



Agenda Item No. (3)

To: Building and Operating Committee/Committee of the Whole
Meeting of June 24, 2021

From: John R. Eberle, Deputy District Engineer
Ewa Z. Bauer-Furbush, District Engineer
Denis J. Mulligan, General Manager

Subject: **APPROVE ACTIONS RELATIVE TO PROFESSIONAL SERVICES AGREEMENT NO. 2010-B-1, GOLDEN GATE SUSPENSION BRIDGE SEISMIC AND WIND RETROFIT PHASE IIIB DESIGN SERVICES, WITH HDR ENGINEERING, INC., TO PERFORM WIND TUNNEL TESTING OF THE SUSPENSION BRIDGE SOUND ATTENUATION MEASURES**

Recommendation

The Building and Operating Committee recommends that the Board of Directors approve the following actions relative to Professional Services Agreement (PSA) No. 2010-B-1, *Golden Gate Suspension Bridge Seismic and Wind Retrofit Project Phase IIIB Design Services* with HDR Engineering, Inc., Walnut Creek, CA:

1. Authorize execution of the Fourth Addendum to the Ninth Amendment to PSA No. 2010-B-1 in an amount not to exceed \$130,420, to perform wind tunnel testing of measures to attenuate the wind-induced sound emanated by the new bridge railing at the Golden Gate Suspension Bridge; and,
2. Establish a 15% contingency for the Fourth Addendum in the amount of \$19,500,

with the understanding that sufficient funds to finance the Fourth Addendum to the Ninth Amendment to the PSA and its contingency are available in the budget for the Golden Gate Suspension Bridge Seismic and Wind Retrofit Phase IIIBCMGC Design Project (Project #1923).

This matter will be presented to the Board of Directors at its June 25, 2021, meeting for appropriate action.

Summary

At its December 16, 2016 meeting, the Board of Directors, by Resolution No. 2016-087, authorized the award of construction Contract No. 2016-B-01, *Golden Gate Bridge Physical Suicide Deterrent System and Wind Retrofit Projects* to Shimmick Construction Company, Inc./Danny's Construction Company LLC, a Joint Venture. The Suspension Bridge Wind Retrofit portion of the

construction involves removal and replacement of the west bridge railing and installation of a wind fairing along the west side of the Suspension Bridge main span, between the two main towers. The inclusion of the Wind Retrofit in Contract No. 2016-B-01 was necessary to mitigate any effect the Physical Suicide Deterrent System could have on the Suspension Bridge to sustain strong winds.

By the end of May 2020, the contractor for construction Contract No. 2016-B-01 had installed approximately 75% of the new railing. In June 2020, during periods of high northwesterly winds, wind-induced sounds were heard coming from the Golden Gate Bridge. The sounds appeared to be a result of the wind passing through the new west bridge railing.

Under PSA No. 2010-B-1, the Golden Gate Bridge, Highway and Transportation District (District) has retained services of HDR Engineering, Inc., to prepare the final design and plans and technical specifications for the Golden Gate Bridge Seismic and Wind Retrofit (part of Project #9102, *Golden Gate Bridge and Wind Retrofit Phase III Design Project*). By Resolution No. 2017-047, the Board of Directors authorized execution of the Ninth Amendment to PSA No. 2010-B-1 for HDR and its subconsultants, including Rowan Williams Davies and Irwin Inc. (RWDI), to perform wind tunnel testing of a scaled Suspension Bridge model to determine the effects of the temporary construction supports and platforms on the aerodynamic characteristics of the Suspension Bridge.

Considering RWDI's expertise in aerodynamics and acoustics, in early July 2020 the District engaged services of HDR and its subconsultants, including RWDI, to conduct sound camera measurements at the Bridge to determine which elements of the new bridge railing were participating in the sound generation and what the level and frequency of tones were emanated. Also in July 2020, by Resolution No. 2020-044, the Board of Directors authorized execution of the Second Addendum to the Ninth Amendment to PSA No. 2010-B-1 for HDR and RWDI to perform wind tunnel testing and acoustic studies on full scale specimens of the new bridge railing and fairing in order to replicate, in the laboratory, the wind-induced sounds and to determine what modifications, if any, could be made to reduce or eliminate the sound without impairing the effectiveness of the wind retrofit. The scope of work included:

1. Fabricating full-scale test specimens of the wind retrofit elements.
2. Performing wind tunnel and acoustic laboratory tests on the specimens and confirm the cause of the wind-induced sound.
3. Developing potential sound mitigation measures.
4. Performing wind tunnel and acoustic laboratory tests on the modified specimens to determine sound elimination effectiveness of the mitigation measures.
5. Preparing a report documenting methodology and findings of the wind tunnel and acoustic tests, and present recommendations regarding the mitigation measures.

