Risk Fact Sheet: Economy

Risk Description

The primary risk to the Santa Cruz economy from water is the possibility that the Water Department will not be able to reliably provide sufficient water to meet business demands. Curtailments are used to allocate limited supplies in Santa Cruz when water supplies are insufficient to meet total demands.

The critical question is, ***"How much water is needed to ensure curtailments do not adversely impact the local economy, if curtailments are frequent, severe, and/or extend over long periods (multiple years)?"***

Available Information

The adverse impact (i.e., risk) to local economies (as well as on the well-being of residential customers) depends on their severity, duration, and frequency of curtailments. Empirical evidence indicates that the adverse economic impact increases dramatically (nonlinearly) as the level of curtailment increases. For example, short-term, moderate water use restrictions that curtail demands by 10% to 15% may be endured as a temporary and relatively minor inconvenience. But as curtailments increase in severity (e.g., to levels of 20% or more), or extend over multiple years, then the adverse impact on households, businesses, and local economies becomes far more pronounced.

Studies of drought impacts for East Bay Municipal Utilities District (EBMUD) provide a glimpse into how economic impacts may be associated with water supply shortfalls. As illustrated in Figure 1 for EBMUD, the economic losses associated with either a 10% and 15% reductions in water supplies are significantly less than the losses associated with a 25% shortage, particularly for commercial entities. Total economic losses for EBMUD are projected to be nearly 4 times greater at a 25% shortage level than for a 15% shortfall. Other studies examining the economic losses for business entities associated with water shortages confirm that the relationship between shortage and economic losses is not linear; rather there is a threshold above which businesses begin to suffer significant losses that may even threaten their viability.

Round table discussions with members of the Santa Cruz business sector indicate that they experience moderate economic losses due to low-level or short duration curtailments, but that there is a threshold, close to what they experienced in 2014, where the losses will probably become more substantial.

Risk Metric

Frequency, duration and severity of curtailment.

Risk Management Options

Risks can be managed by either reducing the probability that an event will occur OR by reducing the consequences of the event if it does occur.

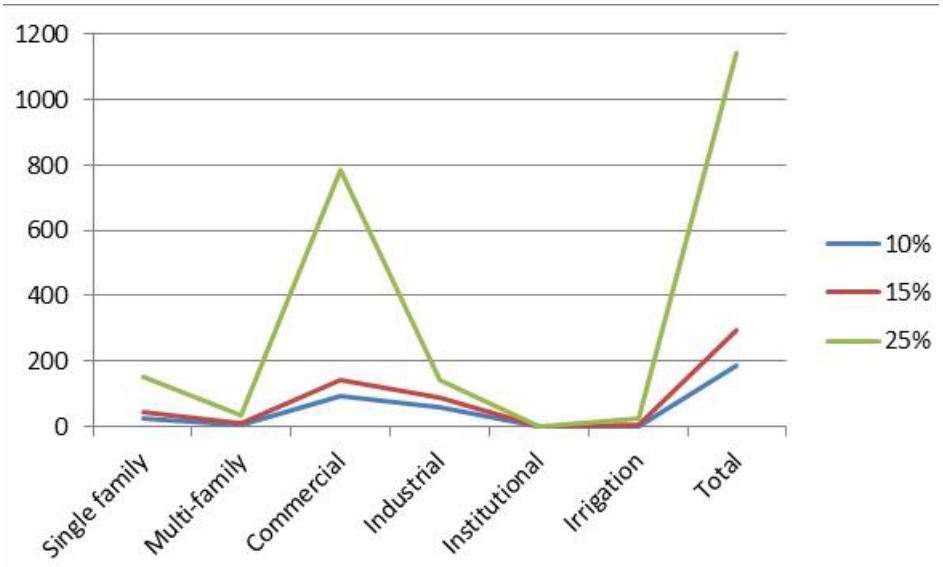

Figure 1. Customer Class Water Shortages and Water Shortage Costs for EBMUD (2040 level of development). Millions of dollars in impact, for shortages of 10%, 15% and 25%. Water shortage cost = consumer surplus losses for residential, institutional, and irrigation customer classes plus regional value added losses for CI customer classes. Regional value added losses equal the sum of losses to labor income, proprietor income, profits and property income, and indirect business taxes.

