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Technical Memorandum

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Technical Memorandum

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1. INTRODUCTION

This technical memorandum defines different seismic performance goals used in water pollution control facilities, presents the process for selecting appropriate performance goals for different structures in the facilities, and proposes a set of performance goals to be used for the seismic assessment of the Sunnyvale Water Pollution Control Plant (WPCP). The seismic performance goals assigned to the structures are consistent with the plant's desired level of post-earthquake service selected by the master planning team. The selection of the goals is based on the right balance between the service provided and cost to improve the facilities to achieve those goals. Issues such as life safety, public health, and protection of the environment will be considered during the WPCP master planning process.

The seismic assessment process for water pollution control facilities consists of the following steps:

- Define the level of service and seismic performance goals for the structures and transmission systems within the facility.
- Define the levels of seismicity and seismic hazards.
- Screen and evaluate the structures and critical equipment in accordance with the seismic performance goal assigned to the assets.
- Report potential deficiencies, provide typical rehabilitation details if required, and provide probable cost for the rehabilitation.
- Reassess the seismic performance goal assigned to the facilities based on the level of service expected and the cost to rehabilitate the facilities.

1.1 Level of Service and Seismic Performance Goals

The first, and most important, task of a seismic assessment of a water pollution control facility is to develop a suitable set of earthquake performance goals for the structures and transmission system. The American Society of Civil Engineers (ASCE), Seismic Evaluation of Existing Buildings ASCE/SEI 31-03 recommends two basic levels of performance, which are the Life Safety and the Immediate Occupancy. The performance levels are selected based on the level of post-earthquake service that needs to be provided with respect to the following categories: life safety, public health, and protection of the environment.

The Life Safety performance level reduces the risk to life loss or serious injury to the plant personnel or public during the design earthquake. This performance level includes damage to both structural and nonstructural components of the structures and transmission system during the design earthquake, such that a partial or total structural collapse does not occur, and that damage to nonstructural components is non-life-threatening. For the public health category, a typical life safety level ensures that hydraulic flow and disinfection is maintained, and the release of hazardous chemicals into the atmosphere is avoided. For the protection of the environment category, this level provides continuous primary treatment and restores secondary treatment within a stipulated time frame, typically between a few weeks up to a few months after the design earthquake, depending on the seismicity level.

The Immediate Occupancy performance level is used for essential facilities which require being in operation after the design earthquake event and without loss of life. This performance level is usually assigned to operation control buildings, hospitals, emergency response centers, police and communication centers, and facilities containing large amounts of hazardous substances. However, for water pollution control facilities the Immediate Occupancy level means that for a specific seismic event the facility will be restored within a determined period of time selected by the master planning team.

1.2 Levels of Seismicity and Seismic Hazards

The second task for the seismic assessment is to define the levels of seismicity for the entire facility site and to identify other potential seismic hazards such as liquefaction, ground rupture, and tsunamis. Throughout the life of the Sunnyvale WPCP the structures may experience several small and one large seismic event. Ground shaking is the most common and significant cause of earthquake damage. The two most generally accepted seismic levels used to conduct seismic assessment of existing facilities are: ground motions with a 10 percent chance of exceedance in 50 years (an event expected to occur, on average, about once every 500 years), and a ground motion with a 2 percent chance of exceedance in 50 years (an event expected to occur, on average, about once every 2500 years). The first seismic level includes more probable earthquakes, while the second level represents large magnitude or "maximum credible" earthquakes.

Maximum credible earthquakes are obtained from the Seismic Hazard Maps published by the U.S. Geological Survey. For the WPCP the maximum credible earthquake has a ground acceleration of 0.6 g (g = gravity acceleration), which is equivalent to a 7.9 magnitude in the Richter scale. A seismic event with 10% exceedance in 50 years will have a ground acceleration of 0.49 g, which is equivalent to a 7.0 magnitude in the Richter scale.

Seismic performance goals are often case-specific; however, it is useful to present a baseline or tentative set of performance goals which provide a starting point in establishing the case-specific goals. Once the seismic assessment has been conducted using the tentative goals and potential system vulnerabilities have been identified, then the performance goals can be modified to suit the plant service level.

