Hanson Aggregates Mid-Pacific, Inc.
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March 17, 2015

Honorable Members of the Commission
Mr. Larry Goldzband, Executive Director
San Francisco Bay Conservation & Development Commission
455 Golden Gate Avenue, Suite 10600
San Francisco, California 94102
larry.goldzband@bcdc.ca.gov
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SUBJECT: **March 19, 2015 Public Hearing – Calendar Items 9, 10, 11, and 12:**
Hanson Marine Operations Permit Application No. 2013.004.00
Suisun Associates Permit Application No. 2013.005.00md
Lind Marine Incorporated Permit Application No. 2013.003.00
Hanson Marine Operations Permit Application No. 2013.006.00

Dear Commissioners and Mr. Goldzband:

This letter responds to the four Staff Summaries and other materials submitted to you on our permit renewal applications. The four Staff Summaries discuss many of the same matters, often in the same words. To consolidate our responses we have responded to each of these summaries in this one letter with attachments to provide greater detail. Contributors to information within the Attachments include Barry Keller, PhD, Briscoe Ivester & Bazel LLP, Boudreau Associates, Coast & Harbor Engineers, Downey Brand LLP, Environ, EPS, and Hanson Environmental and Hanson and Lind the only entities mining sand in the Bay today.

Below we provide a summary of key points for sand mining permit renewals. A project overview and responses to each of the seven issues identified in the BCDC Staff Summaries are provided as Attachment 1. We have also attached four tables with technical and factual corrections of errors, clarifications and responses for each Staff Summary (Attachment 2), as well as reference documents (Attachment 3) for greater detail and the Commission's consideration.

SUMMARY OF KEY POINTS

Sand mining has been ongoing in the Bay for more than 70 years. Marine sand is a local resource and is essential to the needs of modern society, providing material for the construction and maintenance of roadways, dams, canals, buildings, and other parts of California's infrastructure. Sand is also found in homes, schools, hospitals, and shopping centers. Demand for aggregate is expected to continue to increase as the State's population grows and infrastructure is maintained, improved and expanded. The list below provides key points that we ask the Commission consider in its review of the Project:

- The permitting process has been lengthy, including 6 years of environmental review by the State Lands Commission and two-plus years of review by each of the regulatory agencies. The State's EIR found that the majority of impacts related to the Project were less than significant. Those impacts that appeared unavoidable at that time—e.g., impacts to Delta and longfin smelt—have since been "fully mitigated." Of particular importance to BCDC's Bay Plan policies, the EIR concluded that the Project "is not expected in itself, or in combination with other projects, to result in a substantial alteration of sediment transport patterns or the morphology of the seabed outside of the vicinity of the lease areas." All of the key permitting agencies have been consulted directly on the Project and were part of the environmental review process.

- Over the course of almost three years, we have submitted volumes of supplemental information to BCDC staff, in response to its requests. Our supplemental information has been based on the best available scientific evidence and the most current state of knowledge for various issue areas. This information, among other things, shows:
    - Use of alternative sand resources will increase greenhouse gas emissions by as much as 240% (2.4x) and SOx emissions by 4,400% (44x), in direct conflict with state and regional policies governing climate and air quality; and
    - The EPS Economic Analysis (Appendix B) showed substantial costs savings for construction, infrastructure, and restoration projects by using local Bay sand resources.

- Permitted annual volumes have been reduced substantially, from 2,240,000 cubic yards ("cy") in the previous permits, to 2,024,000 c.y. in the State leases, to 1,613,000 cy under the San Francisco Bay Regional Water Quality Control Board ("Regional Board") approvals in January—a total reduction of twenty-eight percent (28%) in permitted volumes. The Applicants are thus minimizing impacts and conserving sandy habitat under BCDC's Subtidal Policies 1 and 2.

- The public and environmental benefits of the Project cannot be overstated. Bay sand is a local resource that provides local jobs and serves the Bay Area economy. Use of Bay sand (as opposed to alternative resources) significantly reduces air and greenhouse gas emissions, regional traffic, and infrastructure and other construction costs. Local public projects have directly benefitted from marine sands, and have included the Hunters Point Reclamation Project, Crown Beach Restoration, Presidio Parkway Construction, and various hospital reconstruction and CalTrans projects.

- Hanson and Lind cannot feasibly develop alternative sources to marine sand mining. We provided Staff with a Technical Feasibility Analysis (Appendix C) that evaluated the feasibility of the project as well as its consistency with BCDC policies. Principal conclusions from this analysis include:

    - The State Lands Commission's findings show no substantial evidence exists that sand mining harms the resources listed in Subtidal Policy 1.[1] That policy calls for projects to seek to minimize or avoid harm "if feasible."

    - Sand mining already occurs in a manner that minimizes disturbance of the Bay due to practical and technical limits on it (mining, for example, is already limited to specific areas, methods, and equipment).

    - Hanson and Lind are already taking measures to avoid, minimize and mitigate effects; those measures are conditions in the State Lands leases, the Regional Board permits, CDFW ITP, and NMFS and USFWS Biological Opinions (Detail provided in Attachment 1).

    - Lind's *only* source of aggregate is sand it mines from Middle Ground and Suisun Channel. Lind does not import aggregate, nor is it in the business of producing land-based sands. Lind cannot feasibly abandon its existing business and entitlements and obtain property rights, permits and entitlements, and build a capital infrastructure to enter an entirely new market. For this additional reason, there is no feasible alternative to sand mining for Lind Marine.

- As in virtually all fields of human endeavor—medicine, pharmacology, space exploration—scientific uncertainties remain. Hanson and Lind have performed numerous studies and will be conducting additional studies (e.g. bathymetric, benthic, water quality) that have been and will be used extensively by professional scientists in the technical literature. We are committed to continuing to contribute to the development of this body of scientific knowledge. Futhermore, we have submitted a proposal to BCDC staff to form a Technical Advisory Committee focused on sediment transport issues and fund reasonable modeling / studies to augment our current understanding of the system and to inform future policy decisions.

For these and the many reasons outlined in the Applicant materials in the administrative record, we are asking the Commission to approve the renewal of Project permits for another ten years with the peak and average volume limits in the application, consistent with the January approval by the Regional Board.

Lastly, BCDC has received comments letters from Coastal Commission staff and the San Francisco Baykeeper, Inc. Responses to each of the letters are provided as Appendices for your review.

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[1] It has been suggested that any physical change to Bay bathymetry or benthic habitat is "harm".. But, "harm" does not mean just any physical change; rather, harm encompasses only those physical changes that are adverse or detrimental or cause injury.

Lastly, BCDC has received comments letters from Coastal Commission staff and the San Francisco Baykeeper, Inc. Responses to each of the letters are provided as Appendices E and F respectively for your review.

Thank you for your consideration in this matter. If you have any questions please contact Mike Roth at (925) 244-6561 or Bill Butler at (925) 785-0057.

Sincerely,

Mike Roth
Vice President
Lehigh Hanson

William H. Butler
Vice President, Regulatory Affairs
Lind Marine

Attachments

1 – Response to BCDC Staff Summary Issues
2- Tables of Technical Corrections and Clarifications for each staff summary
3 – Reference Documents (Appendices to Attachment 1)
 Appendix A - Environ – Air Quality Analysis
 Appendix B - EPS Economic Analysis
 Appendix C - Technical Feasibility Analysis
 Appendix D - CHE Technical Analysis
 Appendix E - Downey Brand LLP Letter re Baykeeper Comments, March 17, 2015
 Appendix F - Downey Brand LLP Letter re Coastal Commission Staff Comments, March 17, 2015

ATTACHMENT 1

Response to BCDC Staff Summary Issues

RESPONSE COMMENTS ON BCDC SAND MINING STAFF SUMMARIES

PROJECT DESCRIPTION

The Project comprises the extension of four permits held by the Permit Applicants—Hanson Marine Operations ("Hanson"), Lind Marine Incorporated ("Lind", formerly Jerico Products, Inc.), and Suisun Associates—that will allow them to continue mining construction-grade sand at specified locations within the Central San Francisco Bay ("Central Bay"), Suisun Bay, and the western Delta. After six years of environmental review, the State Lands Commission ("State") in October 2012 certified an Environmental Impact Report ("EIR") and approved the Project for total permitted volumes at 2,040,000 cubic yards ("cy") per year for another 10-year term.

Volumes mined in any given year vary significantly due to fluctuations in market demand. For this reason, permitted volumes have historically been described as annual and 10-year maximums. That does not mean, of course, that future mining will occur at those maximum levels, and certainly not in every year. For example, during the previous 10-year permit term (1998–2007), Hanson and Lind averaged 1,478,131 cy annually and reached a peak of approximately 1,980,000 cy. Further, the volumes authorized by the State in 2012 represent a *decrease* in overall permitted volumes, from 2,240,000 to 2,040,000 cubic yards ("cy") per year—a *reduction* of 200,000 cy per year (or 9%).

Two months ago the San Francisco Bay Regional Water Quality Control Board ("Regional Board") reduced permitted mining volumes further. As approved by the Regional Board, sand mining volumes were reduced from the State-approved volume of 2,040,000 cy per year over 10 years to an average of 1,613,000 cy per year, with allowable "peaks" in any given year to as much as 1,950,000 cy. The Regional Board added further restrictions on mining within the two southern Central Bay leases (PRC 709.1 and PRC 7780.1), as those areas were identified as the most probable connection to ocean-ward sediment transport pathways, as shown in Table 1.

