

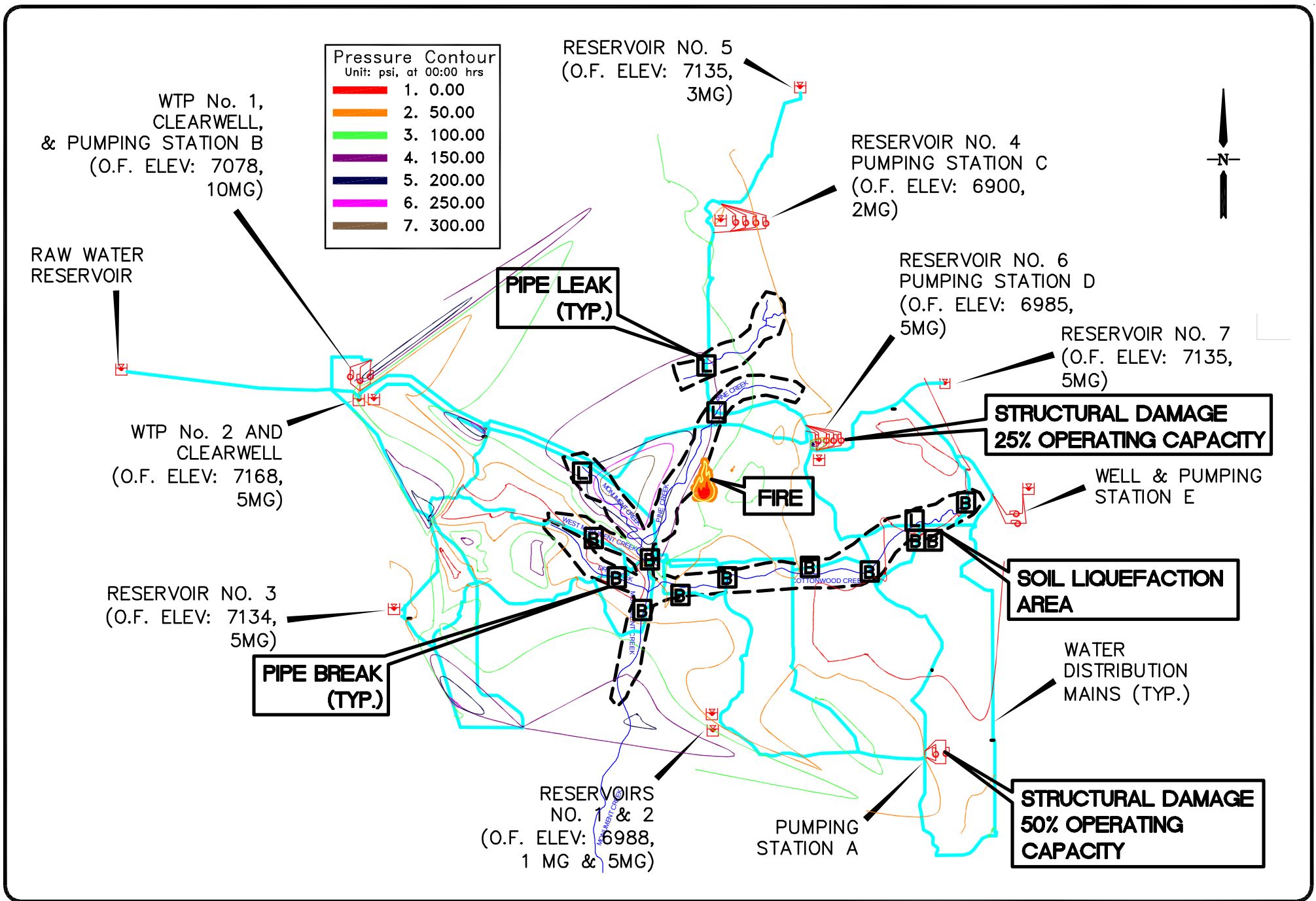


Figure 24. Hypothetical Earthquake As It Occurs
(hydraulic pressure contours -- psi)