Typical post earthquake performance goals for water pollution control facilities are presented in Table 1 below. The proposed post earthquake performance goals for the WPCP are presented in Table 2, and the specific level of service for each facility is included in Table 3.

Table 1. Typical Post Earthquake Performance Goals for Water Pollution Control Facilities

Service Category	Probable Earthquake	Maximum Earthquake
Life Safety	Minimal life-safety risk	Minimal life-safety risk
Public Health	Maintain hydraulic flow and disinfection	Maintain hydraulic flow and disinfection
Protection of the Environment	Provide primary treatment continually. Provide secondary treatment within 2 weeks.	Provide primary treatment continually. Provide secondary treatment within 6 months.

Table 2. Proposed Post Earthquake Performance Goals for Sunnyvale WPCP

Performance Goals	Probable Earthquake	Maximum Credible Earthquake
Immediate Occupancy	No structural damage; minor non-structural component damage only. No environmental damage. No loss of facility use.	Minor to some moderate damage. No major structural damage, partial collapse or threatening conditions. Moderate non-structural damage possible. Limited partial shutdown possible. Structural and non-structural damage repairable within days.
Life Safety	Minimal structural damage. Minimal partial temporary shutdowns possible	Moderate structural damage. No partial collapse or life threatening conditions. Structural and nonstructural damage repairable within weeks to months.

Table 3 – Condition Assessment, Recommended Action from Seismic Assessment and Proposed Level of Service for Sunnyvale WPC Facilities

Structure	Condition Assessment	Recommended Action from Seismic Assessment done By Beyaz&Patel (Nov 2005)	Probable Earthquake Level of Service (See Table 2)	Maximum Credible Earthquake Level of Service (See Table 2)
Operations Building			Immediate Occupancy	Immediate Occupancy
Auxiliary Pump Station	Acceptable	Acceptable	Immediate Occupancy	Immediate Occupancy
Headworks	Concrete slight deterioration	Potential Seismic Deficiencies Identified. Requires further evaluation	Immediate Occupancy	Life Safety
Primary Grit	Severe concrete deterioration and metal corrosion	Potential Seismic Deficiencies Identified. Requires further evaluation	Immediate Occupancy	Life Safety
Sedimentation Basins Gallery	Concrete slight deterioration	Seismic Deficiencies Identified. Requires further evaluation	Immediate Occupancy	Life Safety
Sedimentation Basins	Severe concrete deterioration and metal corrosion	Potential Seismic Deficiencies Identified. Requires further evaluation	Immediate Occupancy	Life Safety
Primary Effluent Channel & Piping to Oxidation Ponds	Severe concrete deterioration and metal corrosion	N/A	Immediate Occupancy	Life Safety
Oxidation Ponds Levees	Last Upgrade in 1982	Last Upgrade in 1982	Immediate Occupancy	Life Safety
Pond Effluent and Filter Water Pump Stations			Immediate Occupancy	Life Safety
Chlorine Contact Basins	Moderate concrete deterioration	Potential Seismic Deficiencies Identified. Requires further evaluation	Immediate Occupancy	Life Safety
Fixed Growth Reactors	N/A	Potential Seismic Deficiencies Identified. Requires further evaluation	Life Safety	Life Safety
Air Flotation Tanks	Severe concrete deterioration at weir channel	Acceptable	Life Safety	Life Safety
Laboratory Building	N/A	Potential Seismic Deficiencies Identified. Requires further evaluation	Immediate Occupancy	Life Safety
Dual Media Filter	Slight concrete deterioration and metal corrosion	Acceptable	Life Safety	Life Safety
Sulfur Dioxide Building	Moderate concrete deterioration and slight metal corrosion	Potential Seismic Deficiencies Identified. Requires further evaluation	Immediate Occupancy	Life Safety
Chlorine Building	Moderate concrete deterioration and slight metal corrosion	Potential Seismic Deficiencies Identified. Requires further evaluation	Immediate Occupancy	Life Safety
Power Generation	Acceptable	Acceptable	Life Safety *	Life Safety *