We originally applied to BCDC at the same volumes approved by the State Lands Commission (2,040,000 cy). Since the Regional Board's ruling in January, we have amended our permit applications to reflect the Regional Board-approved volumes. These new limits mark a substantial decrease in permitted volumes (from 2,240,000, a decrease of 28%). Under these new limits, the ability of Hanson and Lind to peak at the higher levels is crucial to their ability to respond to fluctuations in market demands and the relatively fixed costs afforded sand mining over a 10-year permitting cycle.

Table 1. Sand Mining Annual Volumes

Lease Area	Applicant's Proposed Volumes	Regional Board Permitted (January 21, 2015)	
		Annual Average Volumes	Annual Peak Volumes
Hanson - Central Bay			
Total All Leases	1,540,000 cy	1,203,000 cy	1,450,000 cy
PRC 709.1	340,000 cy	232,000 cy	290,000 cy
PRC 2036.1	450,000 cy	360,000 cy	450,000 cy
PRC 7779.1	550,000 cy	484,000 cy	550,000 cy
PRC 7780.1	200,000 cy	127,000 cy	160,000 cy
Hanson - Middle Ground	50,000 cy	40,000 cy	50,000 cy
Lind - Middle Ground	150,000 cy	125,000 cy	150,000 cy
Suisun Associates – Suisun Channel	300,000 cy	245,000 cy	300,000 cy
Totals:	2,040,000 cy	1,613,000 cy	1,950,000 cy

ISSUES RAISED

BCDC staff in their summaries and analyses of the permit applications raised seven primary issues (p. 2). We address each below in the order listed in the Staff Summary.

1) **Whether The Proposed Level Of Mining Is Consistent With Subtidal Area Policy 1 Which Calls For Projects In Subtidal Areas To Be Designed To Minimize Harmful Effects To Tidal Hydrology, Sediment Movement, And Bay Bathymetry.**

The Staff Summary listing the "Issues Raised," identifies the first issue—tidal hydrology, sediment movement, and Bay bathymetry—as involving Subtidal Policy 1. The body of the analysis, however, also lists Subtidal Policy 2 (among other policies). The two key policies are:

- Subtidal Policy 1 states that projects in subtidal areas should be designed to minimize and, if feasible, avoid harmful effects;
- Subtidal Policy 2 states that changes in use and dredging projects in sandy deep water areas be allowed "only if: (a) there is no feasible alternative; and (b) the project provides substantial public benefits."

The amended permit applications satisfy these two Bay Plan Policies, as follows:

a) **Sand mining has been minimized to the extent feasible.** BCDC staff requested that Hanson and Lind prepare a technical feasibility analysis to address application of Subtidal Policies 1 and 2 to sand mining. The Technical Feasibility Analysis is enclosed as Appendix C, and its conclusions are summarized in Section 3, below. Sand mining disturbs less than 2.2% of all available sandy habitat within the Bay in any given year (see Section 2). As provided in Section 3, potential impacts from sand mining are minimized in several respects, including the overall reduction in volumes to 1,613,000 cy (average annually), special reductions in the southern-most lease areas (37% reduction from PRC 7780 and 32% reduction from PRC 709.1), and geographic limits on mining within specific lease areas.

b) **The Bay Plan should be interpreted to address only "substantial harm" so as to avoid extreme results.** In a staff report to the Commission dated August 6, 2004 page 9, BCDC's Executive Director stated that Subtidal Policy 2 (and its reference to harm) reflected "the staff's understanding that the resource protection objectives of the policy are directed only at those activities that would substantially harm areas that are scarce or rich in aquatic life." While directed at Subtidal Policy 2, this position applies equally to Subtidal Policy 1 (which includes "harm" as a necessary prerequisite). Limiting Subtidal Policies 1 and 2 to only those activities that "substantially harm" subtidal areas is consistent with the Commission's position generally that it interprets its authorities "pragmatically and reasonably."[1] To hold otherwise would render any activity, however marginal, in conflict with the Subtidal Polices, an extreme result.

c) **The State's EIR found that impacts to tidal hydrology, sediment movement, and Bay bathymetry are not likely to be measurable outside the immediate lease areas.** Before approving the lease extensions, the State Lands Commission undertook a comprehensive environmental review—including an extra round of review in a Recirculated Draft EIR—to ensure that decision makers and the public would have a complete and accurate examination of the possible environmental effects of the Project. In conducting this analysis, the State engaged independent experts, among them Applied Marine Sciences ("AMS") and Coast & Harbor Engineering ("CHE") to evaluate benthic habitats and Bay and coastal hydrology and geomorphology. After conducting an extensive evaluation of hydrology, sediment transport, sediment supply, and coastal erosion, the SLC expressly

[1] *Save San Francisco Bay Ass'n v. San Francisco Bay Conservation and Dev. Com.* (1992) 10 Cal.App.4th 908, 926 [despite the seemingly strict and unequivocal language of the McAteer-Petris Act ("MPA") compelling the Commission to consider upland alternatives to filling the Bay, the Commission took the position—and the First Appellate District agreed—that even the strictest provisions of the MPA could be applied "pragmatically and reasonably" to avoid "extreme result[s]. . . ."].

found that sand mining at the full volumes originally applied for (2,040,000 cy annually) "is not expected in itself, or in combination with other projects, to result in a substantial alteration of sediment transport patterns or the morphology of the seabed outside of the vicinity of the lease areas."

The Regional Board further reduced permitted mining volumes to an average annual volume of 1,613,000 cy (with peak volumes limited to 1,950,000 cy), which further minimizes potential impacts from sand mining.

d) **Staff estimates of sand influx to the Bay are speculative.** The Staff Summaries attempt to estimate the amount of sand coming into the Bay by piecing together data and conclusions from other studies that have been conducted over the years. But sediment movement and tidal hydrology are complex systems within the Bay and coastal areas that are driven both by natural and anthropogenic influences. The Science Panel convened at BCDC's request, for example, concluded that there are multiple variables that influence the sediment transport system. During the Science Panel none of the sediment transport experts or coastal geologists assembled for the panel presented any information that contradicted the findings in the EIR. Hanson and Lind's review of the Staff Summaries have found multiple inaccuracies or misleading statements, including the estimate of sand flux to the Bay—a number which has never been produced by the scientific community. Hanson and Lind have provide a detailed list of comments to each of the Staff Summaries which are provided as Attachment 2. Although we commend the efforts to address questions posed by the Commissioners, it should be clearly noted that volume estimates of sediment entering the Bay system presented were generated by BCDC staff, and not scientists expert in geomorphology. Within these sections, the staff summaries also did not provide sufficient detail on the development of the conceptual model used nor provided any accompanying materials to show the methodology or calculations, making it impossible to peer review the numbers. Hanson and Lind recommend that before numbers formulated by BCDC staff are utilized in policy decision making that BCDC staff formulations and estimates for this complex system should be thoroughly and professional reviewed either by sediment transport experts to address the state of knowledge and review and confirm results from the FEIR. This is an example of information that could be generated through Technical Advisory Committee Study Process (see Section 1g).

e) **The modeling conducted for the State Lands Commission represents the best scientific information available on the Project's contribution to the sediment system.** The Staff Summaries state that, with regard to the modeling conducted for the State, it "is difficult to determine whether this is a fully accurate description of mining effects…" The modeling conducted for the State was reviewed by BCDC and others through a collaborative and public process and represent a thoughtful application of a reasonable tool to provide conclusions about mining impacts. The modeling conduct by CHE was used to determine how and whether mining holes generated by a specific volume of mining activity (10 years assumed to occur all at once, a worst-case scenario) would change tidal currents, capture sediment, transform Bay bathymetry (e.g., migrate, widen or shallow the holes), or result in sand deficits or physical changes elsewhere (e.g., the Offshore Bar and Ocean Beach). The model did not need to replicate longer-term large-scale morphology to provide an indication of how the mining holes affect other areas because in analysis of changes outside the lease areas, we have assumed the same level of changes would occur annually, which is not the case in reality as the mining holes would very slowly fill in, each year causing less and less change in other areas until they obviously cause no changes elsewhere when filled in completely. While modeling can never perfectly predict the future, the modeling here is the best and most accurate scientific evidence available to evaluate the possible effects of mining on the sediment system.

f) **The sediment transport system is complex, with a multitude of factors affecting the Bar and Ocean Beach.** Historically, high rates of sediment contribution to the estuary's watershed may have contributed substantially to the formation and evolution of the San Francisco Bar. Indeed, during the second half of the 19th century, hydraulic mining in the Sierra Nevada released an estimated 850 million cubic meters of sediment *into the Bay*—over four times the volume estimated to have been removed from the Bay through dredging, aggregate mining, and borrow pit mining combined over the last century.[2] The Bar may be shrinking over time simply due to a dramatic reduction in the "pulse"–the supply of sediment from the historic hydraulic mining.

As to Ocean Beach, the Staff Summaries have omitted the fact that southern Ocean Beach has experienced a long-term erosion trend since the late 1800s during a time when the hydraulic mining pulse was depositing excess sediment into the Bay,[3] not to mention the "erosion-causing flows" created by the sewage outfall pipe.[4] Indeed, during the Sand Mining Science Advisory Panel hosted by BCDC in January of 2014, Patrick Barnard stated:

> Southern Ocean Beach in particular, there are other aggravating factors. Among them is the fact that the shoreline was built out during the great highway construction in the 1920's. So it doesn't want to be where it is right now. Secondly, there is an outflow pipe immediately adjacent to the erosion, the erosional hotspot. The whole area is eroding, and that's in the background. . . .