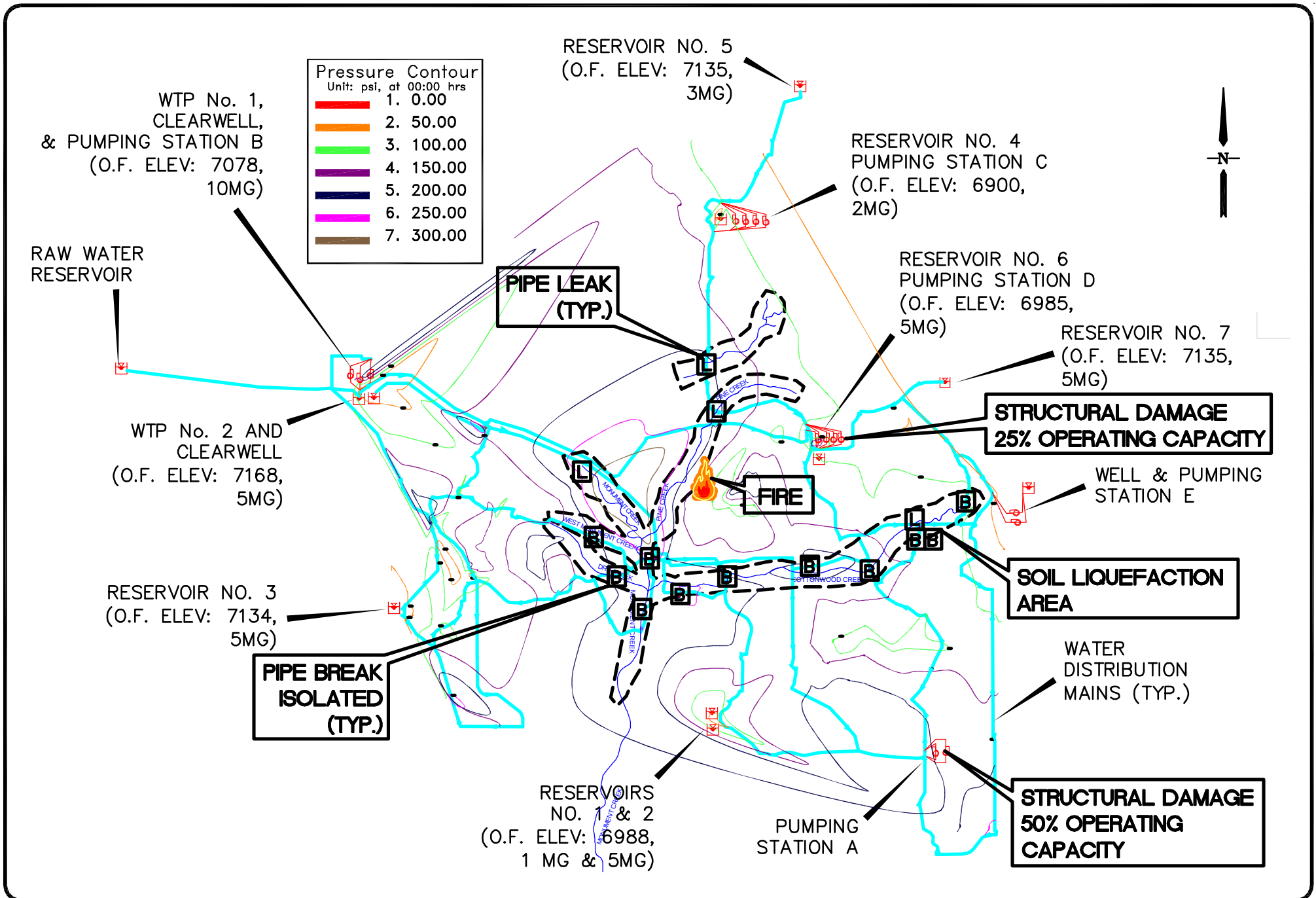


Figure 25. Pipe Breaks Isolated After Hypothetical Earthquake
(hydraulic pressure contours -- psi)