Building				
Standby Power (to replace power generation)	N/A	Performed with Future Design	Immediate Occupancy	Immediate Occupancy
Landfill Gas Pressure Station	Acceptable	Requires further evaluation	Life Safety	Life Safety
Drainage Pumping Station	Slight concrete deterioration and metal corrosion	Acceptable	Life Safety	Life Safety
Chemical Feed Building	Moderate concrete deterioration and slight metal corrosion	Requires further evaluation	Life Safety	Life Safety
Emergency Scrubber (TGO) Containment Basin	Moderate concrete deterioration and slight metal corrosion	Requires further evaluation	Immediate Occupancy	Immediate Occupancy

** Recognizing current power generator facility does not function for standby power.*

1.3 Screening and Evaluation of Structures

The seismic evaluation of existing buildings shall follow the American Society of Civil Engineers ASCE/SEI 31-03 standard. The screening step consists of obtaining general information such as record drawings of the structures, mechanical equipments, and conveying systems; and obtaining geotechnical information of the site. Part of the screening step includes a site visit to the facility to flag potential seismic deficiencies of the structures and piping system. The evaluation step consists of performing quick calculations of the structural systems, including hydrodynamic loads in accordance with the American Concrete Institute (ACI) 350.3 – 06 Seismic Design of Water-Containing Concrete Structures.

Beyaz and Patel conducted a preliminary seismic evaluation of the Sunnyvale WPCP in November, 2005, which consisted of reviewing design drawings and observations made during a site visit of the plant. This work is considered to be part of the screening process described in the ASCE/SEI 31 standard. Beyaz and Patel identified potential deficiencies in several facilities and recommended further evaluation. The facilities identified with potential seismic deficiencies are included in Table 3 above.

The Primary Grit and Sedimentation Basins were identified to be vulnerable to seismic loading. It was determined that the two rows of basins, although partially connected by the Sedimentation Gallery, would act as separate structures during and earthquake. According to the design drawings of the existing sedimentation tanks modifications made in 1969, the roof of the Sedimentation Gallery is just simply supported by the walls of the sedimentation tanks. The vulnerable link is the aerial piping connecting the Primary Grit Tanks and the Primary Sedimentation Tanks. During a seismic event the two structures may move in different directions and the pipes may break and leak, filling the gallery with sewage. This particular structure should be mitigated as soon as possible to avoid potential problems.

As part of the evaluation process, it is imperative that geologic site hazards are identified for facilities located in highly seismic area, such as the Bay Area. There are several geotechnical investigation reports done at the plant during all plant upgrades. The earliest report available is dated February 1975 and it was prepared for the tertiary facility. Based on the information presented in those reports, the Sunnyvale WPCP site soils vary and consequently some structures are supported on deep foundations, such as piles, and others facilities are supported on standard spread footings or mat foundations. All the reports indicate that the geologic hazard of surface ground rupture is low at the site. Liquefaction was not addressed in most of the reports and the last report done in September 2004 for the digester expansion project identifies that the liquefaction potential for

this particular site is negligible. There was a geotechnical investigation conducted in 1982 for the stability of the oxidation pond levees and several specific recommendations were made for strengthening the levees. In September 1991 an investigation was made to determine the stability of the sludge lagoon embankment. These embankments were found to be stable for static and seismic loads.

It is highly recommended that an investigation report be conducted for the whole facility to determine the seismic hazards at the site. Most of the investigation conducted are relatively old and may not be up to date with current liquefaction and ground shaking mapping.

During the Alternatives Development phase of the Strategic Infrastructure Plan (SIP), Brown and Caldwell will perform a planning level screening and evaluation of structures that would be modified in SIP alternative scenarios. This review will contribute to scope definitions that will be the basis of construction cost estimates for the alternatives.

1.4 Reporting Potential Deficiencies and Mitigation Procedures

The last step consists of reporting any deficiencies encountered and providing rehabilitation details to mitigate the seismic deficiencies. It is anticipated that this step would be conduced during the detailed design phase of various SIP projects.