In addition, most of the "shoreline from Crissy Field Beach to northern Ocean Beach has been stable or experienced net accretion since the late 1800s," and significant amounts of

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[2] Barnard, Patrick L. et. al. (2012) *Synthesis Study of an Erosion Hot Spot, Ocean Beach, CA*, Journal of Coastal Research, 28(4), p. 914.
[3] *Id*. at p. 905; *see also* Dallas, Kate L. and Barnard, Patrick L. (2011) *Anthropogenic influences on shoreline and nearshore evolution in the San Francisco Bay coastal system*, Estuarine, Coastal and Shelf Science, 92(1), p. 202.
[4] Barnard, Patrick L. et. al. (2012) *Synthesis Study of an Erosion Hot Spot, Ocean Beach, CA*, Journal of Coastal Research, 28(4), p. 913.

accretion are also present offshore and south of the longitudinal bar west of Ocean Beach.[5] All of these facts highlight the complexity of the issues surrounding sediment transport, sediment supply, and coastal erosion.

For additional information on the current assessment of the state of the data and its effect, if any, on the State Lands Commission's analysis, see Appendix D (CHE Analysis).

g) **To add to the scientific knowledge of the sediment system, Hanson and Lind have committed to continued bathymetric surveys and proposed a new Technical Advisory Committee ("TAC").** To increase the knowledge of the sediment system, including how much sand is transported to and through the Bay, Hanson and Lind have proposed to conduct a study guided by a new TAC, which would include scientific experts and representatives from BCDC, the State Lands Commission, and other agencies actively involved in these issues. Numerous researchers within the scientific community are actively studying the hydrodynamics and transport of sediments within the Bay system for the purpose of guiding significant policy decisions, in particular in terms of water management. Hanson and Lind propose forming a TAC that would focus on developing a work plan that utilizes existing data and bay-wide models.

2) Whether The Proposed Level Of Mining Is Consistent With Subtidal Area Policy 1 Which Calls For Projects In Subtidal Areas To Minimize Impacts To Fish, Other Aquatic Organisms And Wildlife.

The Staff Summary outlining "issues" mentions only Subtidal Policy 1 with regard to fish and other organisms and Wildlife (p. 7), but the body of the analysis lists Subtidal Policy 2 as well (p. 21). Subtidal Policy 1 states that projects in subtidal areas should be designed to minimize and, if feasible, avoid harmful effects. Subtidal Policy 2, on the other hand, states that projects in sandy deep water areas be allowed "only if: (a) there is no feasible alternative; and (b) the project provides substantial public benefits." As set forth above in Section 1, BCDC has historically interpreted the term harm to mean substantial harm. For further analysis of the application of Subtidal Policies 1 and 2, please see the attached Technical Feasibility Analysis.

As a threshold matter, only a fraction of each lease site—and an even smaller fraction of all available sandy habitat in the Bay—is disturbed by sand mining, even during peak years. Of the total Sandy Habitat within the Bay (12,800 acres), the percent disturbed during mining is less than 2.2%, even in peak years. This affirms that mining affects only a small percentage of available habitat within the Bay in any given year.

[5] *Id*. at p. 911.

The Staff Summary states that impacts to biological communities in the Bay are "not well understood" (pp. 26-27) and that such impacts are "difficult to assess" (p. 31). The Project's possible effects on benthic habitats and fish and wildlife were evaluated extensively in the EIR, which concluded that:

> In its assessment of the benthic infaunal communities in the Bay-Delta mining leases in Central Bay, Suisun Bay, and the western Delta, AMS investigated whether sand mining activities had any detectable effect on community composition and abundance (AMS 2009a [Appendix F]). AMS reported that the benthic infauna community in Central Bay was very low in species diversity and individual species abundances compared to other areas of the Bay-Delta and that sandy sediments with little silt and clay fractions, and low organic composition, characterized the sediment composition in the areas of the mining leases where mining occurs (AMS 2009a [Appendix F]). . . . AMS also reported that they could detect no effect of sand mining in the Central Bay leases, and surmised that this is attributable to the natural instability of the sediments in this area caused by the high-energy regime that is present in west Central Bay (AMS 2009a [Appendix F]).[6]

The AMS study is the only site-specific benthic evaluation comparing mined sites to unmined sites and is the best available science for these sites to date.

During the Sand Mining Science Advisory Panel convened by BCDC staff last year, none of the biologists or oceanographers assembled for the panel presented any information that contradicted the findings in the EIR. Indeed, Jay Johnson of AMS noted that sand mining may actually help support aquatic species associated with benthic habitats. He stated that in the areas where mining has occurred, the "physical dynamics would suggest" that these areas would "become carbon sinks" and the communities inhabit those mined areas will be "enriched," i.e. "more diverse" with "more species . . . which could be preferable for some species of fish that would feed on those animals."[7]

Furthermore, as to Suisun Bay, the Science Panel concluded that regarding impacts to benthic species this area will display extreme resilience to whatever activities occur there because of the nature and abundance of the invasive species (clams).[8] Thus, statements made during the Science Panel do not contradict, but rather affirm the EIR's prior findings that the Project would likely have no detectible adverse impact on benthic habitats and associated beneficial uses.

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6 FEIR, p. 4.1-43.

7 Science Panel, Panel 3, Comments of Jay Johnson, AMS.

8 Science Panel, Panel 3, Francis Parchaso [corbicula and potamocorbula clams "have basically taken over that area"]; Mark Stacey ["We can't get the clams out, and so there's going to be extreme resilience to whatever we do up there because of the nature of the clams"].

As to sensitive fish species that inhabit parts of the Bay, the State found that changes were incorporated in the Project that would "substantially lessen" the Project's significant effects on fish (e.g., Delta and longfin smelt) and that "such changes . . . can and should be adopted by" the California Department of Fish & Wildlife ("CDFW").[9] CDFW has, since that time, issued an Incidental Take Permit ("ITP") to each of the applicants and made the express finding that the ITP "minimizes and fully mitigates" any taking of the species caused by the Project.[10]

The Applicants have committed to mitigate all significant adverse impacts at the full, 2,040,0000 cy annual volumes. Further detail of mitigation included as conditions within each of the permits: State Lands Commission leases, USFWS Biological Opinion, NMFS Biological Opinions, CDFW ITP, and the Regional Water Quality Control Board Certifications are provided in Section 5. Hanson and Lind have also agreed to form a Technical Advisory Committee ("TAC") to develop additional scientific information concerning the relationship between sand mining and benthic communities.

3) Whether There Are Feasible Alternatives To Dredging Sand From The Bay's Sandy Deep Water Areas.

The Staff writes that the State rejected as "infeasible" any reduction in sand volumes on the basis that reduced volumes would increase global greenhouse gas emissions associated with trucking or shipping sand from other sources (e.g., land quarries in the Bay area and Canada). This point is emphasized by the attached summary from Environ, which estimates that greenhouse gas emissions would increase by as much as 240% if the material were supplied from alternative sources.

The Staff Summary suggests that, despite the State's findings to the contrary, the Commission may consider alternative sources from Bay area land quarries and foreign shipments from British Columbia. The question, however, is not whether the region can obtain sand from other sources, but whether *the Applicants*—here, Hanson and Lind—can feasibly and practically develop those alternatives sources (along with many other factors considered in determining feasibility). There are substantial limits on the scope of alternatives to be considered:

[9] State CEQA Findings, p. D-9.
[10] California Department of Fish & Wildlife, Incidental Take Permit, as Amended (2014), p. 16.

- The McAteer Petris Act and the Bay Plan do not mandate that the Commission evaluate alternatives that are beyond the immediate Bay Area much less foreign countries[11]; and

- Lind Marine is not in the business of either importing sand or producing sand from land-based quarries. Requiring Lind to enter a new market is unreasonable, impractical, and infeasible.

The Technical Feasibility Analysis provided as Appendix C thoroughly evaluated the feasibility of the project as well as consistency with BCDC policies. Key Conclusions from this analysis are:

- Findings of the State affirm that there is no substantial evidence of harm to the Bay resources delineated in Subtidal Policy 1.[12] Even if there remains disagreement or uncertainty with regard to these effects, Subtidal Policy 1 does not call on the Commission to disapprove projects. On the contrary, the policy simply calls on the Commission to design projects so as to minimize or avoid harm "if feasible" to do so.

- Sand mining already occurs in a manner that minimizes disturbance of the Bay due to a number of practical and technical limits on sand mining (e.g., mining is already limited to specific areas, methods, and equipment).

- Numerous avoidance, minimization, and mitigation measures are being implemented already as permit conditions within the State Lands Leases, the Regional Board permits, CDFW ITP, and NMFS and USFWS Biological Opinions (Section 5).

Sand mined from Middle Ground and Suisun Associates is Lind's ONLY source of aggregate material for their market. Lind does not import aggregates, nor is Lind in the business of producing land-based sands. Lind cannot be expected to abandon its existing business and entitlements and obtain rights, permits, entitlements, and capital infrastructure to enter an entirely new market. For this additional reason, there is no alternative to sand mining that is feasible for Lind Marine.

4) Whether The Sand Mining Project Has Been Designed To Minimize Impacts To Water Quality.

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[11] The Court of Appeal has held that, in evaluating alternatives, BCDC is not required to launch a search of alternatives "outside the San Francisco Bay Area." *Save San Francisco Bay Ass'n v. San Francisco Bay Conservation and Dev. Com.* (1992) 10 Cal.App.4th 908, 926, 929.

[12] It has been suggested that any physical change to Bay bathymetry or benthic habitat is "harm".. But, "harm" does not mean just any physical change; rather, harm encompasses only those physical changes that are adverse or detrimental or cause injury.

