To the Lafayette City Council **May 13, 2024**

Re: Lafayette Reservoir Outlet Tower – EBMUD Seismic Evaluation and Retrofit Studies: Follow-up to April 23rd online meeting between EBMUD, City of Lafayette representatives and the Citizens Technical Advisory Committee

Dear Members of the Lafayette City Council:

As you know, the Citizens' Technical Advisory Committee ("Committee") is a volunteer group composed of citizens of Lafayette. The Committee membership comprises highly qualified structural engineers who are expert in the areas of seismic evaluation and seismic design of structures, and a former national president of the American Institute of Architects.

The Committee members are:

Mason Walters, PE, SE
Jack Moehle, PE, PhD
Loring Wyllie, PE, SE
Matthew Bertics, PE, SE
Gordon H. Chong, FAIA

As volunteers, the Committee members have not performed any of their own seismic evaluation of the Tower, but rather have based the findings discussed herein solely on information provided to the City by EBMUD. The Committee appreciates the participation of EBMUD and their consultants in the multiple in-person and online technical discussions to convey a full understanding of their design approach.

EBMUD Proposed Tower Shortening Scheme

With reference to *Figure 1* below, EBMUD is proposing to shorten the Lafayette Reservoir Outlet Tower ("Tower") by approximately 40 feet as a seismic retrofit measure. To date, EBMUD has defended their proposal to remove this significant portion of the visually exposed height of the Tower by claiming it to be both the safest and most cost-effective solution for the ratepayers.