Source: M.Cubed, 2008.

Probability

Management options for reducing the probability that curtailments will reach a frequency, severity or duration that approaches or exceeds the threshold for economic losses:

- Increase the reliability of water supply
  - Decrease demands[1]
  - Increase water efficiencies
  - Increase supplies from current sources
  - Add new sources
  - Increase current storage
  - Add new storage.

1. Note – Curtailments may be viewed by some people as a form of demand management: when supplies are low, demand is managed - decreased – through mandatory curtailments. This means that as you decrease demands, through demand management, under normal conditions, you decrease the amount of demand that is available to curtail during events that stress the system, for example during droughts.

Consequence

Management options for reducing the consequences of curtailments so that when they do occur businesses do not meet or exceed their economic loss thresholds. These include:

- Targeting curtailments on those entities that are most resilient to reduced water availability,
- Removing curtailments from commercial entities that are at their loss thresholds
- Providing tax or other fiscal benefits to entities struggling under curtailments, and/or
- Discouraging businesses from locating in the City if they cannot manage water supply limits.

Reference

M.Cubed, 2008

Risk Fact Sheet: Drought

Risk Description

The primary risk to the Santa Cruz water supply from drought is the inability of the Department to reliably provide sufficient water to meet user demands during periods of below-average rainfall.

Available Information

The adverse impact of a drought is dependent on the severity, duration, and frequency of drought events. The Santa Cruz Water Department (SCWD) currently plans for a 3-year drought-duration, which is based on the severity of the 1976–1979 drought. Other nearby utilities, such as Santa Barabara and San Francisco, have moved toward using a 7-year and 8-year drought duration model, respectively, in their planning, to reflect greater climate variability than seen in the more recent historical records.

Paleo records show that, historically, droughts in the Santa Cruz region were frequently much longer than 3-8 years. Paleo climate reconstruction for California Valleys show that precipitation from the 17th century until the 20th century was consistently below average 20th-century values, with long periods of relative drought and short periods of high rainfall. These data show that cycles of below-average precipitation have commonly lasted from 30 to 75 years (Figure 1; Fritts, 1991).

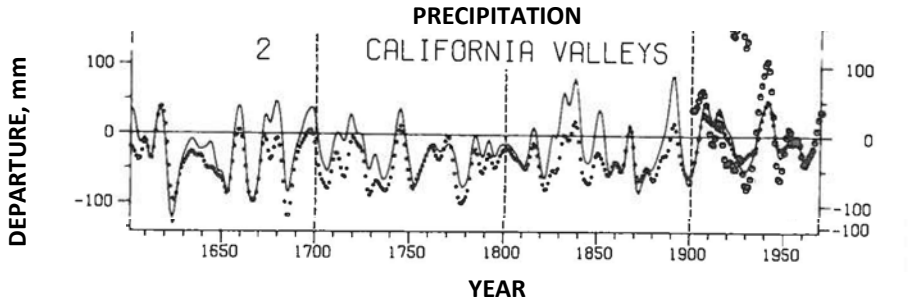

Figure 1. Filtered 46-grid (line) and 77-grid (small dots) annual temperature reconstructions, average over all grid points and expressed as anomalies from the 20th-century values. The larger dots in the 20th-century represent the filtered instrument data.

Source: Modified from Fritts, 1991, Figure 7.4.

Other paleo climate analyses, summarized in (Fritts, 1991) have concluded the following:

- "Realistic planning for the future might better center on seasonal climate and the larger variance of information in the smaller regions, rather than focusing exclusively on worldwide changes varying only on time scales of centuries to millennia."
- "The variability of precipitation was reconstructed to have been higher in the past three centuries than in the present."
- "Lower variability occurred in twentieth-century precipitation. Reconstructions of this kind should be used to extend the baseline information on past climatic variations so that projections for the future include a more realistic estimate of natural climatic variability than is available from the short instrumental record."