The State EIR and Regional Board adopted orders found, respectively, that sand mining will not result in any significant adverse change in Bay water quality and will comply with all water quality standards and receiving water limitations as necessary to protect beneficial uses within the Bay.[13] As conditioned by the Regional Board, verification studies for effluent and receiving water quality and benthic ecology will be conducted by the Applicants to ensure that water quality standards and beneficial uses are being protected. The Staff Summary points to Bay Plan Water Quality Policy 2 (p.29), which states that "[t]he policies, recommendations, decisions, advice and authority of the State Water Resources Control Board and the Regional Board, should be the basis for carrying out the Commission's water quality responsibilities." Hanson and Lind agree. The applications submitted fully comply with those policies, recommendations, and decisions.

5) Whether The Project's Unavoidable Adverse Impacts Have Been Adequately Mitigated.

In summarizing the issues surrounding mitigation, the Staff Summary states that the Commission should determine whether the reduced project volumes and project mitigation are sufficient, and whether the proposed studies and monitoring are sufficient to support further scientific knowledge of the Bay. In addition to the policies listed in the Summary, under the McAteer Petris Act, any permit conditions must also be "reasonable."[14]

In addition to all of the measures included in the EIR's Mitigation, Monitoring and Reporting Plan ("MMRP"), the regulatory agencies have imposed numerous mitigation measures that avoid, minimize, and compensate for potential adverse impacts of the full original 2.04 million cy Project[15]:

a) Monitoring and Verification Studies:

i. Mining Location Tracking. Applicants will track mining locations and provide detailed reports to all regulatory agencies to ensure mining avoids sensitive subtidal areas;

ii. Water Quality Study. To ensure adequate water quality and protection of beneficial uses, Applicants will conduct an updated study to evaluate receiving water quality during mining events ;

iii. Benthic Habitat Study. As conditioned by the National Marine Fisheries Service ("NMFS"), a TAC comprised of key biologists and regulatory agencies will develop a work

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[13] San Francisco Bay Regional Board, *Revised Tentative Order* (adopted Jan. 21, 2015), pp. 9-11, 16.

[14] Pub. Resources Code, § 66632(f).

[15] The term "mitigation" refers to measures that avoid, reduce, rectify, or compensate for an adverse impact. (*See, e.g.*, San Francisco Bay Plan, Mitigation Finding "a"; *CEQA Guidelines*, § 15370.)

plan to identify and address key questions pertaining to potential effects of sand mining on benthic habitats;

iv. Multi-Beam Bathymetric Studies. To support ongoing assessment of impacts to Bay floor and sediment supply system, Applicants will conduct multi-beam bathymetric studies of all lease areas every 5 years; and

v. Biological Monitoring. A designated biologist must conduct monthly compliance inspections.

b) Avoidance and Minimization Measures:

i. Fish Screens. As conditioned by fish and wildlife agencies, Applicants have installed positive barrier fish screens that prevent entrainment of fish;

ii. Operational Restrictions. As conditioned by fish and wildlife agencies, Applicants employ specific techniques for operation of mining equipment (e.g., limits on pump priming and height of drag head off bottom) to reduce disturbance and prevent entrainment of fish;

iii. Depth and Lease Area Limits. Several conditions have been added to limit mining in shallow water, including specific seasonal limits and distance requirements, to avoid sensitive shallow-water habitats and species; and

iv. Seasonal Volume Restrictions. Strict limits on seasonal volumes have been added to the Middle Ground and Suisun Bay operations during sensitive months (December 1 through June 30) to minimize entrainment and other effects on early-stage special-status species.

c) Compensatory Mitigation:

i. Purchase of Habitat Credits. To address any potential “take” of listed species, the Applicants have purchased credits from the Liberty Island Mitigation Bank to provide permanent protection and perpetual management of habitats for sensitive fish species; and

ii. Sandy Bottom Habitat Restoration. To address possible adverse effects on Essential Fish Habitat (“EFH”), the Applicants have agreed to contribute to CalRycle’s Estuary Cleanup Project that will restore benthic habitats.

In addition to the above measures, the Applicants and BCDC staff have discussed the formation of a second TAC to develop a study plan focused on key scientific questions concerning sand mining and its role in the sediment transport system. All told, the above measures will add approximately $2 million to the cost of sand mining.

6) **Whether The Project Is Consistent With The Commission's Policies Regarding Dredging, Navigation Safety And Oil Spill Prevention.**

The Staff Summary recites San Francisco Dredging Policy 2, and says that the Commission should determine whether the project is consistent with this policy (pp. 37-38). In previous Permit amendments on sand mining lease parcels, BCDC staff consistently stated that "while the dredging policy requires the minimum dredging necessary, this project is sand mining for commercial use, and *therefore this policy does not apply*."[16] This prior application of the Dredging Policy that exempts sand mining from the minimization requirement makes sense given that the policy primarily addresses dredging for navigation and the issues unique to those uses—e.g., in-bay disposal practices associated with re-deposition of contaminated sediments. Nevertheless, the proposed Project is consistent with this and the remaining policies of Dredging Policy 2:

a) **Water-oriented use *or* other important public purpose:** See Feasibility Analysis and Section 7, below.

b) **Dredged materials meet water quality requirements:** See Section 4, above, and accompanying WDRs and WQCs from the Regional Board.[17] Further, the Regional Board expressly found that "historical bulk sediment chemistry data for deep water Bay sand deposits has shown that they do not contain pollutants at concentrations likely to cause a threat to beneficial uses."[18]

c) **Important fisheries are protected:** As set forth in Section 2, above, and in the CDFW ITPs and Biological Opinions issued by the USFWS and NMFS, the Applicants have added a series of measures—including substantial volume reductions—that will protect important fisheries by avoiding, minimizing, and mitigating any possible adverse impacts associated with direct take or changes in habitat.[19] This is in-line with the conclusions of the State's EIR and

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[16] See, for example, BCDC Permit No. M98-19 (2008), p. 14; Permit No. 5-80 (2008), p. 14; Permit No. 12-94 (2008), p. 15.
[17] San Francisco Bay Regional Board, Tentative Orders (Jan. 21, 2015).
[18] San Francisco Bay Regional Board, *Response to Comments on Tentative Orders for San Francisco Bay Mining* (Jan. 21, 2015), P. 11.
[19] California Department of Fish & Wildlife, Incidental Take Permits, as Amended (2014); U.S. Fish & Wildlife Service, Biological Opinion (2014); National Marine Fisheries Service, Biological Opinion (2014).

supporting studies.[20] While these measures were included to protect listed species and essential fish habitat, they are protective of other, more common aquatic species as well.

d) Siting and design minimizes volumes necessary for the project: Only certain areas within each lease are mined, and not in every year. As stated in Section 2, above, mining in peak years will temporarily disturb, at most, about 2.2% (282 acres) of available sandy habitat (12,800 acres). And because there is limited storage for sand at offloading facilities, inventories are small and sand is mined only in response to demand. Thus, mining volumes are limited by what the market demands. For these reasons, mining activities will be minimized.

7) Whether The Project Is Consistent With The Public Trust.

The Staff Summaries write that recovery of mineral resources is an accepted trust use and that the State's EIR considered trust resources in detail. That is correct. They then state that the State did not make specific written public trust findings (p. 38). That is wrong. In the State Land Commission's Minute Item certifying the EIR and approving the continued leasing of the lands for sand mining, the State found:

> These mitigation measures, taken together, will ensure consistency with plans and policies specifying that sand mining operations be conducted in an environmentally sound manner, *that agencies protect public trust resources*, and that sand mining operations be carried out in a manner that minimizes interference with critical wildlife activities.[21]

The Staff Summary writes that it is unclear whether the project is consistent with the public trust as it pertains to habitat protection and preservation of lands in their natural state. That is wrong. As outlined in Section 2, above, the EIR and AMS study concluded that sand mining has had no "detectable effect" on benthic community composition and abundance.[22] There is no evidence that sand mining will result in the loss of habitat for fish and wildlife species.

Further, this question of public trust consistency was put squarely before the Superior Court of San Francisco, which found that the State in "the CEQA process analyzed the sand mining impacts regarding sediment loss, and the effects on the San Francisco Bar and coastal erosion . . . [and] fulfilled its obligation to conduct a public trust analysis" in that process.[23]

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[20] FEIR (2012), AMS (2009), Hanson Environmental (2004).
[21] State Lands Commission, Minute Item (Oct. 12, 2012) p. D-19; FEIR, p. 4.7-20.
[22] FEIR, p. 4.1-43 and Appendix F [AMS 2009a].
[23] San Francisco Co. Superior Court, Order After Hearing (2014).