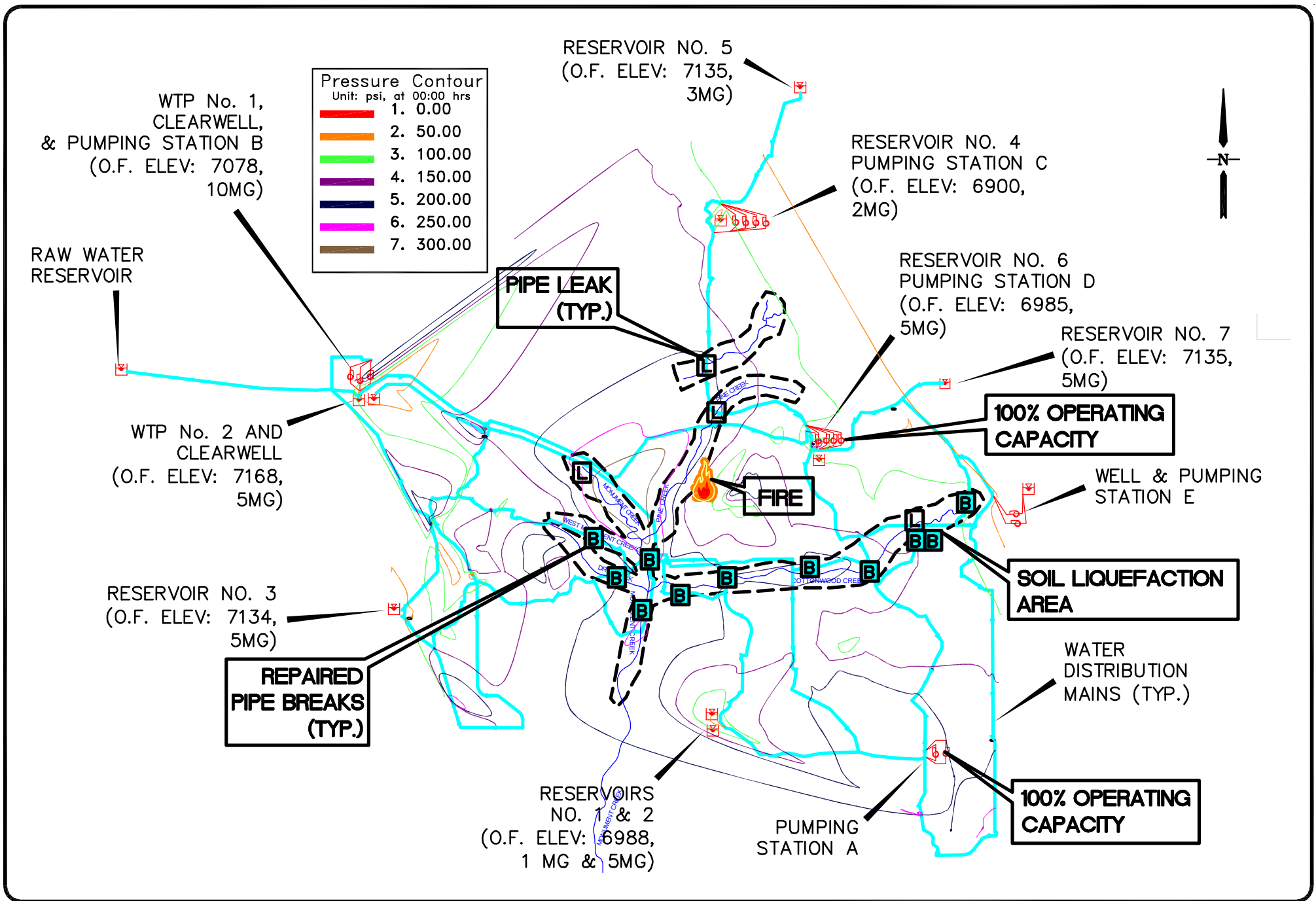


Figure 27. Pumping Stations and Pipe Breaks Repaired After Hypothetical Earthquake
(hydraulic pressure contours -- psi)

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Terms and Definitions

Acceleration. The rate of change of velocity. As applied to strong ground motions, the rate of change of earthquake shaking velocity of a reference point. Commonly expressed as a fraction or percentage of the acceleration due to gravity (g), wherein $g = 980 \text{ cm/s}^2$.

Active Fault. An earthquake fault that is considered to be likely to undergo renewed movement within a period of concern to humans. Faults are commonly considered to be active if they have moved one or more times in the last 10,000-11,000 years, but they may also be considered potentially active when assessing the hazard for some applications even if movement has occurred in the last 500,000 years. See **fault**.

Adverse Consequences. Those negative consequences of a particular event, including property damage, injuries, deaths, illnesses, business interruption losses, lost productivity, psychological setbacks, loss of family and group cohesion, defaults, job losses, environmental degradation, looting, and so on. Many of these negative consequences can be subjected to quantifiable measures. Typically these negative consequences are defined relative to specific stakeholders.(modified from FEMA, 1997)

Alluvium. A soil type consisting of loosely compacted gravel, sand, silt, or clay deposited by streams.

Amplification. An increase in seismic wave, wind speed or storm surge amplitude as they propagate through certain soils, tunnels, or embayments.

Annualized Loss. The loss per annum due to hazards, calculated as the probabilistic loss contribution of all events. Annualized loss is expressed as a probability distribution of loss per annum. The expected annual loss is the expectation of the probability distribution of loss per annum, and under certain assumptions may be calculated as the probability—weighted average—of loss due to all possible hazard events.

Attenuation. The rate at which seismic, wind, or water intensities decrease with distance from their sources or shoreline landing points.

Average (Expected) Annualized Loss, (AAL). See **Annualized Loss**.

Base Isolation. A structural design concept that reduces the magnitude of lateral response by preventing earthquake ground motion from being transmitted from the foundation into the building superstructure. Application is accomplished through the installation of isolator bearings at all of the connections between the structure and the foundation. The isolators are vertically stiff, capable of supporting vertical gravity loads, while being laterally flexible, capable of allowing large horizontal displacements. In effect, the ground is allowed to move back and forth under a base isolated building during an earthquake, while leaving the building to remain

“stationary.” In practice, the amplitudes of motion transmitted into the building are substantially reduced.

Baseline Risk. The existing risk, under current or as-is conditions.

Blizzard. A combination of heavy snowfall, high winds, extreme cold, and ice storms. (FEMA, 1997)

Business Interruption (BI) Loss. Economic loss associated with loss of function of a commercial enterprise.

Canal. A free-flowing gravity-water conduit, open to the atmosphere, and usually at grade. A canal may be lined or unlined. (ALA, 2001, modified by LeVal Lund, 9/19/01)

Coastal Erosion. A hydrologic hazard defined as the wearing away of land and loss of beach, shoreline, or dune material as a result of natural coastal processes or manmade influences. (FEMA, 1997) A hydrologic hazard defined as the eroding of land and loss of beach or shoreline as a result of natural processes or manmade influences. (9/19/01 by LeVal Lund)

Combined Event. An event consisting of the simultaneous occurrence of two or more natural hazards. (modified from ANS, 1978, p. 1)

Compaction. The uniform or differential settlement of loose soils or poorly consolidated alluvium as a result of ground shaking or applied overburden.

Component Damage Algorithm or Model. A procedure or function for estimating damage to a component subjected to a natural hazard event. (modified from ALA, 2001)

Component Downtime Model. A component vulnerability model or function relating the degree of downtime for the component as a function of its damage state. Can be combined with a component damage model to produce a model relating downtime to hazard severity.

