

Based on these assumptions, it was projected that the participating utilities would experience a total of about 360 sewer collapses and about 90 manholes replacements as a result of a Cascadia subduction zone earthquake.

## Assessment of Water and Wastewater Structures

Participating utilities also compiled available data on the construction and age of critical water and wastewater facilities, such as treatment plants, pump stations, and reservoirs. To identify the degree and severity of likely failures of existing facilities, the task group compared the age distribution of existing facilities to the building code seismic requirements that were in effect at the time the facilities were constructed. Figure 8.22 is an example of the typical output that the task group used to estimate (for each utility) the damage that facilities may experience.

Based on this preliminary assessment, the following general observations were made regarding existing key structures:

- Reservoirs and Tanks
  - Nearly all reservoirs and tanks are likely to experience some damage at the connection between the buried pipe system and the reservoir structure.
  - 33 percent of total tankage was built before 1960 and had no lateral force requirements—these tanks will most likely fail and release contents.
  - 30 percent of total tankage was built between 1960 and 1970 and had only a .06 gravity lateral force requirement—tanks that are near the epicenter will most likely fail and release contents.
  - 12 percent of total tankage was built between 1970 and 1990 and had only a .12 gravity lateral force requirement—tanks that are close to the epicenter will most likely fail and release contents.
  - 12 percent of total tankage was built between 1990 and 2000 and had somewhat more stringent lateral force requirement—these tanks will most likely suffer some damage, but may not release contents.
  - 13 percent of total tankage was built after 2000 and had stringent lateral force requirements—these tanks will most likely remain intact.
- Pump Stations
  - Nearly all pump stations are likely to experience some damage at the connection between the buried pipe system and pump station structure.
  - 13 percent of pump stations were built before 1960 and had no lateral force requirements—these stations will likely fail structurally and mechanically.

- Replacing vulnerable pump stations built before 1970; hardening (as needed) pump stations that were built after 1970 so that they meet current standards.
- Replacing flow control equipment when it reaches the end of its current economic life.
- Rebuilding and redesigning transitions between soft piping, such as mains and hard piping at tanks and pump stations.
- Replacing 20 to 30 percent of the transmission systems using more earthquake resistant design standards and more earthquake resistant materials.
- Replacing 20 to 30 percent of the distribution systems using more earthquake resistant design standards and more earthquake resistant materials.
- Replacing tankage built before 1960 with earthquake resistant designs.
- Hardening tankage built after 1960 so that it meets current codes.
- Incorporating seismic resilience objectives into future capital improvement projects.

For typical systems, potential improvements needed to achieve performance goals in the Valley zone include (dates provide only general guidance):

- Hardening existing transmission facilities (river crossings, bridges, liquefaction, landslide areas, etc.) where possible.
- Replacing existing vulnerable transmission facilities where hardening is impractical or impossible.
- Installing additional line valves to isolate damaged sections.
- Stockpiling critical replacement pieces.
- Hardening valve and other control facilities.
- Providing for vacuum relief valves where needed to prevent pipeline collapse.
- Installing earthquake shutoff valves at appropriate locations, such as selected storage facilities and areas of the distribution system that are highly vulnerable.
- Replacing pump stations built before 1970; hardening pump stations built after 1970 so that they meet current standards.
- Replacing flow control equipment when it reaches the end of its current economic life.
- Rebuilding and redesigning transitions between soft piping, such as mains and hard piping at tanks and pump stations.
- Replacing 80 to 90 percent of the transmission facilities using more earthquake resistant materials.

- Replacing 20 to 30 percent of the distribution systems using more earthquake resistant design standards and more earthquake resistant materials.
- Replacing tankage built before 1960 with tankage of earthquake resistant design.
- Hardening tankage built after 1960 so that it meets current code.
- Incorporating seismic resilience objectives into future capital improvement projects.

### ***Wastewater Systems***

Notable performance gaps include the following:

- Threats to public health and safety are expected to exist for one to three years on the Coast and six months to a year in the Valley.
- Less than 90 percent of the raw sewage is expected to be contained or routed away from the population centers for one to three years on the Coast and for six months to a year in the Valley.

Research is required to develop sewer designs that will be resistant to permanent ground deformation resulting from a Cascadia subduction zone earthquake.

For typical systems, potential improvements needed to achieve performance goals in the Coastal zone include:

- In liquefiable soils, replacing 50 to 60 percent of the collection system with more earthquake resistant materials.
- In liquefiable soils, replacing 50 to 60 percent of the trunk lines with more earthquake resistant materials.
- Relocating or seismically upgrading wastewater treatment plants built before 2000 and all treatment plants built in areas subject to liquefaction.
- Rebuilding or seismically hardening pump stations built before 2000.
- Providing for emergency power and emergency treatment chemicals.
- Incorporating seismic resilience objectives into future capital improvement projects.

For typical systems, potential improvements needed to achieve performance goals in the Valley zone include:

- In liquefiable soils, replacing 50 to 60 percent of the collection system with more earthquake resistant materials.
- In liquefiable soils, replacing 80 to 90 percent of the trunk lines with more earthquake resistant materials.