ATTACHMENT 2

Tables of Technical Corrections and Clarifications for each BCDC staff summary

RESPONSE COMMENTS TO BCDC STAFF REPORT FOR HANSON CENTRAL BAY

Page:Paragraph	Comment
3:2	Aggregate (rock and sand) is essential to the needs of modern society, providing material for the construction and maintenance of roadways, dams, canals, buildings, and other parts of California's infrastructure. Aggregate is also found in homes, schools, hospitals and shopping centers. In the 30 year period from 1981 – 2010, California consumed an average of 180 million tons of construction aggregate per year or about 5.7 tons per person per year (California Department of Conservation- Geological Survey). Demand for aggregate is expected to continue to increase as the State's population continues to grow and infrastructure is maintained, improved and expanded. **Current Condition of Aggregate Supply in the San Francisco Bay Area** The California Geological Survey projects demand for aggregates throughout California to continue growing, exceeding the supply of permitted reserves. The 50 year demand (2012 – 2062) in North and South San Francisco Bay Regions (as defined by CA Geological Survey) is over 1.9 billion tons while the permitted reserves are 514 million. These reserves will be depleted in as little as 11 years and on the outside 20 years.
3: 4	Sand from Mexico is not imported to Northern California.
4:1	The Bay sediment regime is probably not significantly more complex that other similar sized estuaries in the world. For a general description, see http://en.wikipedia.org/wiki/Estuary, which notes that "Of the thirty-two largest cities in the world, twenty-two are located on estuaries." Overall, during Pleistocene time (the past 2 million years), the regime has been depositional, with minor erosional events. Of more geologic interest is that it has varied several times between marine and nonmarine conditions as sea level has changed with global climatic conditions. A description of sedimentation in the system, with references through 2009, is in Keller (2009). For a recent USGS description of the geologic time scale, see Orndorff (2010).
4:3	The water depth is not defined by Hanson's equipment and varies to depths greater than 100ft in some lease areas. Equipment limitations prevent mining in depths greater than 90ft.
5:Table	PRC # for the Alcatraz South Shoal is incorrect it should be #7780.1 and in fact all the state leases have a decimal one on the end.
6:5	Central Valley steelhead are not a state listed species under CESA; NOAA Fisheries Service should be NOAA National Marine Fisheries Service (NMFS).
9:1	While it seems intuitive that this should be true in the long run, actual documentation of sediment decrease into the Bay is only for suspended sediment (Schoellhamer et al, 2013). There are no direct quantitative measurements of the bedload transport volumes (Porterfield, 1980). Although not well resolved, bathymetric data from Suisun Associates and Middle Ground, the locations where sand is presently entering the Bay from the Sierra Nevada erosional system, do not unequivocally indicate reduced sediment transport (in fact, Suisun accreted in the most recent period of review), so this blockage effect may not yet have reached this area.
9:2	The article cited, Barnard et al (2013), presents various types of evidence that the San Francisco Bay estuarine system was erosional during the past century. It does

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	include a reference to an equation for "predicted mean equilibrium bedform heights" that is in agreement with the general conclusion, but is minor part of it. Importantly, the article also points out that some parts of the mining lease areas do not contribute to possible erosion of the ocean coast, for instance, "such as PRC2036 in Point Knox Shoal, where ongoing heavy mining has resulted in significant local erosion (mean depth increase of>2 m during the survey interval) but impact sediment supply to the mouth of San Francisco Bay."
10:1	As has been repeatedly noted, in USGS and other studies, only south Ocean Beach is erosional, while north Ocean Beach is notably accretional (as acknowledged later in the staff report by BCDC). It is possible that the volumetric accretion at north Ocean Beach is greater than the erosion at south Ocean Beach. Within the Bay, the beaches from Crissy Beach to San Francisco Marina have been well studied, by Dr. Barry Keller and USGS, and are definitely accretional (and this is what is indicated by the green line of Figure 3 within the staff report). Other small pocket beaches within Central Bay have been studied by Dr. Keller and appear to be locally derived from nearby cliffs and not related to the tidal current bedload sand transport.
11:1-4	**General comment:** We commend the efforts to address questions posed by the Commissioners, it should be clearly noted that volume estimates of sediment entering the Bay system presented were generated by BCDC staff, and not scientists expert in geomorphology. Within these sections, the staff summaries also did not provide sufficient detail on the development of the conceptual model used nor provided any accompanying materials to show the methodology or calculations, making it impossible to peer review the numbers. Hanson and Lind recommend that before numbers formulated by BCDC staff are utilized in policy decision making that BCDC staff formulations and estimates for this complex system should be thoroughly and professional reviewed either by sediment transport experts to address the state of knowledge and review and confirm results from the FEIR. This is an example of information that could be generated through Technical Advisory Committee Study Process.
11:2	This figure represents an attempt to combine various types of modeling estimates and data on suspended load. It does not represent actual measurements of bedload sand transport, which do not exist. It is also noteworthy that transport of sand as bedload downstream from the Delta is presently documented to end at about San Pablo Bay, although some fine sand may be incorporated in silty sand deposits further downstream. Thus, the evidence indicates that bedload sand from the Delta does not presently reach Central Bay. The staff report states that load to the Bay is 3% sand and cites McKee et al 2013, however this reference shows a large range of sand fractions based on other studies. They noted that sand coming from some sources form a delta nearby and not enter the larger system, which further reduces any predicted source of sand to the larger system. All estimates of sand influx are based on these empirical estimates which will vary wildly within the Bay, vary wildly with every tributary or input source, etc. McKee references several other papers when he presents in (his 2013 reference) the various estimates of bedload/suspended load ratios. Interestingly he also

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	notes that bedload datasets are available but does not present anything on them. Without the newer references, especially the "written communication 2015" citations it is difficult to review BCDC staff calculations. Based on this presentation it seems that BCDC staff may have verbally communicated with McKee about the numbers in his Marine Geology paper, and he may have advised that 3% bedload vs. suspended load was probably reasonable for SF Bay (mid-range of estimates by Krone and Porterfield). A reviewer might assume that BCDC staff then just applied that to suspended load numbers from McKee and arrived at 77,000cy/yr of sand coming from the Delta. This estimation may or may not be within a reasonable order of magnitude (i.e. it's not 7,700cy and it's not 770,000cy) but greater detail should be provided when staff are developing ranges of numbers to be used to assess consistency with policy or potential impacts.  *L.J. McKee et al. / Marine Geology 345 (2013) 47–62* 57 2013–this issue). In contrast, a greater proportion of coarse sediment will likely remain near a tributary mouth forming a deltaic deposit or nourishing near-field beaches, marshes, or mudflats. Estimates of bed load in relation to suspended load have been proposed for California coastal watersheds of 3.4–19% (Lehre, 1981; Griggs and Paris, 1982; Inman and Jenkins, 1999; Willis and Griggs, 2003). Milliman and Meade (1983) used a ratio of 7–14% for an estimate of bed load transported by rivers to the world oceans. Estimates for supply to San Francisco Bay are on the lower end of these ranges (1.4–6.4%, Krone, 1979; Porterfield, 1980). This may be reasonable given that the slope of most of the small tributaries decreases sharply as they pass from the upland catchments to the Bay plain. The effect of this transition on suspended-sediment transport has recently been studied for one tributary (Downing-Kunz and Schoellhamer, 2013–this issue) and deposition of bed load is likely to be greater. Although many small tributaries enter the Bay via storm drains with no capacity for storage, many larger tributary watersheds in the nine-county Bay Area have managed flood control channels that pass water and sediment from upland catchment areas across the Bay plain. Sedimentation and loss of flood capacity in these flood control channels is a problem (Griggs and Paris, 1982) and sediment can be removed during channel maintenance. As the Bay Area continues to urbanize, bank erosion and bed incision may provide ever greater coarse sediment load (Trimble, 1997). We presently know of about 40 yr of bed load data collected across about ten watersheds in the Bay Area, a diminutive data set compared to the 235 station years of suspended sediment load information collected across 38 watersheds presented and analyzed in the current work. Improved estimates of coarse sediment bed load transport to the Bay will require a regional synthesis of the existing bed load data and a synthesis of sediment storage and removal in the flood conveyance facilities managed by the Bay Area Flood Protection Agencies Association (BAFPAA); a subject of ongoing research by McKee and others.
11:3	The gradients of the local tributaries are so low that they appear to be transporting silt and clay sized particles, not sand. The other primary source for sand in Central Bay is the cliffs near Golden Gate, as has been documented by USGS and other studies, on the basis of lithologic type and grain size (Keller, 2009, Chin et al, 2010). At Golden Gate, long-term active landslides are presently contributing sediment of Franciscan complex origin (Schlocker, 1974), part of which is transported, or has been in the geologic past, into Central Bay. As noted, the tributaries have very low gradients (slopes) and their beds normally contain only fine sediment, not sand. It is possible that in rare, very large storms,

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	some sand might be transported, but normally is not. The largest drainage for the South Bay is Alameda Creek, which has a wide, flat flood control channel in its lower reach, and diversion for groundwater infiltration, and very rarely, if ever, transports sand size material to the Bay. It should be noted that the Sacramento River also has a low gradient in the Delta, but clearly does transport sand, at least during large floods, so large enough flows can do this.
22:4	et seq …. , the total volume of sand being transported into the Bay from the Delta and local tributaries may be on the order of approximately 375,000 to 400,000 cy per year. This paragraph goes on to quote the same cy range for "Delta suspended sediment from local tributaries", a phrase whose meaning is unclear. As noted above, it is unlikely that the local tributaries transport much, if any, sand sized material to the Bay, the Delta input was estimated (speculatively) as only 77,000 cy/yr, and the volumetric input from Golden Gate is unknown. The range cited is completely speculative and has no relation to any quantitative measurements.
12:1	Reference #28 is also new 2015 written communication. The full email exchange or written documentation of the reference has not been provided by BCDC.
12:1	In a USGS study (Chin et al, 2010), Chin and co-workers wrote: "It is not known whether either of the two sand sources [Central Bay and near Richmond] described above is active presently or if the sand masses are made up of reworked, older, relict sediments." Note that word "relict" has a "t" at the end. The USGS study only stated this as a possibility and did not interpret the age of deposition. It made no statements regarding the "majority of deep deposits". In any case, the last ice age (Wisconsin) occurred near the end of Pleistocene time, whereas Holocene time is the past 11,000 years, during which time sea level rose to its present level. As noted, for a recent USGS description of the geologic time scale, see Orndorff (2010). At low sea level stands (Wisconsin and earlier – there were several), the depression of San Francisco Bay was a valley through which ran the ancestral Sacramento River (Keller, 2009, and references therein).
12:3	This information, attributed to Dr. Keller, is reasonably accurate. However, significantly more coring and sampling was done by the ADEC project (ADEC, 2000), including at Point Knox Shoal and Presidio Shoal, Hanson and Lind have been coordinating with San Francisco Airport to obtain this data. Sediment types appropriate for construction use has been investigated by Hanson Aggregates (unpublished) and by ADEC (2000), both of which examined sub-bottom cores. The Hanson core data extended from 20 to 25 feet, with most samples described as "sand", sometimes with minor clay and silt content, and a few described as "clay." The ADEC (2000) core data extended as deep as 20 to 47.5 feet. The descriptions are similar to the Hanson samples, mostly fine or medium sand, with auxiliary silt, coarse sand, and gravel. These descriptions were consistent to the maximum depths of the cores, so there is no indication of a systematic vertical variation of composition within these intervals. Thus, as far as is known from the available data, the sediment appears to be depth homogenized and of consistent quality and size, with marginal interspersion of clay, silt, course

