Technical Memorandum

TO: City of Sandy – Jenny Coker, Public Works Director

FROM: Keller Associates, Inc. – Jason King, PE; Jesse Fields, PE

DATE: September 30, 2022

SUBJECT: Sandercock Reservoir Inspection and Recommendations

BACKGROUND

The Sandercock Lane Reservoir is a 0.5-million-gallon welded steel, ring foundation water storage tank in Sandy, Oregon. It has a diameter of 52 feet and a height of 32 feet. The tank was built by American Tank Company in 1966. The exterior was painted eighteen years ago and has not been cleaned since. The tank inlet and outlet were previously replumbed to penetrate the tank at the side wall, and the existing floor penetrations were sealed. The City noted severe leaking from the tank and wishes to discover the cause of the leak and perform the repairs necessary to stop it. On June 15th, 2022, an inspection of the reservoir interior was completed by attendees from Cathodic Protections Engineering (CPE), The Saunders Company, MJE Industrial, and Keller Associates. The findings of this inspection and an additional exterior surface inspection, performed by CPE, are summarized in the proceeding sections along with recommendations for improvements and repairs.

FIGURE 1 – VICINITY MAP

OBSERVATIONS

The site is accessed by a gravel road, extending from Sandercock Lane off Highway 26. The tank sits on a forested lot, and the site around the tank is well maintained. An emergency overflow and drain line extend from the tank to a drainage way located on site. The City indicated the lot size is large enough that another tank could be constructed on the site to supply water for current and future development. The tank appears in good general condition for its age.

The City staff discussed the process to drain the tank and keep it offline. Currently, there is no SCADA operational scenario programmed to bypass this tank. Operators manually bypass relays at the pump station that feeds the tank's distribution network to maintain system pressures and adjust field valve positions to take the tank offline.

Appendix A contains additional inspection photos.

FIGURE 2 – TANK EXTERIOR

The exterior of the tank showed visible signs of dirt accumulation but did not show any indications of major paint degradation except in spots on the exterior roof access ladder. A simple tank wash down will remove the soil accumulation and facilitate future external coating assessment. Access to the roof ladder requires walking on the corrugated roof of the adjacent valve shed. This presents a safety concern and fall hazard. The roof appears in excellent condition. Several low points on the roof retain water and soil/debris.

Visual inspection of the tank ring foundation indicates good condition with very minor cracking, and no upheaving or differential settlement was observed. The tank is not anchored to the foundation, but there is

no indication of slippage. Discussions with City staff revealed that the tank visibly leaks from between the tank wall-to-floor seal and the foundation to the point of saturating the soil, pooling on the ground, and filling the valve shed with water. Vegetation in the vicinity of the leak was bleached. The City tested the water, confirming it contains traces of chlorine, suggesting the water is, in fact, coming from the water system and not a groundwater source.

Tank Interior

Minimal coating loss or damage was observed on the inside tank walls in the water storage zone. The atmospheric zone above the water storage zone showed signs of metal loss in the form of dark rust staining and delamination of the structural steel, and several of the vertical support rods used for the original installation were corroded to the point of separation.

FIGURE 3 – DELAMINATION OF TANK STEEL AT ROOF ACCESS HATCH

The tank floor was littered with random material deposits, approximately one inch in diameter, several of which showed signs of significant wall loss, up to a quarter inch deep. This likely results from galvanic corrosion from exposed steel coating pinholes. The welds for the tank floor panels all appeared to be in good condition.

A leak was identified in the tank floor at the overflow pipe penetration. Water and debris were visibly passing through a crack between the tank floor and overflow pipe at the time of inspection. A previous attempt to seal the penetration with epoxy made it difficult to identify the extent of the leak. The newer inlet and outlet penetrations in the tank wall and sealed penetrations at the tank floor all appeared intact and free of leaks.

