ESA

550 Kearny Street
Suite 800
San Francisco, CA 94108
415.896.5900 phone
415.896.0332 fax

esassoc.com

memorandum

date	December 10, 2020
to	Arun Parsons, PE (HDR)
from	Matt Brennan, PE
subject	**Flood Hazard Assessment for PG&E Ravenswood Substation to Support Menlo Park SAFER Bay 2020 FEMA BRIC Grant Application**

To support Menlo Park SAFER Bay's 2020 FEMA BRIC Grant Application, ESA conducted an initial flood hazard assessment for the PG&E Ravenswood Substation. This memorandum described the sources and methods for estimating water levels, inundation depths, and inundation duration for specific event frequencies.

Water Levels

Water levels during flood events were derived from FEMA flood hazard mapping and technical studies. FEMA Coastal Transect B47 from the current effective Flood Insurance Rate Map (FEMA 2019) originates in San Francisco Bay and traverses across the PG&E Ravenswood Substation (Figure 1). Location-specific bay water level recurrence intervals were mapped and tabulated by AECOM (2016). The source for this mapping was the same DHI (2013) hydraulic model hindcasting and flood frequency analysis used by FEMA for flood mapping. Since the levees between the bay and the substation are not FEMA-accredited, the bay still water levels were assumed to occur at the substation, in the same manner as was assumed for the water levels along the coastal transect for FEMA mapping purposes. The water levels for return intervals of 10-yr (10% annual chance of exceedance or ACE), 50-yr (2% ACE), 100-yr (1% ACE), and 500-yr (0.2% ACE) events from AECOM (2016) Point 745, the point closest in the bay to the starting point for Coastal Transect B47, are listed in Table 1.

The sea-level rise design criteria for Menlo Park SAFER Bay is 3.5 ft, in agreement with the latest State of California strategy (OPC, 2020). This amount of sea-level was added linearly to the existing conditions water levels to project the future water level elevations at specified return intervals, as shown in Table 2. No changes to the existing flood management infrastructure were assumed for these sea-level rise conditions.

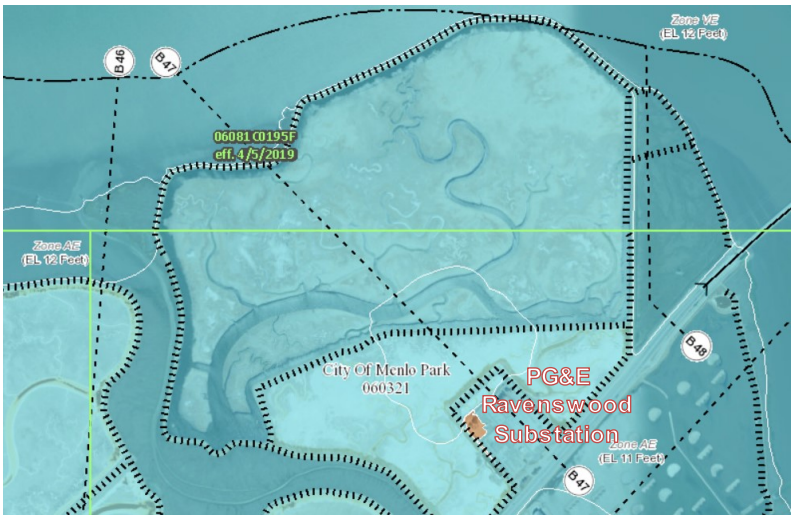
Table 1. Water level, inundation depth, event duration, and drainage duration at the PG&E Ravenswood Substation, existing conditions

Event Recurrence Interval	Water Level (ft NAVD)	PG&E Ravenswood Substation Inundation Depth (ft)	Event Duration (days)	Drainage Duration (days)
10-yr / 10% ACE	9.47	1	1	2
50-yr / 2% ACE	10.32	1.5	2	4
100-yr / 1% ACE	10.79	2	3	5
500-yr / 0.2% ACE	12.23	2	3	5