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	sand, and gravel. For use in concrete, sand with a range of grains sizes is desirable, and this is what is mined at Pint Knox Shoal in particular. Extensive grain size information has been provided to BCDC in the past (San Francisco Marine Sand Miners, 2007).
13:2	Yes for this purpose the FEIR relied on a numerical model, but also thorough analysis of bathymetric changes to evaluate potential project impacts. The lack of sediment impoundment in the mining holes is an indicator that mining activities were not generating sediment deficits elsewhere, which is the primary potential morphological impact of sand mining.
13:3	The lease areas total 2,601 acres not 2,061.
13:4	The modeling is only qualitative in the sense that the predictions of actual changes for existing conditions and post-project conditions are not likely going to occur in reality because of many factors (such as not knowing what delta flows will occur next year), however the CHANGES caused by the mining holes give a quantitative result in terms of the <u>spatial extents of those potential changes</u>, which is critical component of the potential impacts. Changes in areas outside the areas of change shown in the modeling results are not expected to be measurable**.**
13.5	The first sentence in this paragraph is incorrect. In the USGS study, Chin and co-workers wrote: "No evidence exists for mixing of sand from the western sand mass [Point Knox Shoal and rest of Central Bay] with sand from the northern sand mass [off Richmond]. Instead, fine- to medium-grain sands from San Pablo Bay are apparently moved past the Richmond-San Rafael Bridge into central San Francisco Bay and there mixed with silty muds."
14:3	The beaches both within San Francisco Bay and on the ocean coast have been investigated by Dr. Keller, and information has been provided to BCDC. The beaches within the Bay are local pocket beaches derived by erosion of local cliffs. With the advent of sea level rise, these beaches may reasonably be expected to migrate uphill, whereas mud flats may be expected to be inundated. During the Science Panel, Dr. Barnard stated that his results addressed the "provenance" of sediment, but not "residence time" – i.e., "where" but not "how fast". Thus, the mineralogical distinctions of "Sierran" vs "Franciscan" do not distinguish between material that is presently being transported in the system and material that is "reworked" (eroded) from older sedimentary deposits. In Dr. Keller's site visits to various Bay beaches, on Angel Island and east Bay, it was his professional opinion that the material appeared to have been locally derived - the east Bay beaches with which Dr Keller is familiar are not derived from the present day subtidal sands. Schlocker (1974) describes the Colma formation, and also the derivation of south Ocean Beach sand from the Merced formation, a slightly older Pleistocene sand deposit; his map clearly shows the Colma formation there. This is not the case for the sand at Crissy Beach - SF Marina, which is being actively transported by a wave-driven longshore drift littoral process.
15:2	While the information included in this paragraph is accurate, it overlooks the fact that it is not known whether the Bar was shrinking prior to 1873, so while there appears to be a temporal correlation with the anthropogenic activities noted, a

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	causal relation cannot be definitely proved. This paragraph does acknowledge that accretion, not erosion, is occurring at the beaches closest to the sand mining leases.
16:1&2	Dr. Barnard during the Science Panel stated that there are multiple aggravating factors contributing to the erosion at Southern Ocean Beach. Among them is 1) the fact that the shoreline was built out during the great highway construction in the 1920s. So the beach doesn't want to be where it is right now. 2) there is also an outflow pipe immediately adjacent to the erosional hotspot. The whole area is eroding, and that's in the background. But specifically, there's a hotspot where the city had to spend $5 million to put in a revetment pipe two years ago. There's an outfall pipe which is meant to be buried offshore. There's scour of one to two meters around that rock crown and it's causing this canyon effect and actually driving the hydrodynamics in such a way to basically build a huge rip current in the lee of this scoured out outfall pipe. And so right in that area is where the erosion is most acute. That doesn't speak to the regional issue of sediment supply to the south, but very specifically there are a number of other factors that contribute to erosion in the southern portion of ocean beach."
16:2	This sentence should be corrected to reflect that the SLC permitted volumes of 2.04 million cubic yards were used in this modeling effort not the revised application volumes of 1.613 million cy.
17:1	"If the overall reduction in sediment supply in the Bay-Delta system is the cause, or a contributing cause, of the erosion of the San Francisco Bar, it would be reasonable to conclude that the Project could make a considerable contribution to this process." BCDC staff extracted this sentence from the draft EIR but did not provide the full context in the Draft EIR page 4.3-41 "In the absence of greater certainty regarding the physical processes at work, however, such a conclusion is considered speculative, and the cumulative impact is therefore less than significant." Furthermore within the Final EIR text, the sentence cited by BCDC and the accompanying full paragraph were stricken and a revised conclusion based on additional analysis was inserted which read (FEIR page 4.3-12) "The supplemental analysis of the previous modeling effort and the results of the new modeling effort conducted for this Final EIR both confirm the findings and conclusions reached in the Bathymetric and Hydrodynamic Study (Appendix G), in Impact HYD-2, and in this discussion of cumulative effects of the Project on sediment transport: • the Project is not expected in itself, or in combination with other projects, to result in a substantial alteration of sediment transport patterns or the morphology of the seabed outside of the vicinity of the lease areas; • the Project is not expected to result in a substantial decrease in the supply of sediment to the San Francisco Bar and Ocean Beach."

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	The sediment transport experts analyzed the contribution to "this process", i.e. Bar erosion, was clearly stated to be 0.2 to 0.3% of its erosion caused by mining. NOTE if sediment supplies to the Bay are reduced, less sediment is impounded by the mining depression, resulting in the mining have less of an effect on any ongoing Bar erosion/migration."
17:3	Reference #50 should be Coast & Harbor Engineering 2009
17:3	Last sentence – the paper attempts to correlate lower rates of mining with perceived changes in erosion/accretion trends. No causal link has been shown between lower rates of mining and overall accretion trends.
21:1	Evidence and opinions should be referenced to applicable technical documents.
21:1	The information in this paragraph is reasonable, although it is not clear if the term "erosional" is meant to describe the effects of mining itself, or processes that would otherwise occur. The fact that some filling did occur in the mined areas between 1997 and 2008 might suggest that the "erosion" only means the mining itself.
22:1	In addition to getting nutrients from coastal upwelling the upstream tributary rivers and Delta supply a large amount of nutrients to the system
24:2	There are no data or analyses to support the speculation that temporary turbidity from a mining event impacts plankton and aquatic plants
24:5 **25:2**	Hanson does not ballast and through consultation with CDFW, USFWS, and NMFS limits priming to reduce potential entrainment.
26:2	Impingement is not likely to occur, and has not been observed on the fish screen; the 0.2 ft/sec approach velocity is intended to avoid impingement on the screen and is the approved criteria set by CDFW, USFWS, and NMFS. observations are made at the end of each mining event.
27:2	The loss estimates presented suggest a much higher confidence and accuracy than appropriate; none of the estimates have been validated or based on actual observations; the estimates are from the EIR and do not assume the use of a fish screen or other operational avoidance procedures and therefore do not reflect current operating conditions; extrapolation of the loss of 700,000 sand lance based on a study in the Pacific Northwest is not scientifically sound and represents unsupported extrapolation and speculation; these estimates were based on a mining volume that is different than that in the permit application
27:3	The estimated loss of 1.2 million shrimp is from the EIR and does not assume the use of a fish screen, operational avoidance procedures and does not reflect current operations
27:3	The discussion of losses states these as fact but provides no supporting documentation e.g., "the California Bay shrimp are more heavily entrained"; the loss estimates from the EIR are based on a large number of assumptions that have not been presented
29:2	The report should note that not only the Commission needs to consider items 1-4 but that CDFW, NMFS, and USFWS all concluded that the minimization and mitigation was acceptable to issue permits
30:2	In addition to turbidity potentially enhancing delta smelt feeding success increased turbidity reduces predation risk for some species
30:4	The report states that Lind is required to study discharge effects – is only Lind

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	required to do this? Is a study by Lind appropriate for a Hanson Central Bay permit?
31:4	many of the invasives were also introduced with the import of live oysters to the Bay and by intentional introductions of sport fish (e.g., striped bass) or forage fish
34:5	The report states "the applicants have each purchased 0.017 acres" but should be singular since this permit is for only Hanson "the applicant has purchased"
35:5 - 36:1	Various field studies have been proposed in staff summaries. Surveys, sampling and analytical work will not fully address them for the following reasons: 1. Field samples (cores, tracers) represent conditions at a single location geographically and therefore cannot surmise total processes such as budgets and transport. 2. Field samples represent conditions at a single point in time, where certain forcing conditions are controlling sand transport, sand budgets, morphology and other factors. We know that these forcing conditions vary greatly year-to-year, and are changing over time due to water management activities, among other things. 3. The question of sediment transport and budget impacts caused by sand mining are hypothetical questions. In coordination with sediment transports experts; these question would be best answered through the use of transport modeling methods. To be able to estimate volumes of sand moving into the Bay, test hypothetical scenarios for the impacts of various levels of sand mining, and estimate the volumes of sand movement and locations, the only reasonable and practical approach is numerical modeling with a well-respected, calibrated/validated modeling system operated by an independent group. While the numerical modeling tools are an approximation of processes occurring in nature, the questions that have been posed cannot be addressed practically and efficiently with other field methods. Numerous researchers within the scientific community are actively studying the hydrodynamics and transport within the Bay system for the purpose of guiding significant policy decisions, in particular in terms of water management. One such group is the Bay-Delta SCHISM, an application of the 3D open source SCHISM hydrodynamic and water quality suite. The project resulted from collaboration between the California Department of Water Resources and the Virginia Institute of Marine Sciences (VIMS). Hanson and Lind propose to establish a Technical Advisory Committee to provide oversight in the development of a study which would focus on specific objectives to enhance knowledge of the system impacts from sand mining.
36:3	California Department of Fish and Game should be California Department of Fish and Wildlife
39:1	Science Review Panel An abridged transcript can be found at http://www.bcdc.ca.gov/dredging/SandMiningSciPanAbridged.pdf How was this abridged and what portions were omitted and why?