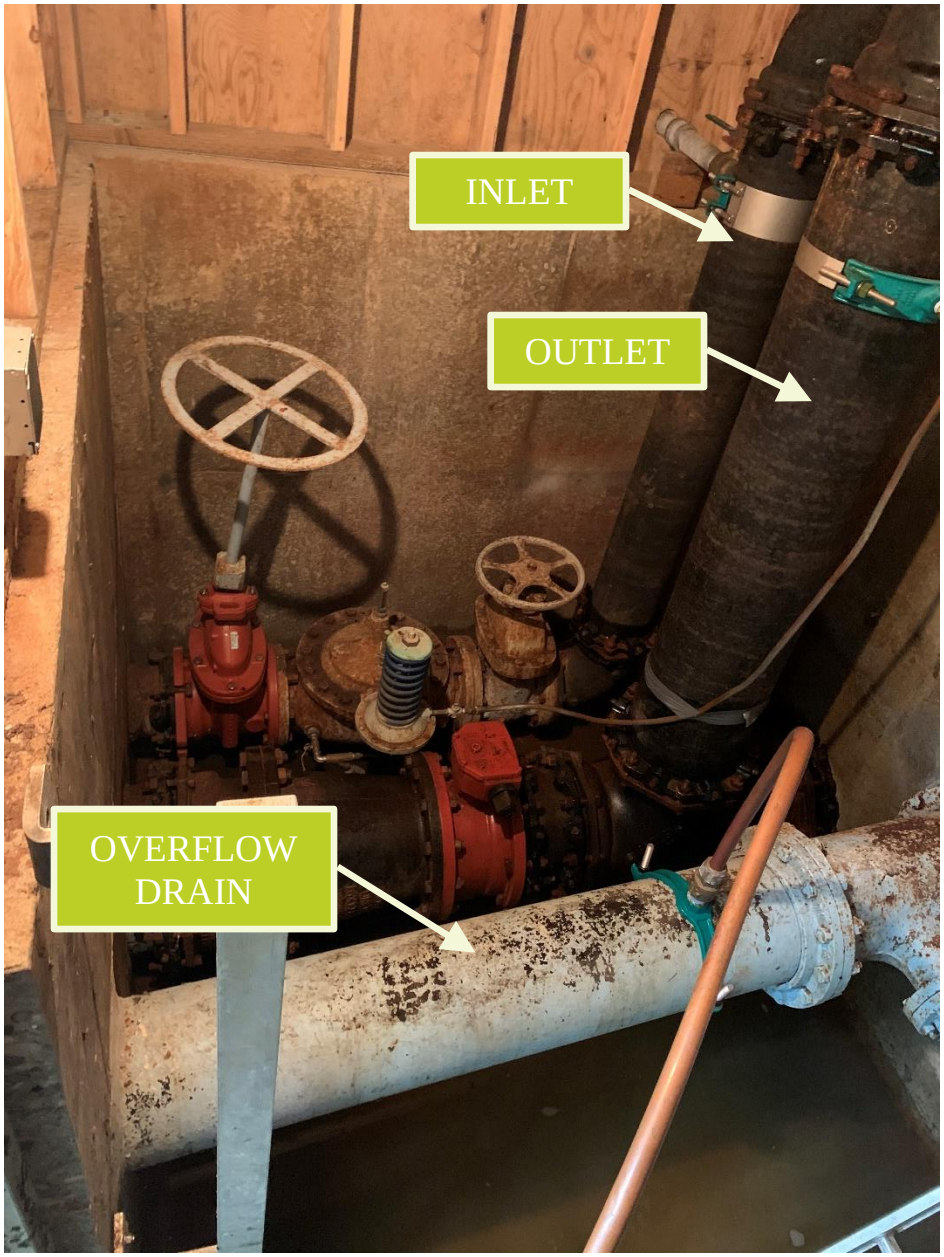
While walking around inside the tank, there were noticeable areas where the tank floor deflected from the weight, indicating the foundation material beneath the tank floor had settled and/or been washed away, presumably magnified by the leaking water.

FIGURE 4 – TANK FLOOR PITTING

Valve Shed

The valve shed is constructed of an open concrete vault foundation with an enclosed wood framed structure built over the top. Mechanical components inside include a dedicated inlet (looked to be 8-inch diameter), with a piloted control valve and two gate valves for isolation; a dedicated 12-inch outlet (increases to 16-inch before penetrating vault wall), with a butterfly valve for isolation; and a combined drain/overflow line that discharges to an onsite drainage way. A telemetry panel with a pressure transducer for monitoring tank level is also located in the valve shed. At the time of the inspection, a sump pump was hard piped into the reservoir drain line to remove leaked water from the vault. City staff indicated that the vault has a floor drain, but it is currently clogged.

FIGURE 5 – VALVE SHED MECHANICAL



RECOMMENDATIONS

Tank Exterior

The exterior of the tank, ladder, and ring wall should be cleaned and pressure washed for general maintenance. A safer means for accessing the ladder, such as a raised platform or catwalk type scaffolding, should be constructed to eliminate the existing fall hazard. In lieu of a raised platform or catwalk, the existing ladder could potentially be relocated to avoid the need for gaining access from above the valve house, these alternatives should be evaluated for cost/benefit in future design phases. In either alternative, the existing fall protection track should be removed as it is not in use and is now a hazard.

While the exterior coating appears to be in decent condition, the cost estimate shown in **Figure 6** includes an optional coating cost for City consideration.

Tank Interior

The internal surfaces of the tank walls and structural supports above the water storage zone should be sandblasted clean, inspected further, and repaired, as needed based upon the inspection results. Once repairs are completed, all surfaces in the atmospheric zone should be primed and painted with a high-quality NSF 61 coating system. The tank floor and walls should be pressure washed to remove the material deposits, and the integrity of the steel wall loss and corrosion locations should be evaluated. Areas identified with substantial floor and wall pitting should be repaired, prepped, and coated a high-quality NSF 61 coating system.