Component Fragility Curve. A mathematical expression, represented graphically as a curve, that relates the probability of a component reaching or exceeding a particular damage state, given a specific level of a hazard. (modified from ALA, 2001)

Component Loss Algorithm or Model. A component damage algorithm or model in which component repair costs are the defined damage states.

Conduit. A free-flowing conduit can be an open channel or ditch, or may be a tunnel flowing partially full. A pressurized conduit can be a pipeline or tunnel flowing under internal pressure. An open channel can be a canal or a flume. (ALA, 2001) A free-flowing gravity water conduit, rectangular, oval, or circular in shape. A pressurized conduit is a conveyance facility flowing water under internal pressure. (LeVal Lund, 9/19/01)

Connectivity Matrix. A matrix which indicates for each node and link modeled in the water system whether or not a node and/or link is immediately connected to another node and/or link, and whether water flows from the first node/link to the second node/link. Non-functioning nodes and/or links are not connected to other nodes and/or links.

Damage. Physical disruption, such as cracking in walls or overturning of equipment (often used synonymously but erroneously with **Loss**).

Damping. The dissipation of energy in the process of viscous flow, deformation of viscoelastic materials, frictional sliding, or permanent material deformation or yielding (hysteretic damping).

Decision Under Risk. A decision in which decision-makers must take a chance on an unknown future whose chances are known with certainty (e.g., a wage on a gamble whose odds are known).

Decision Under Risk and Under Uncertainty. A decision in which decision-makers must take a chance on an unknown future whose chances are calculated, but where these calculations do not objectively incorporate the uncertainties in all pertinent parameters.

Decision Under Uncertainty. A decision in which decision-makers must take a chance on an unknown future whose chances are unknown.

Dependent Events. Event combinations for which the occurrence of one event gives information about (increases or decreases) the possibility of the occurrence of the other event. For example, the occurrence of a hazard such as an earthquake may increase the chance of headwater flooding. For another example, the occurrence of a drought may increase the chance of a subsequent wildfire. (modified from ANS, 1978, p. 1)

Deterministic-. A method of engineering and decision-making evaluation based solely on the selection of a few natural hazards events used as scenarios. For instance, a previous flood may be used as the basis for a scenario evaluation of what would happen if that flood recurred. Methods that are thoroughly deterministic are based on source models and intensity propagation methods that exclude **random effects**.

Deterministic-Based System Performance Metrics. System performance metrics based only on a deterministic evaluation of the system.

Distribution Storage Reservoir. Most water systems include various types of storage reservoirs in their distribution systems. Storage reservoirs can be either tanks or open-cut reservoirs. (ALA, 2001) A water storage reservoir used for daily or maybe weekly variation in demand and also includes capacity for fire suppression. Distribution water storage reservoirs can be either tanks or excavated basin, lined or unlined, covered or uncovered. Seasonal storage reservoirs store water for seasonal variation in demand and climatic variations in supply. (LeVal Lund, 9/19/01)

Distribution Water System. The system that delivers treated water to customers for end use from the supply. Most water distribution systems in the United States deliver treated water for drinking, sanitary, irrigation, commercial, industrial, and fire flow purposes. In some cities, separate distribution systems are built to deliver reclaimed water for irrigation or industrial purposes or ground water recharge or to supply water to fire hydrants. (ALA, 2001; modified by LeVal Lund, 9/19/01)

Ductile Detailing. Design details specifically intended to achieve an intended stable yielding mechanism in a building structure or equipment support structure. For example, special requirements for the placement of the reinforcing steel within structural elements of reinforced concrete and masonry construction necessary to achieve non-brittle, ductile behavior (**ductility**). Ductile detailing may include close spacing of transverse reinforcement to attain confinement of a concrete core or to prevent shear failures, appropriate relative dimensioning of beams and columns and 135 degree hooks on lateral reinforcement.

Earthquake. A sudden ground motion or trembling caused by an abrupt release of accumulated strain acting on the tectonic plates that comprise the Earth's crust. (FEMA, 1997) A sudden motion or trembling in the earth caused by the abrupt release of slowly accumulated strain. (Bates and Jackson, 1980)

Earthquake Hazard. The representation of an earthquake hazard can cover ground shaking, response spectra (peak spectral acceleration, peak spectral velocity, peak spectral displacement), peak ground velocity, peak ground acceleration, duration of significant shaking, time-history evaluation, and/or permanent ground deformation including fault offset. (modified from ALA, 2001)

Energy Dissipation Systems. Various structural devices that actively or passively absorb a portion structures of the intensity in order to reduce the magnitude or duration (or both) of a structure response. These devices include active mass systems, passive visco-elastic dampers, tendon devices, and **base isolation**, and may be incorporated into the building design.

Epicenter. The projection on the ground surface directly above the **hypocenter** of an earthquake.

Expansive Soils. The swelling or shrinking of soils and soft rock as a result of changes in moisture content. (FEMA, 1997)

Exposure. The number, types, qualities, and monetary values of various types of property or infrastructure, life, and environment that may be subject to an undesirable or injurious hazard event. (modified from FEMA, 1997)

Exposure Period. The period of time over which risk is to be computed; the period of time over which a facility or population at risk is subjected to a hazard.