RESPONSE COMMENTS TO BCDC STAFF REPORT FOR HANSON MIDDLE GROUND

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2:2	Hanson does not lighter now as it is economically infeasible. Also the import lightering terminal in Oakland is closed.
3:2	**General Comment 2** - As to the underlying issues with regard to demand for sands from the Middle Ground (and Suisun) lease area, many alternative sources of "sand " do not provide the same type and quality of sand as that obtained from Middle Ground (or Suisun Assoc.). For example, sands imported from British Columbia and some other land-based sources have superior characteristics for use in high strength ready-mix concrete. BC sands are well graded (i.e. they are comprised of a continuous variation of sand sizes) and have a fairly uniform grain size distribution between the 3/8" mesh to the #200 mesh. BC sands are also less water absorptive and thus have a higher strength characteristic, which allows them to be used economically in the high strength concrete applications like the Bay Bridge or tall buildings. The finer sands from Middle Ground, on the other hand, have a narrower grain size distribution mostly on the finer meshes, with upwards of 70% sitting on the #100 mesh. The sand from Middle Ground is also more water absorptive, resulting in a lower concrete strength characteristic. Consequently, Middle Ground sands are not suitable by themselves for high strength concrete applications. Middle Ground sands, however, are superior for general construction uses. For example, the finer grain sizes make the Middle Ground sands more suitable for construction fill sands and for use in hot mix asphalt. Thus, due to differences in quality, characteristics, and grain size, Middle Ground sands and sands imported from BC other land-based sources are not necessarily interchangeable, and Middle Ground sands provide an important segment of the market for aggregate."
3:3	Sand from Mexico is not imported to Northern California.
4:1	**General clarification on the difference between sand and suspended sediment.** Suspended transport and bedload transport are due to different and distinct physical mechanisms. Suspended transport occurs when the water column has enough energy, generally characterized as turbulence, to keep small particles from setting out. Near the bottom of the water column, fine sand may be transported as suspended load. In this context, it is important to note that the term “sand”, as defined below from AGI data sheets (below), spans the size range from 0.0625 mm to 2.000 mm, a factor of 32 in diameter. The volume of a spherical grain is proportional to the cube of the diameter, so for a given rock density the largest sand grain weighs 32,768 times as much as the smallest one. This means there is a large difference in the ability of forces in water to lift or suspend material that would be called “sand”. Note that particles finer than “sand” (i.e., the normal suspended load) are called “silt” or “clay”, whereas the BCDC documents frequently use the less preferable term “mud” when these are deposited on the Bay floor. As described by USEPA, “Bedload is that portion of the total sediment in transport that is carried by intermittent contact with the streambed by rolling, sliding, and bouncing.” (http://water.epa.gov/scitech/datait/tools/warsss/bedload.cfm) The tractive force (g/m^2) necessary to transport a grain in the “sand” size range varies

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	many orders of magnitude. Thus, transport of coarse sand, such as is mined at Point Knox Shoal, requires much more energy than transport of fine sand. "Suspended sediment" is measured by USGS in the water column of the Delta and Bay using an optical backscatter instrument, at various levels in the water column. It is likely that none of the suspended sediment measured by this method is the fine sand that may be carried in suspension near the bottom. Marineau & Wright (more below) have "estimated" that bedload transported <u>into</u> the Delta is 2% of the measured suspended load, but there is no verification of this estimate.
4:3	Clarification: A portion of the Middle Ground lease site is actually within the Federal Channel, and includes a significant portion of the area deep enough to mine at Middle Ground. Therefore, sand mining operations here actually aid in channel maintenance, and reduce the amount of maintenance dredging that would be needed to maintain navigable depth in this area.
5:6	This report is for Middle Ground not Central bay as referenced in text.
10:1	As has been repeatedly noted, in USGS and other studies, only south Ocean Beach is erosional, while north Ocean Beach is notably accretional (as acknowledged later in the staff report by BCDC). It is possible that the volumetric accretion at north Ocean Beach is greater than the erosion at south Ocean Beach. Within the Bay, the beaches from Crissy Beach to San Francisco Marina <u>have</u> been well studied, by Dr. Barry Keller and USGS, and are definitely accretional (and this is what is indicated by the green line of Figure 2 within the staff report). Other small pocket beaches within Central Bay have been studied by Dr. Keller and appear to be locally derived from nearby cliffs and not related to the tidal current bedload sand transport.
10:2&3	**General comment:** we commend the efforts to address questions posed by the Commissioners, it should be clearly noted that volume estimates of sediment entering the Bay system presented were generated by BCDC staff, and not scientists expert in geomorphology. Within these sections, the staff summaries also did not provide sufficient detail on the development of the conceptual model used nor provided any accompanying materials to show the methodology or calculations, making it impossible to peer review the numbers. Hanson and Lind recommend that before numbers formulated by BCDC staff are utilized in policy decision making that BCDC staff formulations and estimates for this complex system should be thoroughly and professional reviewed either by sediment transport experts to address the state of knowledge and review and confirm results from the FEIR. This is an example of information that could be generated through Technical Advisory Committee Study Process.
10:3	Change 58,000 cy" to "58,000 cy per year
11:1	This figure represents an attempt to combine various types of modeling estimates and data on suspended load. It does not represent actual measurements of bedload sand transport, which do not exist. It is also noteworthy that transport of sand as bedload downstream from the Delta is presently documented to end at about San Pablo Bay, although some fine sand may be incorporated in silty sand deposits further downstream. Thus, the evidence indicates that bedload sand from the Delta does not presently reach Central Bay.
11:3 -12:1&2	This figure represents an attempt to combine various types of modeling estimates and data on suspended load. It does not represent actual measurements of

Page:Paragraph	Comment
	bedload sand transport, which do not exist. It is also noteworthy that transport of sand as bedload downstream from the Delta is presently documented to end at about San Pablo Bay, although some fine sand may be incorporated in silty sand deposits further downstream. Thus, the evidence indicates that bedload sand from the Delta does not presently reach Central Bay. The derived numbers from the references provided as well as text could not be reproduced. The report states that "the average volume of sand entering the Bay as bedload to be 58,000 cy (sand makes up 86 - 90 % of the total bedload)." then goes on to state the 77,000 cy/year sand number. Marineau et all 2014 stated that " 0.83 Mt (million metric tons) was transported from the Delta annually". If BCDC staff used a 2% estimated bedload figure applied to sediment leaving, as well as entering the Delta, this would be 16,600 mt. 1 metric ton = 1.1 "english" ton, so this would be 18,260 tons. The conversion for fine sand is tons X 0.77 = cy, so this would be 14,060 cy. Using BCDC's "86 - 90% proportion", there would be even less. Thus, BCDC's 77,000 number cannot be replicated without further discussion on their assumptions, and the additional derived figures of 375,000 - 400,000 cy figure even more so.
12:3	This section needs clarification: In a USGS study (Chin et al, 2010), Chin and co-workers wrote: “It is not known whether either of the two sand sources [Central Bay and near Richmond] described above is active presently or if the sand masses are made up of reworked, older, relict sediments.” Note that word “relict” has a “t” at the end. The USGS study only stated this as a possibility and did not interpret the age of deposition. It made no statements regarding the “majority of deep deposits”. In any case, the last ice age (Wisconsin) occurred near the end of Pleistocene time, whereas Holocene time is the past 11,000 years, during which time sea level rose to its present level. As noted, for a recent USGS description of the geologic time scale, see Orndorff (2010). At low sea level stands (Wisconsin and earlier – there were several), the depression of San Francisco Bay was a valley through which ran the ancestral Sacramento River (Keller, 2009, and references therein).
12:4	From staff report “However, once mined, natural processes that exist today are not sufficient to replenish this bedded sand.” This sentence did not appear in the Suisun Associates text. It is cited to “SLC FEIR pg”, without a page number. Bathymetric data do not seem to support this statement, at least in the short term.
14:1	The Bathymetric data showed reductions in sediment availability not modeling.
15:1	During the Science Panel, Dr. Barnard stated that his results addressed the “provenance” of sediment, but not “residence time” – i.e., “where” but not “how fast”. Thus, the mineralogical distinctions of “Sierran” vs “Franciscan” do not distinguish between material that is presently being transported in the system and material that is “reworked” (eroded) from older sedimentary deposits. In Dr. Keller’s site visits to various Bay beaches, on Angel Island and east Bay, it was his professional opinion that the material appeared to have been locally derived - the east Bay beaches with which Dr Keller is familiar are not derived from the present

