further Limit Potential for Water Release

Isolation (shutoff) valves will be installed at intervals of approximately 2,000 feet along the entire land-based alignment of the RWP and FWP. The valve closest to any damaged section of pipe can be closed within minutes by O&M staff or by local jurisdiction emergency crews.

For the FWP, once an isolation valve is closed, there is no reservoir of water available. With no pumps running, the potential water volume release consists of only the water in the pipe between the break and the nearest upgradient isolation valve. For the RWP, the only upgradient source of water is the volume in the pipe itself, since finished water from the clear well cannot backup through the WTP and re-enter the RWP.

If a pipeline break were to occur in the FWP, an estimated 500,000 gallons of water may be released. For the RWP, a water release of less than 100,000 gallons could be expected. In addition to erosion at the site of the break in the public right-of-way, some limited, localized erosion and private property damage is possible, though the rate of release may be handled by existing roadway drainage systems, particularly on Highway 43. No widespread or ongoing flooding damage is expected from these relatively small volumes.

Greater volumes of water are much more likely to be released from West Linn's aging, and in many cases, fragile, water distribution pipes and reservoirs than from the robust RWP and FWP.

7.0 Risk Factors for Pipeline Failure Are Positively Mitigated

In addition to local water distribution mains, large water transmission lines are in operation in cities throughout the U.S., including the Portland metropolitan area. In many cases, these lines run through residential areas. Compared to the major water lines for large cities serving millions of people, the proposed RWP and FWP (at 42- and 48-inch-diameter, respectively) are relatively small and under low internal pressure and low external loading.

Major pipeline failures are almost always due to advanced pipe age, combined with one or more of the following:

- lower quality materials, such as cast iron or asbestos cement
- lower quality pipe jointing method, such as unrestrained push-on joints
- lack of condition assessment efforts to identify deterioration of pipe material and linings/coatings
- deferred maintenance and rehabilitation/replacement projects even though poor condition is known
- limited to no protection against corrosion
- aggressively corrosive soil and/or source water

For the proposed RWP and FWP, none of these risk factors apply. State-of-the-art materials, jointing, corrosion protection, and asset management practices will be employed. In addition to these strategies, prudent operational practices and a valving system will limit the volume of water that could be discharged, even if a catastrophic pipe failure occurred.

The Partnership appreciates the seriousness of constructing large-diameter water transmission pipelines through residential communities and is committed to designing, constructing and maintaining a robust, reliable piping system that poses minimal risk to adjacent properties and residents, both in West Linn and throughout the pipeline alignments as they traverse Gladstone, Lake Oswego, and Tigard.