Falls and Topples. Detachment of masses of rock or other materials from a steep slope or cliff and their descent by free fall, rolling, or bouncing. (FEMA, 1997)

Fault. A fracture along which there has been significant displacement of the two sides relative to each other parallel to the fracture. *Strike-slip faults* are predominantly vertical fractures along which rock masses have mostly shifted horizontally. If the block opposite an observer looking across the fault moves to the right, the slip style is termed right lateral; if the block moves to the left, the motion is termed left-lateral. *Dip-slip faults* are inclined fractures along which rock masses have mostly shifted vertically. If the rock mass above an inclined fault is depressed by slip, then the fault is termed *normal*, whereas if the rock above the fault is elevated by slip, then the fault is termed *thrust* (or *reverse*). *Oblique-slip faults* have significant components of both slip styles.

Fault Rupture. The differential movement of two land-masses along a fault. A concentrated, permanent deformation that occurs along the **fault trace** and caused by **slip** on the fault. (modified from AWWA, 2001)

Fault Scarp. A step-like linear land form coincident with a **fault trace** and caused by geologically recent **slip** on the fault.

Fault Trace. An intersection of a fault with the ground surface; also, the line commonly plotted on geologic maps to represent a fault.

Flooding. The accumulation of water within a water body and the overflow of excess water onto adjacent floodplain lands. (FEMA, 1997) a rising body of water (as in a stream, lake, or sea, or behind a dam) that overtops its natural or artificial confines and that covers land not normally under water; esp. any relatively high streamflow that overflows its banks in any reach of the stream, or that is measured by gage height or discharge quantity. (Bates and Jackson, 1980)

Flood-coastal. Abnormally high water on open and semi-enclosed bodies of water resulting from storm surge and tsunami, precipitation, tide, wind-wave activity, and possible flood at nearby stream. (ANS, 1978, p. 1)

Flood-lake. Abnormally high water on enclosed bodies of water resulting from high lake level, storm surge and seiche, precipitation, wind-wave activity, and possible flood of nearby stream. (ANS, 1978, p. 1)

A Floodplain. The land adjoining the channel of a river, stream, ocean, lake, or other watercourse or water body that is susceptible to flooding. (FEMA, 1997)

Flood-river. Abnormally high water on an inland stream resulting from precipitation and snowmelt runoff, possible ice blockage, wind-wave activity, and possible dam failure or stream diversion. (ANS, 1978, p. 1)

Flows. Shear strains distributed through the mass of material. Unlike slides, flows have high water content and the distribution of velocities resembles that of viscous fluids. (FEMA, 1997)

Flume. A free-flowing conduit, usually open to the atmosphere and usually elevated. A flume is typically built from wood or metal with wood or metal supports. (ALA, 2001)

Frost Heave, Frost Heaving. The uneven lifting or upward movement, and general distortion, of surface soils, rocks, vegetation, and structures such as pavements, due to subsurface freezing of water and growth of ice masses (esp. ice lenses); any upheaval of ground caused by freezing. (Bates and Jackson, 1980)

Fragility. See Vulnerability Model.

Frequency. See Probability and Frequency.

Fundamental Period. The longest period of oscillation for which a structure shows a maximum response (the reciprocal of natural frequency).

Ground Failure. A general reference to fault rupture, liquefaction, landsliding, and lateral spreading that can occur during an earthquake or other land movement causes.

Ground Shaking. The energy created by an earthquake as it radiates in waves from the earthquake source. A general term referring to the qualitative or quantitative aspects of movement of the ground surface from earthquakes. Ground shaking is produced by **seismic waves** that are generated by sudden slip on a fault and travel through the earth and along its surface. (modified from AWWA-M19, 2001)

Hazard. An event or physical condition that has the potential to cause fatalities, injuries, property damage, infrastructure damage, agricultural loss, damage to the environment, interruption of business, or other types of harm or loss. (FEMA, 1997) A chemical or physical condition that has the potential for causing damage to people, property, or the environment. (AWWARF, 1998)

Hazard Event Identification. The process of defining the source of a specific hazard, including its magnitude and source location. For modeling events probabilistically, expected frequency of occurrence of the initiating hazard as a function of its severity and location also needs to be modeled.

Hazard Identification. The process of defining and describing a hazard, including its physical characteristics, magnitude and severity, probability and frequency, causative factors, and locations/areas affected. (FEMA, 1997)

Hypocenter. The location within the earth of initial radiation of **seismic waves** caused by faulting action.

Intensity. A judgmental numerical index describing the severity of a hazard in terms of its effects on the ground surface and on people, structures, and the environment.

Iso-intensity. A contour line of a map bounding points of equal intensity for a particular hazard.