Risk Metrics

Severity, frequency and duration of curtailments.

Reductions in water quality.

Drought may also compound risks associated with flooding and fire.

Risk Management Options

Probability

Based on paleo records and observed current conditions, the risk of long-term and severe droughts is high. There are no actions the WSAC can take to reduce the probability of a drought.

Consequence

Management options for reducing the consequences of drought events include:

- Diversifying the supply portfolio
- Decreasing demands
- Increasing current water storage
- Adding new water storage
- Maximizing use of high-flow events
- Developing climate independent water supplies including reuse and desalination
- Other?

Reference

Fritts, H.C. 1991. *Reconstructing Large-Scale Climatic Patterns from Tree-Ring Data: A Diagnostic Analysis.* University of Arizona Press, Tucson, AZ.

Risk Fact Sheet: Seismic Events

Risk Description

The Santa Cruz drinking water system is at risk from earthquake events from nearby active faults. Based on the experience of the Santa Cruz Water Department (SCWD) and other utilities during earthquake events, possible damage could include, but is not limited to:

- Structural damage to and/or failure of transmission, treatment, and distribution facilities and occupied buildings
- Loss of the control system and automated operation of facilities
- Ruptured chemical tanks and/or feed piping
- Power outages at the raw water supply pumps, treatment plants, and treated water pump stations.

Available Information

The nearest active faults are the Butano, Zayante, and San Andreas faults. According to a 1994 report by the California Division of Mines and Geology, "Fault Activity Map of California and Adjacent Areas," the Butano and Zayante faults are potentially active undivided quaternary faults. This type of fault has had evidence of displacement during the last 1.6 million years. The San Andreas is a well-known active fault. USGS has reported there is a 10% chance of an earthquake of magnitude 6.7 Richter or greater on the Santa Cruz segment of the San Andreas fault before 2030, and a 21 % chance for the entire San Andreas fault system (USGS Fact Sheet 152-99,1999; CDM, 2002).

Seismic activity on these faults could cause damage (ranging from minor to severe) to the supply, treatment, and distribution system components. Earthquake damage to the Santa Cruz system has in the past, and would most likely in the future, result from ground shaking or seismically induced liquefaction. Conversely, ground rupture is not a likely threat to the Santa Cruz Facilities. Ground shaking will create forces of varying magnitude (based on soil conditions) throughout the system. Piping and structures (buried or above grade) would be subjected to these forces and could potentially sustain damage. Liquefaction can also occur to varying degrees throughout the system. The area's most susceptible to liquefaction are the lower San Lorenzo River basin and other areas with sandy soils. Sandy soils tend to liquefy during ground shaking and can cause localized soil failure, displacement, and subsequent damage to piping and structures that are buried or above grade structures that rely on the soil's strength to support the foundations. Because the Ben Lomond Fault, that passes through the Santa Cruz system, is not considered active, the probability of an earthquake and significant ground ruptures within the Santa Cruz system is low. Based on the experience of the SCWD and other utilities during earthquake events, possible damage could include, but is not limited to:

- Structural damage to and/or failure of transmission, treatment and distribution facilities and occupied buildings
- Loss of the control system and automated operation of facilities

- Ruptured chemical tanks and/or feed piping
- Power outages at the raw water supply pumps, treatment plants, and treated water pump stations.

Risk Metric

Severity, frequency and duration of curtailments, and/or service outages for all or parts of the system.

Risk Management Options:

Probability

The SCWD cannot take any measures to reduce the probability of a seismic event.

Consequence

The SCWD has already responded to these risks by:

- Installing an emergency generator system at the University Pump Station No. 2.
- Purchasing three portable generators
- Providing emergency power system at the Felton Booster Station.

Additional options to manage seismic risks include reducing the consequences of possible transmission line failure through adding redundancy (e.g., back-up pipelines, additional water sources, hardening vulnerable infrastructure).

Reference

CDM. 2002. Draft Technical Memorandum No. 2. System Service Reliability Goals. City of Santa Cruz Water Department. December 18.