Wind tunnel testing was conducted by RWDI from October 25, 2020 to November 5, 2020. The test specimens were subjected to air flow at various angles and speeds, with a top speed of approximately 67 miles per hour. The tests replicated the low, 400-500 Hz, and the high, about 1.1 kHz, frequency tones, recorded at the Bridge. The tests verified that the sound was generated by interaction between railing pickets and wind flowing around the pickets. The tests also verified that the railing posts, the top rail and the wind fairing were not engaged in the sound generation.

The low frequency tone was found to be dependent on speed and angle of wind. The wind tunnel testing demonstrated that the low-frequency tone continuously increased in frequency with increasing wind speed. Therefore, depending on the observed wind speed, this tone could span a wider range of frequencies than originally observed at the Bridge. Wind tunnel testing results indicate that this tone occurs at frequencies as low as 280 Hz to frequencies as high as 700 Hz. The high-frequency tone was noted to be persistent at approximately 1.1 kHz, with no significant change relative to the wind speed. Wind tunnel testing at various angles showed a difference between the low-frequency and high-frequency tones in terms of their loudness. The two tones did not appear to be correlated as the onset of tones did not occur at the same time and tone loudness did not increase and decrease simultaneously.

The consultant developed and tested a series of different modifications of the pickets to determine the effectiveness of the modifications in preventing the emanation of sound. Potential mitigation options were subdivided into four categories:

1. Structural changes consisting of the addition of horizontal bars attached to the pickets.
2. Disruption of airflow by applying coarse tapes to the leading and trailing edges of the pickets.
3. Disruption of airflow and damping of picket vibration by fitting plexiglas c-shape clips over the picket leading and/or trailing edges; or by applying anti-vibration viscoelastic textured paint to the wide faces of the pickets.
4. Damping of picket vibration by filling the top rail cavity with metal to increase railing mass and its damping capacity.

Category 3 mitigation option consisting of c-shape clips fitted over the edges of pickets showed an ability to significantly reduce the lower-frequency tone, which appeared only weakly at high wind speeds (>55 mph), while the higher-frequency tone was eliminated for all tested speeds and angles.

Engineering and the consultant reviewed and evaluated the test results and developed c-clip designs with damping material inserts, which, based on the previously conducted tests, could be a potentially effective measure to attenuate the sound. In addition, the designs account for the clips to be easily fabricated, to be readily installed on the bridge railing pickets, to be durable enough to withstand the harsh environmental conditions at the Bridge, to be relatively easy to maintain, and to have no negative impact on the effectiveness of the wind retrofit. It was concluded that rectangular or chamfered aluminum c-clips fabricated to precise dimensions to fit over the edges of pickets would satisfy the above listed requirements. To verify the sound attenuation capability of c-clips and the most effective configuration of clips installed on leading and/or trailing edges of the pickets and with different thicknesses of vibration damping inserts, additional wind tunnel testing of different arrangements of the aluminum c-clips is required.

Under the General Manager's authority, payment in an amount of \$39,000 for manufacturing of custom dies for fabrication of the c-clips, procurement of the aluminum clip material and vibration damping material, fabrication of 400 clips and power coating/painting of the clips has been included in the Third Addendum to the Ninth Amendment to the PSA to be financed from the contingency authorized with the Second Addendum to the Ninth Amendment. These services will be reimbursed on a time and material basis.

Engineering staff requested, and HDR Engineering, Inc. provided, a cost proposal in the amount of \$130,420 to perform the wind tunnel testing and analysis of the sound attenuation capability of c-clips and the most effective configuration of clips with different c-clip geometries and with different thicknesses of the vibration damping inserts installed on leading and/or trailing edges of the pickets.