Landslide. The downward and outward movement of slope-forming earth materials reacting under the force of gravity. The term covers a broad category of events, including mudflows, mudslides, debris flows, rock falls, rock slides, debris avalanches, debris slides, and earth flows. When slopes lose shear strength because of a disturbance such as ground shaking. (modified from FEMA, 1997 and AWWA-M19, 2001)

Land subsidence. The loss of surface elevation owing to the removal of subsurface support. Settlement of the surface of the ground, usually occurring over a large area, sometimes precipitated by a removal of water or oil. (modified from FEMA, 1997)

Lateral Spreads. The landsliding of gentle, water-saturated slopes with rapid fluid-like flow movement caused by ground shaking and liquefaction. Large elements of distributed, lateral displacement of earth materials. (modified from FEMA, 1997)

Linear System or Sub-system, see **Series System or Sub-system.**

Liquefaction. When the pressure of the pore water, water located in spaces between soil particles, exceeds particle friction forces, particularly in loose sands with high water content. The soil becomes a soil-water slurry with significantly reduced shear strength. The result can be foundation bearing failure, differential settlement, lateral spreading, or floating of underground components. A process by which water-saturated soil temporarily loses shear strength due to build-up of pore pressure and acts as a fluid. (modified from AWWA-M19, 2001)

Local Seismic Hazards. The phenomena and/or expectation of an earthquake-related agent of damage, such as vibratory ground motion (i.e., ground shaking), inundation (e.g., tsunami, seiche, dam failure), various kinds of permanent ground failure (e.g., fault rupture, liquefaction), fire or hazardous materials release.

Loss. The human or financial consequences of **damage**, such as human death or injury, cost of repairs, or disruption of social, economic, or environmental systems.

Magnitude. A unique measure of an individual earthquake's release of strain energy, measured on a variety of scales, of which the moment magnitude, M_w (derived from **seismic moment**) is often preferred. (See **Richter Scale**.)

Mean. Here, arithmetic mean, the average value in a distribution.

Median. The value in a distribution for which 50% of the distribution values are greater or less than the median value.

Mitigation. Sustained action taken to reduce or eliminate long-term costs and risks to people and property from hazards and their effects. Mitigation distinguishes actions that have a long-term impact from those that are more closely associated with preparedness for, immediate response to, and short-term recovery from a specific event. (Modified from FEMA, 1997)

Model. A representation of a physical system or process intended to enhance our ability to understand, predict, or control its behavior (AIAA G-077-1998)

Modified Mercalli Intensity (MMI) Scale. A qualitative or judgmental scale for measuring the severity of earthquake ground shaking at a site through the evaluation of the way people react to it and its effects on typical types of structures, such as chimneys and masonry buildings. The MMI scale is the most commonly used intensity scale in the United States and can be correlated with such other measures of physical intensity as peak ground accelerations, peak ground velocities, and peak ground displacements.

Mutually Exclusive. Two or more events which cannot physically occur simultaneously. (ANS, 1978, p. 1)

Natural Frequency(ies). The discrete frequency(ies) at which a particular elastic system vibrates when it is set in motion by a single impulse and not influenced by other external forces or by damping. It is the reciprocal of fundamental period.

Natural Hazard. In the context of these guidelines, a natural phenomenon which has the potential for causing damage to potable water structures, systems, or components. (adapted from ANS, 1978, p. 1)

Non-ductile Frames. Structural frames lacking **ductility** or energy-absorption capacity due to lack of **ductile detailing**. Ultimate load is sustained over a smaller deflection (relative to ductile frames) and for only a few cycles before a generally **brittle failure**.

Open Cut Reservoir. A reservoir built by creating a reservoir in the natural lie of the land, often with one side of the reservoir made up of an earthen embankment dam. Many open cut reservoirs are enclosed by adding a roof so that treated water inside is protected from contamination from outside sources. A few open cut reservoirs in treated water systems are open to the air, and water in these reservoirs usually must be treated before being delivered to customers. (ALA, 2001)

Parallel System or Sub-system. A system or sub-system in which there are multiple sources or at least multiple pathways or conduits to service connections or fire hydrants. For an antonym, see series system or sub-system.

Peak Ground Acceleration (PGA). The maximum amplitude of recorded acceleration (also termed the ZPA, or zero-period acceleration).

Performance Objectives. A range of limiting structural damage and functionality states for a facility or system, given a specific hazard. Very typically, only facility performance objectives are considered. This document emphasizes the application of system performance metrics in the light of **system performance objectives**.

Probability and Frequency. Frequency measures how often an event (including a natural hazard event, a state or condition of a component, or a state or condition of the system) occurs. One way to express expected frequency is the average time between occurrences or exceedances (non-exceedances) of an event. The mean annual rate of occurrence of a hazard parameter within a range of values is another way to express expected frequency of a hazard. Probabilities express the change of the event occurring or being exceeded (not exceeded) in a given unit of time. Whereas probabilities of occurrence cannot exceed 1.0, expected frequencies (for a given time unit) can exceed 1.0. For instance, expected frequencies of auto accidents in Washington D. C. for a given year are far in excess of 1.0 even though the probability of an auto accident within a given year can only approach very closely 1.0. (modified from FEMA, 1997; ANS, 1978, p. 2)

Probabilistic Methods. Scientific, engineering, and financial methods of calculating severities and intensities of hazard occurrences and responses of facilities that take into account the frequency of occurrence as well as the randomness and uncertainty associated with the natural phenomena and associated structural and social response.

Probability of Exceedance. A measure (expressed as a percentage or ratio) of estimation of the chance that an event will meet or exceed a specified threshold (e.g., magnitude, intensity, or loss).