Risk Fact Sheet: Flood (does not include sea level rise factors)

Risk Description

The primary risk to the Santa Cruz water system from floods is damage to electrical equipment.

Risks associated with 100-year floods include:

- Inundation of the Tait Street Wells, which would impair the Santa Cruz Water Department's (SCWD's) ability to pump water from the San Lorenzo due to loss of electricity
- Flooding of the Coast Pump Station, which would hinder SCWD's ability to deliver water to its customers along the Coast Pipeline due to loss of electricity

Risks associated with 100-year to 500- year floods include:

- Inundation of the Graham Hill WTP, Beltz WTP, and almost all pump stations due to a loss of electricity
- Impaired access to valves and service connections for distribution lines.

Other flood related system risks include:

- Bridge washouts along the supply lines off the Coast Pipeline and running from Loch Lomond Reservoir to the Graham Hill WTP, which have many creek and river crossings.

Available Information (CDM, 2002)

Figure 1 identifies the areas of 100-year flooding, 100- to 500-year flooding, and 500-year flooding potential. Areas along the coast and river ways have a potential to flood once every 100 years. Almost all of the area shown in Figure 1 has a flooding potential of once in every 100 to 500 years. There are a few small areas that are located in the 500-year flood zone. This does not reflect sea level rise or increased storm surge, as associated with climate change.

President Obama recently established a Federal Flood Risk Management Standard in order to improve the resilience of communities against the impacts of flooding changes due to climate change. Federal projects must now update floodplain maps using climate-informed science, by adding 2 feet to the base flood elevation for non-critical actions and 3-feet for critical actions, or by increasing the area subject to flooding by the 0.2 percent annual chance of flood. The term "critical action" shall mean any activity for which even a slight chance of flooding would be too great

Risk Metric

- Inability to access water from the Tait Street wells.
- Loss of ability to deliver water to customers along the Coast Pipeline
- Loss of treatment capacity
- Loss of access to distribution system values
- Loss of supply due to breaks in supply lines because of bridge washout.

These risks are measured by the severity, frequency and duration of curtailments, water quality issues (possible contamination, boil water advisories), supply outages to parts or all of the service area, and infrastructure repair costs.