Repair the overflow pipe floor penetration. At the time of inspection, it was difficult to determine the condition of the overflow pipe. However, based on available information, it is assumed that a section of the pipe will need to be replaced to complete the repair. Additionally, the floor-to-pipe penetration should be reinforced to prevent future separation. A section of the tank floor plate around the overflow pipe should be removed and below grade piping inspected for condition and material type. The under-reservoir piping should be replaced if heavy corrosion or damage is observed. The pipe penetrating the tank floor must be steel for a proper weld. After repair or approval of the overflow piping, it should be backfilled with sand or controlled density fill before repairing the tank floor. Repair of the tank floor around the overflow piping should include a thick steel plate (thickness TBD) with a lap joint weld. The weld at the pipe penetration should be of a complete joint penetration type to ensure a strong bond between the pipe and the tank floor. All repairs must be recoated with an NSF 61 coating system.

Areas of the foundation material beneath tank floor (likely sand) have either been wash away or settled, resulting in floor deflection when walked on during the inspection. When the tank is full, the floor will also deflect, which may cause the separation between the tank floor and the overflow penetration and, thus, cause the leak. It is recommended that the tank floor support be improved by filling the void areas with injected grout or epoxy.

Cathodic Protection

Cathodic protection is commonly used in conjunction with coating systems to protect damaged coating areas where bare steel is exposed to water (i.e., installation damage or coating pinholes). To maximize the useful life of this tank, installation of a low maintenance galvanic cathodic protection system is recommended. The system would consist of magnesium anodes and an anode control box. If installed, a site-specific inspection training should be performed to train the utility operators to monitor the system performance and identify abnormal operating conditions.

Foundation

Evaluation of the ring foundation condition did not indicate any immediate need for improvements. Ring foundations typically require additional anchorage or reinforcement, if the height to diameter ratio is greater than 0.70. The existing tank has a height to diameter ratio of 0.61. Additionally, the visual inspection of the foundation did not reveal any issues with tank slipping, upheaving, or significant cracking/settlement. If seismic conditions are considered in the future, the final section of the report discusses methods to increase resiliency.

FIGURE 6 – OPINION OF PROBABLE COST

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PRELIMINARY OPINION OF PROBABLE COST

CLIENT:	**City of Sandy, OR**	**AACE Estimate Class:**	**5**
PROJECT :	**Sandercock Reservoir Recommended Repairs**	ACCURACY HIGH	50%
KA JOB # :	**222200-001**	ACCURACY LOW	-50%
LOCATION :	**Sandercock Lane, Sandy, OR**	**DATE :**	18-Oct-2022
		REVIEWED:	J. King

Project Element		Cost
Exterior cleaning		$ 12,000
Raised platform		$ 15,000
Tank surface prep and coating - full exterior *(Optional)*		$ 140,000
Tank surface prep and coating - interior atmospheric zone only		$ 190,000
Overflow pipe leak repairs and coating - assumes adequate existing overflow pipe		$ 25,000
Floor repairs and coating		$ 30,000
Floor support material injection		$ 20,000
Cathodic protection system		$ 20,000
	Subtotal:	$ 460,000
Contractor Overhead and Profit	10%	$ 46,000
Contingency	30%	$ 138,000
	Subtotal:	$ 650,000
Mobilization	10%	$ 65,000
	Total Project Cost:	**$ 720,000**
	Total Project Cost (Minus Exterior Coating):	***$ 500,000***

Estimated Range of Cost		
Low	Mid	High
50%	100%	150%
$ 360,000	**$ 720,000**	**$ 1,080,000**

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our professional opinion of accurate costs at this time and is subject to change as the project design matures. This cost opinion is in 2022 dollars and does not include escalation to time of actual construction. Keller Associates has no control over variances in the cost of labor, materials, equipment, services provided by others, contractor's methods provided by others, contractor's methods of determining prices, competitive bidding or market conditions, practices or bidding strategies. Keller Associates cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented herein.

MATERIAL LEAD TIMES

In the current market of municipal utility improvements, material leads times must be taken into consideration during the design of projects. Municipal water system components that have recently been creating project delays due to lead times include, but are not limited to gate and butterfly valves, control valves, ductile iron pipe and fittings, steel pipe and fittings, electrical components, and controls. For this repair project, steel pipe potentially needed for the overflow repair may possess a lead time consideration. Current discussions as of the date of this report with steel pipe suppliers is that lead times are very much specification dependent and are frequently subject to change. Specification can be flexible within feasibility to accommodate lead times for the low-pressure application of the overflow pipe penetration to mitigate potential delays in this project.

FUTURE CONSIDERATIONS

Seismic Considerations

The height to diameter ratio is such that foundation anchorage is likely not required for seismic conditions; however, the existing freeboard may be inadequate for seismic sloshing. Further analysis is required to determine adequate tank freeboard. If available tank freeboard is not adequate, potential solutions include raising the roof, reinforcing the roof, or lowering the high-water level.

The existing pipe connections are not suitable for seismic conditions. Seismic pipe assemblies are recommended for the inlet and outlet pipes. Seismic valves and sensors detect seismic events and will automatically close the inlet and outlet to prevent loss of the stored water in the event of a line break. The tank vent should be evaluated to ensure proper venting and to avoid tank collapse if the tank drained during a seismic pipe break event. A SCADA system should be installed to monitor a seismic condition and allow remote actuation of valves.