Engineering staff has reviewed the proposal and found it to be fair and reasonable in terms of consultant's budgeted labor hours to perform the additional scope of services requested by the District and consistent with the consultant's audited labor and overhead billing rates.

The District's Disadvantaged Business Enterprise (DBE) Program Administrator has verified that the subconsultant work under the Fourth Addendum includes 9.2% DBE participation.

Staff recommends that the Building and Operating Committee recommend that the Board of Directors authorize the execution of the Fourth Addendum to the Ninth Amendment to PSA No. 2010-B-1 with HDR Engineering, Inc., in the not to exceed amount of \$130,420, to perform the wind tunnel testing and analysis of the sound attenuation measures as presented in this report. HDR will be compensated for actual time expended and expenses incurred plus fixed fee. Staff also recommends that a 15% contingency for this Fourth Addendum in the amount of \$19,500 be established for any additional scope of services that may develop while work progresses.

Fiscal Impact

On April 26, 2019, by Resolution No. 2019-023, the Board of Directors authorized the establishment of Project #1923, *Golden Gate Bridge Seismic and Wind Retrofit Phase IIIB/CMGC Project*. To finance Project #1923, by the same resolution, the Board approved a transfer to Project #1923 budget of all unspent Federal Highway Administration funds from Project #9102, *Golden Gate Bridge Seismic and Wind Retrofit Phase III Design*, and Project # 9206, *Golden Gate Bridge Phase IIIA Construction*. After the close-out of Project #9102 and Project #9206 had been finalized, the unspent funds in the amount of \$9,861,844 budget (100% federal funds) were transferred to finance Project #1923.

Sufficient funds are available in the \$9,861,844 budget of Project #1923 to finance the proposed Fourth Addendum to the Ninth Amendment to PSA No. 2010-B-1 in the amount of \$130,420, and the addendum contingency of \$19,500, for a total of \$149,920.

The following is the history of PSA No. 2010-B-1:

DESCRIPTION	DATE APPROVED	RESOLUTION NO.	AMOUNT	SOURCE OF FUNDS
Original Contract PSA No. 2010-B-1	11/17/2010	2009-070	\$18,258,232	100% Federal (part of the Phase III Design Project,) Project #9102
Wind-Lock Repair Design				100% District (not part of the Phase III Design Project)
1 st Amendment	10/3/2012	under the GM authority	\$24,576	
and				
2 nd Amendment	7/3/2013	under the GM authority	\$11,449	
		<hr/> Total Wind-Lock Repair Design	<hr/> \$36,025	
No Cost Time Extension				
3 rd Amendment	9/26/2013		\$0	
and				
6th Amendment	12/31/2016		\$0	
EDD Testing				100% Federal (part of the Phase III Design Project) Project #9102
4 th Amendment	3/4/2015	2015-008	\$1,521,789	
and				
1 st Addendum	1/25/2016	under the GM authority using the authorized 4 th Amendment contingency	\$152,034	
		<hr/> Total EDD Testing	<hr/> \$1,673,823	

Wind Tunnel Testing				100% Federal (part of the Phase III Design Project) Project #9102
9 th Amendment and 1 st Addendum	5/26/2017 11/17/2017	2017-047 2017-106	\$191,000 \$216,500	
2 nd Addendum and 3 rd Addendum and <u>4th Addendum, proposed</u>	7/24/2020	2020-044 Under GM authority using the authorized 2nd Addendum Contingency	\$260,218 \$39,000 <u>\$130,420</u>	100% Federal (part of the Phase IIIB Design/CMGC Project) Project #1923
		<u>Total Wind Tunnel Testing (proposed)</u>	<u>\$837,138</u>	
Risk Assessment Plan and Major Project Management Plan				100% Federal (part of the Phase III Design Project) Project #9102
10 th Amendment	7/28/2017	2017-068	\$399,000	
Testing of EDD Welding Procedures				100% Federal (part of the Phase IIIB Design/CMGC Project) Project #1923
11 th Amendment	5/16/2019	2019-037	\$235,500	
		<i>TOTAL PSA AMOUNT proposed</i>	<i>\$24,121,630</i>	

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