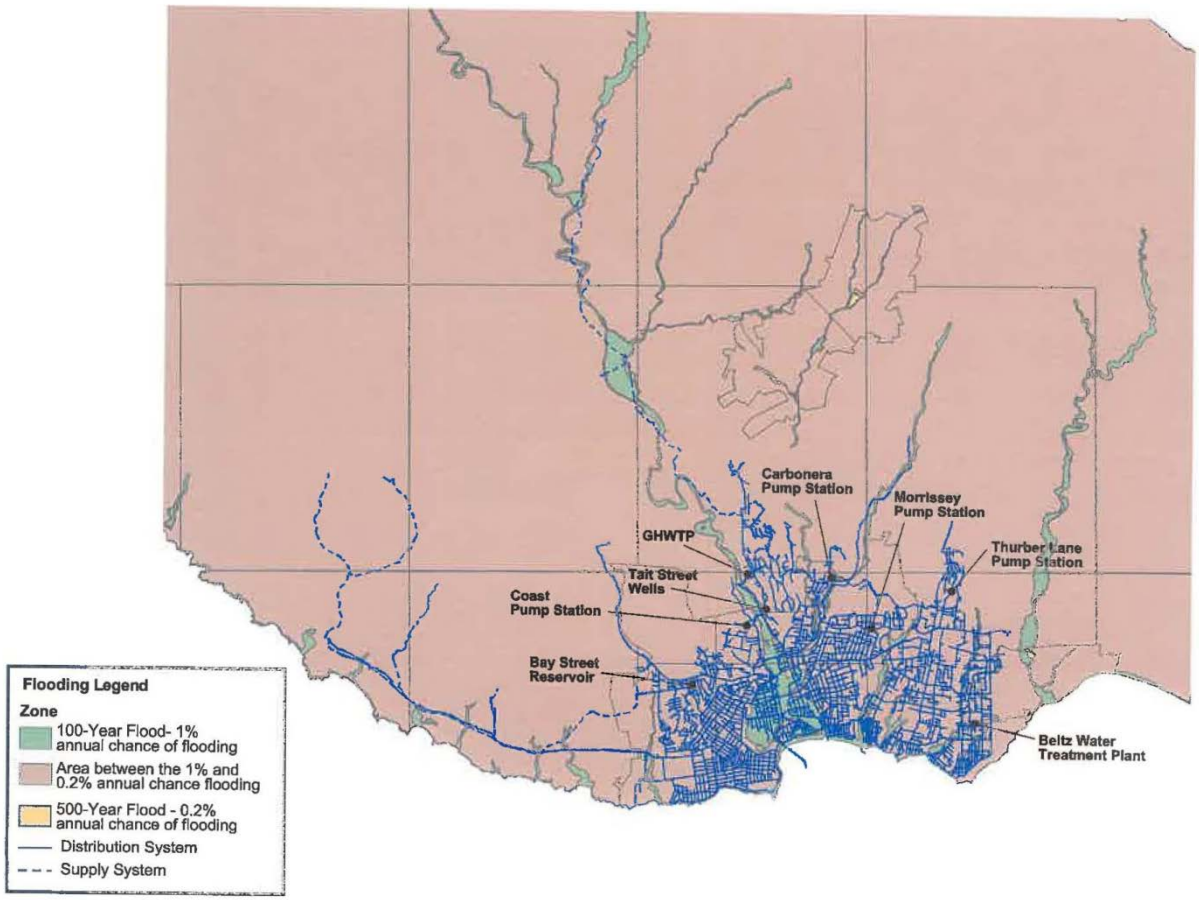

Figure 1. Flooding potential in the Santa Cruz area.

Source: CDM, 2002, Figure A-2.

Risk Management Options

Probability

Management options for reducing the probability that flood events will result in one of the losses listed above include:

- Moving electrical connections and components to higher locations within a facility (Tait St Wells, Coast Pipelines)
- Investing in movable back-up generators
- Fortifying, moving, or providing duplicate supply lines that run under bridges.

Most of the available actions are beyond the domain of WSAC.

Consequence

Management options for reducing the consequences of flood events include implementing an alternative that provides water and water treatment that is not vulnerable to flood risks.

Reference

CDM. 2002. Draft Technical Memorandum No. 2. System Service Reliability Goals. City of Santa Cruz Water Department. December 18.

Risk Fact Sheet: Wildfires

Risk Description

Wildfires have the potential to affect the Santa Cruz Water Department (SCWD) system both directly and indirectly.

Direct risks include damage to:

- Critical transmission lines
- Treatment facilities
- Distribution facilities (CDM, 2002).

Indirect risks include:

- Turbidity excursions
- Contamination from runoff leading to severe taste and odor problems
- Limited access to facilities and pipelines.

Available Information

Figure 1 shows fire hazard severity zones for places within the State Responsibility Areas (SRAs). While none of the SCWD system is expected to be in the highest severity areas, some parts do fall within moderate and high hazard areas, including the Felton Booster Station; Loch Lomond Reservoir; Rolling Woods Pump Station; Rolling Woods Reservoir; Santa Cruz Gardens Reservoir; Thurber Lane Pump Station; University No. 4 and 6 Pump Stations; University No. 2, 4, and 5 Reservoirs; and Liddell Springs, Laguna Creek, and Majors Creek intakes (see Figure 1; CDM, 2002).

The Felton and Tait Street Diversions and the Graham Hill Water Treatment Plant (GHWTP) are outside of the SRAs but are adjacent to wooded areas that are within moderate to high fire hazard area. If wildfires hit in these areas, they could prevent staff from safely operating these facilities and could cause structural or mechanical damage (CDM, 2002).

Risk Metric

Reduction in supply reliability as measured by the frequency, severity, and duration of curtailments.

Risk Management Options

Risks can be managed by either reducing the probability that an event will occur OR by reducing the consequences of the event if it does occur.