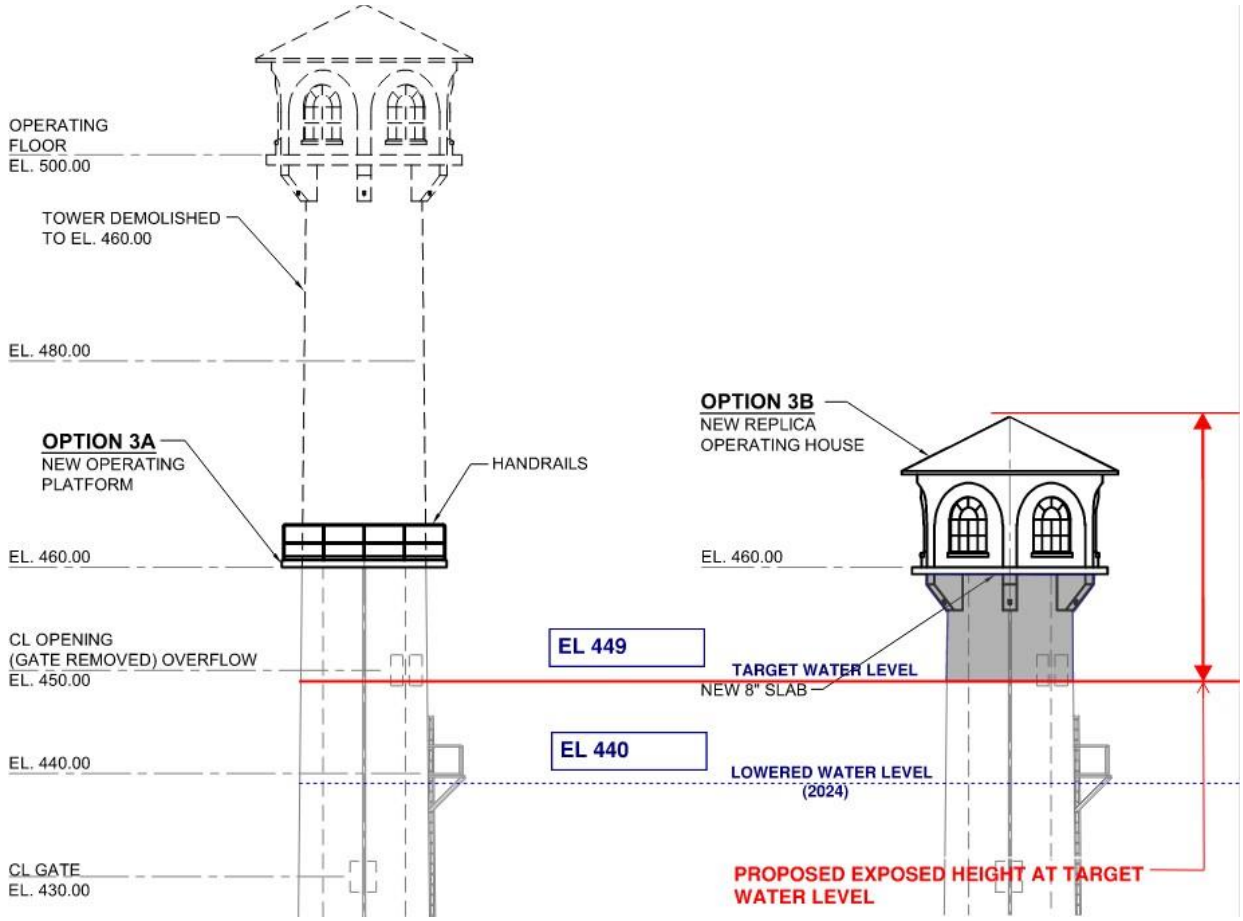

Figure 1 – Side-by-Side Overlay of Tower Shortening Retrofit Option (right) Proposed by EBMUD, Compared to As-Built Tower Height
(Overlay by Committee using EBMUD-provided images)

Citizens' Technical Advisory Committee Consensus Opinion

Based on extensive review of EBMUD's seismic analysis and conceptual design documentation, it is the consensus opinion of the Committee members that EBMUD's proposed shortening of the Tower would *increase* the seismic risk for the downstream residents of Lafayette in a major earthquake, rather than lessening the risk.

The basic idea behind EBMUD's scheme is that decreasing the height of the Tower would reduce the seismic effects on the Tower by eliminating a significant amount of its seismic inertial mass. While shortening of the Tower would reduce "bending" forces in the Tower, doing so would cause the Tower to *shake more violently.* This exacerbated shaking would significantly increase the more pernicious *lateral shear forces* near the base of the Tower. In the Committee's opinion, the resulting intensification of lateral shear forces near the base of the Tower would increase the seismic hazard to the entire Tower structure, and consequently to the emergency outlet system of the reservoir.

The proposed shortening of the Tower would exacerbate the shear problem through the following two mechanisms:

1. EBMUD's own analysis shows that shortening the Tower would change its dynamic response by shortening its vibration “period” (that is, the interval of time over which the Tower sways back and forth once) to a range where the Tower would respond *more violently* to earthquake shaking, which will actually *increase* the critical shear forces on the Tower.

   Structural engineers who practice in the field of seismic design sometimes refer to the above-described phenomenon as “climbing the spectrum.” (Refer to *Figure 2* below for illustration of this effect). Based on results of the evaluation of the Tower shortening scheme by EBMUD’s engineering consultants, the seismic spectral response of the Tower is anticipated to shift to very near the peak (or worst possible) intensity of earthquake ground motion for the criterion-level earthquake spectrum that EBMUD’s seismic evaluation is based upon.

   In simple terms, the shortened *Tower would be expected to shake harder* than the full-height Tower. By EBMUD’s own calculation, the fundamental dynamic period of the shortened Tower retrofit would be reduced to about 55 percent of that for the full- height Tower, which would result in a spectral acceleration in the Tower itself that is about 45 percent higher than for the full-height Tower. This more intense shaking of a shortened Tower would correspond to about a 13 percent increase in the seismic shear at the Tower base, according to EBMUD documentation.