Table 2. Water level, inundation depth, event duration, and drainage duration at the PG&E Ravenswood Substation, +3.5 ft sea-level rise

Event Recurrence Interval	Water Level (ft NAVD)	PG&E Ravenswood Substation Inundation Depth (ft)	Event Duration (days)	Drainage Duration (days)
10-yr / 10% ACE	12.97	2	1	5
50-yr / 2% ACE	13.82	2	2	5
100-yr / 1% ACE	14.29	2	3	5
500-yr / 0.2% ACE	15.73	2	3	5

Figure 1. Current Effective FEMA Flood Insurance Rate Map



Inundation Depths

Inundation depths for the PG&E Ravenswood Substation are intended to represent the typical depth during the entire duration of inundation. They are calculated from the average ground surface elevation within the substation's footprint, 9 ft NAVD, subtracted from the water level during that event and then rounded up to the nearest half foot (Table 1). The levees and Highway 84 embankment surrounding the substation are assumed to have a crest elevation of 11 ft NAVD. Therefore, the inundation depth was capped at 2 feet, the difference

between the surrounding levees and the substation elevations. This surrounding levee and embankment would detain flood waters and is assumed to set the typical depth during an inundation event. For larger events, such as the 500-yr existing conditions event or all of the events with 3.5 ft of sea-level rise (Table 2), the peak water level would briefly surge higher and cause greater inundation for a few hours, but then as the high tide receded, the water would rapidly drain from the peak water levels until it is detained by the surrounding levees and embankment.

Event and Drainage Duration

The event duration, i.e. the time during which flood waters are entering into the substation, is derived from tidal hydrology during historic flood events. 10-year events typically threaten inundation for a day as the casual storm system passes over the bay. On January 27th 1983, the highest observed water level over more than a century of observation was recorded at the Golden Gate, NOAA Station 9414290[1]. The previous day, peak water levels were only 0.3 ft lower and the following day peak water levels were only 0.5 ft lower. Based on the duration of this observed event, whose peak water levels nearly match the 100-yr water level, the duration of the 100-yr and 500-yr events is assumed to be three days. The 50-yr event duration was assumed to be two days, between the 10-year and the 100-yr event duration.

The drainage duration, i.e. the time for flood waters to drain off of the substation after the event has passed, were estimated via simple calculations with readily available data. The detention area created by the surrounding levees and Highway 84 embankment was estimated from a georeferenced aerial photograph. Multiplying this detention area by the inundation depth provides an estimate of the detained water volume inundating the substation. In aerial photographs, there is one hydraulic structure penetrating the surrounding levee, which appears to be a pipe approximately three feet in diameter. Assuming this pipe could discharge at capacity to the bay approximately half the time (to account for tidal water level fluctuations), the time to drain water from the substation was estimated to the nearest day, as reported in Table 1 and Table 2.

Assessment Limitations

This flood hazard assessment is preliminary in nature and only intended for use in the benefit-cost analysis for Menlo Park SAFER Bay to apply for a 2020 FEMA BRIC grant. The values reported in this memorandum are not intended as the basis of design for flood management measures to protect the PG&E Ravenswood Substation. These estimates should be reviewed and refined as necessary when the design process moves forward in the future.

1 https://tidesandcurrents.noaa.gov/waterlevels.html?id=9414290&units=standard&bdate=19830115&edate=19830131&timezone=GMT&datum=NAVD&interval=h&action=

References

AECOM. 2016. San Francisco Bay Tidal Datums and Extreme Tides Study. Prepared for Bay Conservation and Development Commission.

DHI. 2013. Regional Coastal Hazard Modeling Study for South San Francisco Bay. Final Draft Report. Prepared for FEMA, January 2013.

FEMA. 2019. Flood Insurance Rate Maps 0681C0195F and 0681C0307F. San Mateo County. As displayed by FEMA National Flood Hazard Layer Viewer. https://hazards-fema.maps.arcgis.com/apps/webappviewer/index.html

Ocean Protection Council (OPC). 2020. Strategic Plan to Protect California's Coast and Ocean, 2020-2025.