Probability

Management options for reducing the probability that wildfire events will negatively affect water supply reliability include:

- Increase the resilience of the forest to wildfire events (forest management practices)
- “Harden” facilities to withstand wildfire events.

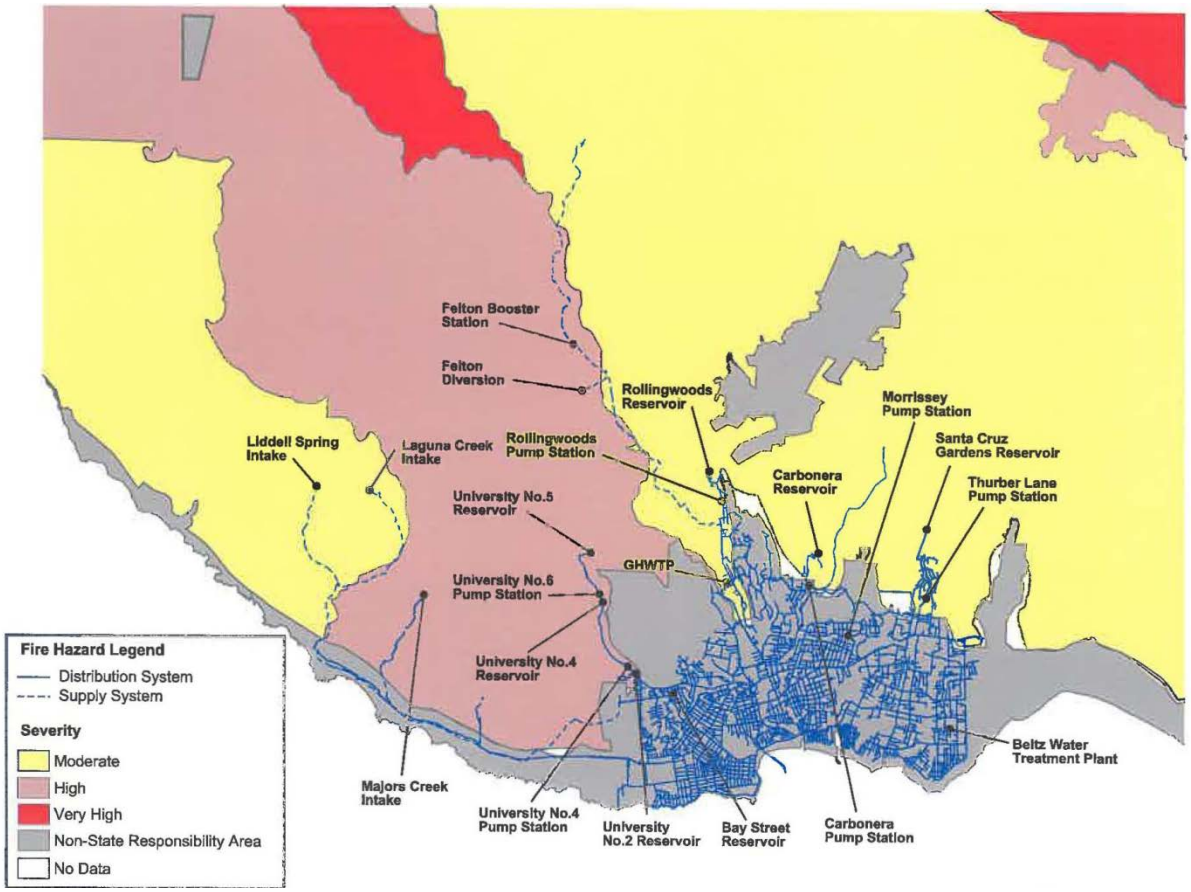

Figure 1. Fire hazard severity zones.

Source: CDM, 2002, Figure A-4.

Consequence

Management options for reducing the consequences of wildfire include developing redundant distribution and treatment facilities in areas with lower probabilities of wildfire.

Reference

CDM. 2002. Draft Technical Memorandum No. 2. System Service Reliability Goals. City of Santa Cruz Water Department. December 18.