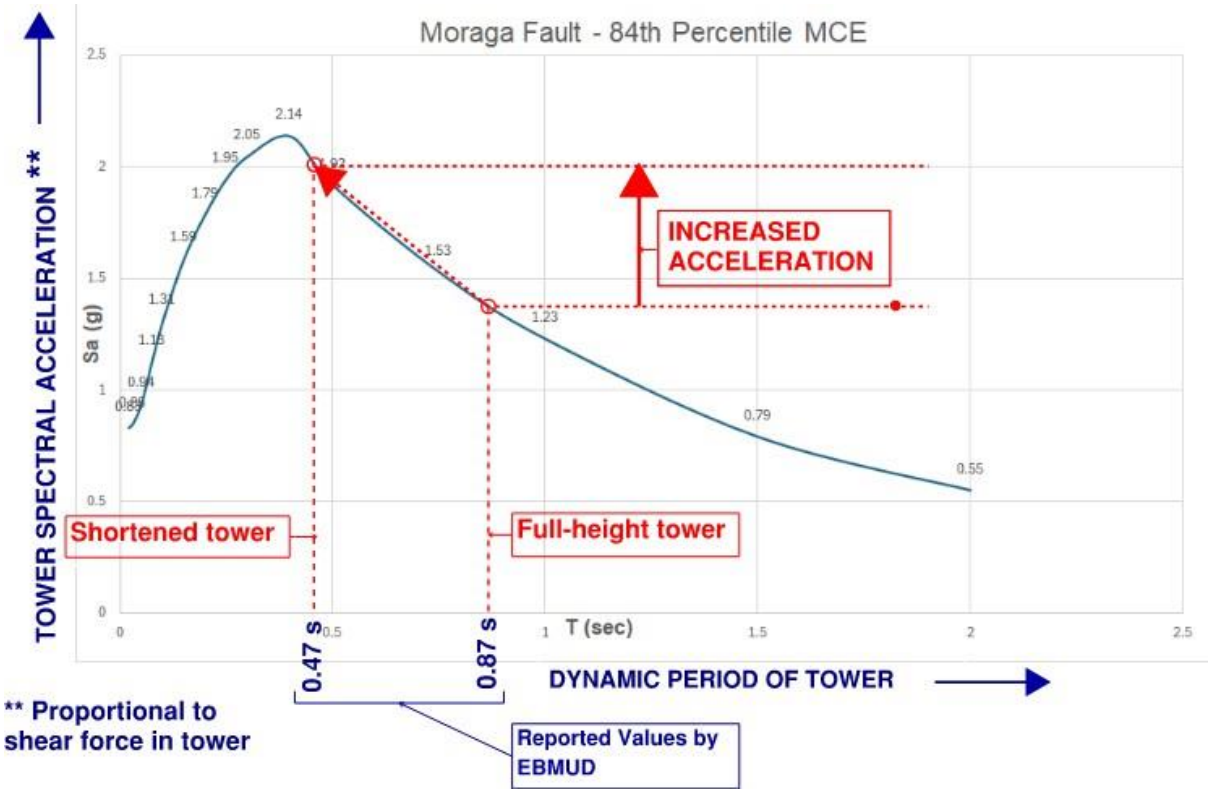

Figure 2 – Dynamic Effects of Tower Shortening

2. Despite the fact that shortening the Tower would reduce its seismic inertial mass, it would correspondingly eliminate hundreds of thousands of pounds of beneficial vertical compressive force on the lower portion of the Tower. Such compression is beneficial in resisting seismic shear forces. This loss of beneficial vertical pressure on the lower walls of the Tower would reduce the benefit to Tower base lateral shear capacity from vertical load.

It is the Committee's consensus opinion that the above two mechanisms would combine to intensify the risk to seismic safety of the Lafayette Reservoir and to downstream residents.

It is notable that EBMUD was informed of the issues discussed above in 1995 by the authors of its earliest seismic evaluation. Specifically, the 1995 ICEC Report titled *Seismic Evaluation of Lafayette Reservoir Tower*, which was written under the direction of Dr. Joseph Penzien, a UC Berkeley professor of structural engineering and structural mechanics who was a pre-eminent international expert and foremost authority in the field of dynamic behavior of structures responding to earthquake ground motion. The evaluation that ICEC performed used a seismic analysis approach like that used in EBMUD's current evaluation with similar results. ICEC's conclusion number 2 on page 11-1, excerpt provided below, is unequivocal in its recommendation to not shorten the Tower:

> The alternative action of reducing the tower height to achieve an acceptable seismic response scenario is not a viable approach, and should not be taken. This is because reducing the tower height increases the seismic demands on the structure and, therefore, does not reduce damage levels.

Conclusion

The Committee understands that EBMUD, along with its engineers and consultants, are ultimately accountable for the Tower retrofit design and are dedicated to the safety of the Lafayette Reservoir and the residents of Lafayette in the event of an earthquake.

We hope that EBMUD recognizes that the City of Lafayette and the Citizens Technical Advisory Committee are likewise committed to safeguarding the facilities and communities downstream. Our dedication to ensuring the safety and well-being of all the downstream residents remains our top priority.

Shortening the Tower would intensify its seismic shaking by its increased lateral acceleration. Such violent shaking would make the seismic shear forces at the base of the Tower worse. The proposed shortening of the Tower would also eliminate a significant amount of beneficial vertical pressure on the reinforced concrete of the Tower base.

It is the Committee's consensus opinion that shortening the Tower would therefore be antithetical to the concept of *"do no harm,"* which is a standard of practice when modifying structures.

The California Division of Safety of Dams (DSOD) has noted that *"the [Lafayette Reservoir] tower system is a critical appurtenance to the dam that serves as both the emergency outlet and spillway for the dam and reservoir. Because of this dual purpose, there are critical risks*

associated with the potential failure of the system that would impact all means of evacuating the reservoir in the event of an emergency or result in an uncontrolled release of the reservoir, which is not acceptable for public safety." EBMUD has also noted that *"For this reason, the safety, reliability, and robustness of the selected alternative is of paramount importance."*

The consensus opinion of the Committee is that Tower shortening would increase the seismic risk to the Tower and the safety of the downstream residents and is therefore not a viable retrofit option.

Sincerely,

Members of the Citizens Technical Advisory Committee