Pumping Plant. A facility that boosts water pressure to a higher elevation in both transmission and distribution systems. The plant is usually composed of a building, one or more pumps, electrical and mechanical equipment, and, in some cases, backup power systems.(ALA, 2001; modified by LeVal Lund, 9/19/01)

Ranking. A process of establishing the order of priority.

Raw Water. Water as it is found in nature. This water may be in lakes , rivers or below-ground aquifers. Water is classified as raw water before treatment. Raw water is generally not used for drinking water because it does not conform to water quality requirements set by various Federal and State agencies. (ALA, 2001; modified by LeVal Lund, 9/19/01)

Reachability Matrix. A matrix which determines for each node and/or link in a water system whether or not there is a connection or series of connections by which water can theoretically move from the first node and/or link to the latter node and/or link. Reachability matrices are used to determine whether or not a pathway exist from water sources to demand nodes. However, reachability matrices do not determine whether or not pressures are adequate to service demand nodes either for domestic or for fire-flow purposes.

Reclaimed Water. Wastewater that has been through primary and secondary treatment, and perhaps tertiary treatment, so that it may be reused, generally for non-potable purposes. In some cities, separate distribution systems are built to deliver reclaimed water for irrigation or industrial purposes, groundwater recharge, and to supply water to fire hydrants. (LeVal Lund, 9/19/01)

Recurrence Interval. The average time span between like events (such as large hazard intensities exceeding a particular intensity) at a particular site or for a specific region (also termed return period).

Residual Risk. The remaining risk after risk management techniques have been applied.

Response Spectrum. A plot of maximum amplitudes (acceleration, velocity or displacement) of a damped, single degree of freedom oscillator (SDOF) as the natural period of the SDOF is varied across a spectrum of engineering interest (typically, for natural periods from 0.03 to 3 or more seconds, or frequencies of 0.3 to 30+ hertz).

Response spectra are tabulated or plotted for specified levels of viscous damping, typically 5%.

Richter Scale. A system developed by American seismologist Charles Richter in 1935 to measure the strength (or **magnitude**) of an earthquake, indicating the energy released in an event. Owing to limitations in the instrument used (a Wood-Anderson Seismograph) and the waves it measures, this scale has been supplemented by other, more comprehensive measure of earthquake size (often moment magnitude, M_w).

Risk. The chance of adverse consequences. (modified from FEMA, 1997) The combination of the expected likelihood and the consequences of incidents that could result from a particular activity. (AWWARF, 1998)

Risk Assessment. An evaluation of the risk associated with a specific hazard. Quantitative elements of this assessment are defined in terms of probabilities and/or frequencies of occurrence and severity of consequences. (modified from FEMA, 1997)

Risk-Based System Performance Metrics. System performance metrics that are based on the evaluation of how the system responds to a random suite of natural hazards events (scenarios). Financial and economic methods tend to require a risk-based evaluation in order to avoid underestimation of the benefits of proposed risk-reduction measures..

Risk Reduction Measures. Those activities that reduce overall the costs and risks associated with specific hazards.

Risk Transference. A risk management technique to remove risk from one area to another or one party to another. Insurance transfers risk of financial loss from the insured to the insurer.

Scenario A type of event as defined by its natural hazard source parameters. That is, a scenario is defined by the source (the initiating event, e.g., the initial location and its severity expressed in

such terms as magnitude or wind velocity), which may have many variable consequences dependent on random factors. A simulation is the assessment of these random factors to define specifically the consequences of the specific source event.

Scenario Loss. The loss from one scenario event (given specific values of the random values for other factors not defining the specific scenario).

Seiche. A standing wave oscillation of an enclosed water body that continues, pendulum fashion, after the cessation of the originating force, which may have been either seismic or atmospheric. (ANS, 1978, p. 2)

Seismicity. The geographic and historical distribution of past historic or future expected earthquakes.

Seismic Zonation. Geographic delineation of areas having different potentials for hazardous effects from future earthquakes. Seismic zonation can be done at any scale—national, regional, or local. For example, California has two Seismic Zones as identified in the 1997 Uniform Building Code (UBC): Zone 3 and Zone 4. Zone 3 is the less seismically active area and is located in the northern-central valley of the State extending from the northern border to Bakersfield, plus a portion of the desert area east of the San Bernadino Mountains. This is a large portion of the State and includes Sacramento. Zone 4 is the most seismically active area and is located along the western coast of the State extending from Eureka to San Diego. This is a large portion of the State and includes most of the inland area from Bakersfield to the southern border.

Series System or Sub-system. A system or sub-system that is non-redundant, lacking multiple water sources and lacking multiple pathways to the service connections or fire hydrants. For an antonym, see parallel system or sub-system.

Severe Environmental Load. A load that could infrequently be encountered during the operating life of a water system component or the water system as a whole. (modified from ANS, 1978, p. 2)

Simulation. The exercise or use of a model (AIAA G-077-1998); a simulated event based on modeling.

Site Amplification. See **Amplification**.

Slip. The relative displacement of formerly adjacent points on opposite sides of a fault, measured on the fault surface.

Slip Model. A kinematic model that describes the amount, distribution, and timing of slip associated with a real or postulated earthquake.

Slip Rate. The average rate of displacement at a point along a fault as determined from geodetic measurements, from offset man-made structures, or from offset geologic features whose age can be estimated.

A Snow Avalanche. A slope failure composed of a mass of rapidly moving, fluidized snow that slides down a mountainside. (FEMA, 1997)

Soil or Rock Slides. Downward displacement along one or more failure surfaces. (FEMA, 1997)

Soil Profile. The vertical arrangement of soil horizons down to the parent material or to bedrock. Under current building codes (e.g., the Uniform Building Code, the International Building Code) and FEMA NEHRP guidelines, the soil profile may be categorized by average shear wave velocity in the upper 30m of sediments.

Source. The geologic structure that generates a particular earthquake or class of earthquakes.

Spectrum Amplification Factor. The ratio of a response spectral parameter to the ground motion parameter (where parameter refers to **acceleration**, velocity or displacement).

Storm Surge. When the water level of a tidally influenced body of water increases above the normal astronomical high tide. (FEMA, 1997)

Strike. The approximate direction of the intersection of a fault and the surface of the earth, usually measured from North. (e.g., the fault strike is N 60 degrees W)

A Swelling Clay. A clay (a natural, earthy, fine-grained material that develops plasticity when mixed with a limited amount of water) that is capable of absorbing large quantities of water and so increasing greatly in volume. (FEMA, 1997)

System Performance Metrics. Quantitative measures by which the performance of a system may be evaluated.

System Performance Objectives. See **Performance Objectives**.

System State. A state of the overall water system or network in which water components that bear on water service from source to service connection or fire hydrant are modeled as being fully operational, partially operational, or inoperable.

System Risk Evaluation. The evaluation of the probabilities of adverse consequences to the system. A more thorough evaluation than merely the evaluation of the system at risk, the severity and likelihood of natural hazards, or the vulnerability of components to natural hazards.

System Vulnerability Evaluation. The evaluation of system performance relative to a small number of selected natural hazard states or scenarios. Generally suitable for emergency planning, but not for financial evaluations that require a Systems Risk Evaluation.

System Vulnerability Model. See Vulnerability Function or Model.

Tanks. A vessel that holds water. Water tanks are usually circular in shape, built of steel, concrete or wood—most often redwood. Tanks can be elevated by columns; built “at grade” to rest directly on the ground or on a foundation on the ground; or buried. Also, in some smaller parts of distribution systems, water can be stored in pressure tanks, which are small horizontal cylindrical pressure vessels on supports, at grade. (ALA, 2001; modified by LeVal Lund, 9/19/01)

Tornado. A rapidly rotating vortex or funnel of air extending groundward from a cumulonimbus cloud. (FEMA, 1997.) A violently rotating column of air pendent from a convective type cloud and nearly always observable as a funnel cloud or tube. Tornadoes have large rotational wind speeds, pressure gradients along their radii and translational movement. A tornado can create structural loadings. A tornado has the potential for creating missiles, the characteristics of which depend on the intensity of the tornado. (ANS, 1978, p. 2)

Water Transmission System. A system that stores “raw” water and delivers it to water treatment plants. Such a system is made up of canals, tunnels, elevated aqueducts, buried pipelines, pumping plants and reservoirs. (ALA, 2001) See also **Distribution System**.

Treated Water. Water that has been processed to meet water quality requirements set by various Federal and State agencies. Under normal conditions, water flowing out of taps in residences is treated water. (ALA, 2001)

Tropical Cyclone. A low pressure area of closed circulation winds that originates over tropical waters. Winds rotate counterclockwise in the Northern Hemisphere. (FEMA, 1997)

Tsunamis. A series of sea or lake waves produced from the displacement of water by either a local or distant submarine earthquake, volcanic eruption, submarine or coastal landslide. A tsunami may cause flooding loss, impact loads from waves or floating debris, or both, and erosion of earth foundations from structures. (modified from ANS, 1978, p. 2)

Vulnerability Function or Model. A generic function or model relating for components the severity of adverse consequences to some measure of the severity of the hazard and for systems the severity of adverse consequences to the state of the disrupted system. If treated probabilistically, in terms of damage states for a specific component or type of component, a vulnerability function is a component fragility function. Being generic, a vulnerability function or model can also be treated deterministically as the best estimate of adverse consequences (and possibly their confidence levels) relative to a specific hazard severity. Vulnerability models can also be developed for systems, to relate the degree of system degradation or loss as a function of the operability of its individual components. (modified from ALA, 2001)

Water Wells. Used in many cities as both a primary and supplementary source of water, wells include a shaft from the ground surface to the aquifer, a pump to bring the water up to the surface, equipment used to treat the water, and a building to enclose the well and other electrical or mechanical equipment. (ALA, 2001, modified by LeVal Lund, 9/19/01)

Yield. The point at which a structural element or material begins to lose its ability to resist any additional applied load. The transition point between elastic and inelastic behavior. Yielding describes the continued inelastic deformation under load prior to loss of load-carrying capacity or sudden brittle failure. For ductile materials having a linear stress/strain behavior, yield can be defined as the departure of material response from this linear behavior due to permanent strain.