Page:Paragraph	Comment
	day subtidal sands. Schlocker (1974) describes the Colma formation, and also the derivation of south Ocean Beach sand from the Merced formation, a slightly older Pleistocene sand deposit; his map clearly shows the Colma formation there. This is not the case for the sand at Crissy Beach - SF Marina, which is being actively transported by a wave-driven longshore drift littoral process.
15:3	While the information included in this paragraph is accurate, it overlooks the fact that it is not known whether the Bar was shrinking <u>prior</u> to 1873, so while there appears to be a temporal correlation with the anthropogenic activities noted, a causal relation cannot be definitely proved. This paragraph does acknowledge that accretion, not erosion, is occurring at the beaches closest to the sand mining leases.
16:1	It is not clear how the discussion of Central Bay relates to the Middle Ground permit application or analysis
16:1&2	Dr. Barnard during the Science Panel stated that there are multiple aggravating factors contributing to the erosion at Southern Ocean Beach. Among them is 1) the fact that the shoreline was built out during the great highway construction in the 1920s. So the beach doesn't want to be where it is right now. 2) there is also an outflow pipe immediately adjacent to the erosional hotspot. The whole area is eroding, and that's in the background. But specifically, there's a hotspot where the city had to spend $5 million to put in a revetment pipe two years ago. There's an outfall pipe which is meant to be buried offshore. There's scour of one to two meters around that rock crown and it's causing this canyon effect and actually driving the hydrodynamics in such a way to basically build a huge rip current in the lee of this scoured out outfall pipe. And so right in that area is where the erosion is most acute. That doesn't speak to the regional issue of sediment supply to the south, but very specifically there are a number of other factors that contribute to erosion in the southern portion of ocean beach."
16:2 17:1	Rather than reporting the contribution from Central Bay it would be more appropriate for this report to describe the Suisun Bay contribution which is more relevant to the analysis; the same comment applies to the paragraph below
17:1 18	A discussion of the historic single beam data is not included. Similar speculation is included as in Suisun Associates about slumping possibility. Such slumping was not apparent in the 2014 multibeam data.
19:1 and Fig 7	This represents Central Bay, not Suisun Bay - the bedforms are different.
20:3	Conclusions made here are mainly related to Central Bay conditions, not Middle Ground. Evidence and opinions should be referenced to applicable technical documents and literature.
22:2	In addition to the negative effects of suspended sediments cited there are also potential benefits to delta smelt for improved prey detection and to some fish from reduced predation risk
22:2	There are no data or analyses to support the speculation that temporary turbidity from a mining event impacts plankton or zooplankton
23:2	The report cites delta smelt as endangered; under the ESA and USFWS delta smelt are listed as threatened
24:1	There is no evidence that organisms are impinged on the fish screen; observation are made at the end of each mining event; the screen approach velocity of 0.2

Page:Paragraph	Comment
	ft/sec is intended to avoid impingement
24:2	*Corbula amurensis* has been reclassified as Potamocorbula amurensis
24:3	The report discusses halibut and Dungeness crabs using sandy habitat in the Bay – this is true for Central Bay but rare if ever in Suisun Bay which is the subject of the report
25:2	Given the differences in the requested mining volume are between Lind and Hanson at Middle Ground how can the estimates of loss from the EIR be the same for both permit applications? The loss estimates presented suggest much higher confidence and accuracy than appropriate; none of the estimates have been validated or based on actual observations; the estimates are from the EIR and do not assume the use of a fish screen or other operational avoidance procedures and therefore do not reflect current operating conditions; these estimates were based on a mining volume that is different and operational procedures and seasonal restrictions than submitted in the permit application.
25:3	The discussion of Dungeness crab losses in Suisun Bay and commercial harvest is not appropriate since Dungeness crabs seldom occur in the lower salinity habitat of Suisun Bay and any loss to mining would be for juvenile lifestages not the adults that are harvested in the commercial fishery – the 0.1% is for Central Bay and not Suisun Bay.
25:3	The estimated loss of 1.2 million shrimp is from the EIR and does not assume the use of a fish screen and does not reflect current operations; comparison to bay-wide abundance and total mining including that in Central Bay is not appropriate for analysis of Suisun Bay mining and does not reflect the current requested mining volume or the application of the fish screen
27:1	There is no evidence of slumping in the recent multibeam imagery. Also, the reference to "slumping" in the NMFS BO was used in a general context about deepening of ALL lease areas, and was NOT referencing Middle Ground.
28:3	Many of the non-native species were also introduced by importing oysters to the Bay and through intentional introductions of game fish and forage fish
29:1	As stated in previous comments Hanson does not ballast water.
29:2	*Corbula amurensis* has been reclassified as Potamocorbula amurensis
30:2	The discussion of mining effects on X2 location is unnecessary, as the conclusion is the magnitude of this effect will be extremely small (non-detectable). The referenced USFWS BO simply indicated that “The proposed project is not expected to have any effect on salinity, since the river flows will not be affected, thus not affecting the position of X2.”
32:2	rinsing sand with fresh water is not needed in Suisun Bay. The water is lower in salinity so sand does not have to be rinsed.
32:5	Import sand is not a comparable sand as it is a much high grade and priced sand.
36:2	The report cites Suisun Associates as mining as a water-oriented use but this report should be referring to Hanson as the applicant
36:4	The ten year volume should be 400,00cy not 2.45 million cy.
38:4	Science Review Panel An abridged transcript can be found at http://www.bcdc.ca.gov/dredging/SandMiningSciPanAbridged.pdf How was this abridged? What portions were omitted and why?

RESPONSE COMMENTS TO BCDC STAFF REPORT FOR LIND MIDDLE GROUND

Page	Para-graph	Comment
4	**1**	**Correction:** There is no sand or gravel being imported into the Bay Area from Mexico.
4	**1**	**General Comment 1 –** As noted on multiple submittals to BCDC, the Middle Ground and Suisun Associates sand is Lind's ONLY source of aggregate material for our market. Lind is not in the business of importing aggregates, does not currently import aggregates, nor are we in the business of producing land-based sands. Lind cannot be expected to enter into a new market and abandon our existing business and obtain rights, permits, etc. to enter an entirely different market area as an alternative.
4	**1**	**General Comment 2** - As to the underlying issues with regard to demand for sands from the Middle Ground (and Suisun) lease area, many alternative sources of "sand " do not provide the same type and quality of sand as that obtained from Middle Ground (or Suisun Assoc.). For example, sands imported from British Columbia and some other land-based sources have superior characteristics for use in high strength ready-mix concrete. BC sands are well graded (i.e. they are comprised of a continuous variation of sand sizes) and have a fairly uniform grain size distribution between the 3/8" mesh to the #200 mesh. BC sands are also less water absorptive and thus have a higher strength characteristic, which allows them to be used economically in the high strength concrete applications like the Bay Bridge or tall buildings. The finer sands from Middle Ground, on the other hand, have a narrower grain size distribution mostly on the finer meshes, with upwards of 70% sitting on the #100 mesh. The sand from Middle Ground is also more water absorptive, resulting in a lower concrete strength characteristic. Consequently, Middle Ground sands are not suitable by themselves for high strength concrete applications. Middle Ground sands, however, are superior for general construction uses. For example, the finer grain sizes make the Middle Ground sands more suitable for construction fill sands and for use in hot mix asphalt. Thus, due to differences in quality, characteristics, and grain size, Middle Ground sands and sands imported from BC other land-based sources are not necessarily interchangeable, and Middle Ground sands provide an important segment of the market for aggregate."
4	**3**	Suspended transport and bedload transport are due to different and distinct physical mechanisms. Suspended transport occurs when the water column has enough energy, generally characterized as turbulence, to keep small particles from setting out. Near the bottom of the water column, fine sand may be transported as suspended load. In this context, it is important to note that the term "sand", as defined below from AGI data sheets (below), spans the size range from 0.0625 mm to 2.000 mm, a factor of 32 in diameter. The volume of a spherical grain is proportional to the cube of the diameter, so for a given rock density the largest sand grain weighs 32,768 times as much as the smallest one. This means there is a large difference in the ability of forces in water to lift or suspend material that would be called "sand". Note that particles finer than "sand" (i.e., the normal suspended load) are called "silt" or "clay", whereas the BCDC documents frequently use the less preferable term "mud" when these are deposited on the Bay floor. As described by USEPA, "Bedload is that portion of the total sediment in transport that is carried by intermittent contact with the streambed by rolling, sliding, and bouncing." (http://water.epa.gov/scitech/datait/tools/warsss/bedload.cfm) The tractive force (g/m^2) necessary to transport a grain in the "sand" size range varies many orders of magnitude. Thus, transport of coarse sand, such as is mined at Point Knox Shoal, requires much more energy than transport of fine sand. "Suspended sediment" is measured by USGS in the water column of the Delta and Bay using an optical backscatter instrument, at various levels in the water column. It is likely that none of

		the suspended sediment measured by this method is the fine sand that may be carried in suspension near the bottom. Marineau & Wright are referenced later in the staff summary and have "estimated" that bedload transported into the Delta is 2% of the measured suspended load, but there is no verification of this estimate.
5	**2**	Clarification: A portion of the Middle Ground lease site is actually within the Federal Channel, and includes a significant portion of the area deep enough to mine at Middle Ground. Therefore, sand mining operations here actually aid in channel maintenance, and reduce the amount of maintenance dredging that would be needed to maintain navigable depth in this area.
6	**4**	Correction on mining procedures - Lind's barge is NOT ballasted and filled with water prior to mining.
7	**2**	Correction / clarification on offload procedures: a conveyor on the Lind barge and a front-end loader OR excavator transport the sand from the barge to the land-side conveying equipment. Also, there is currently NO further processing of the sand at the sites served by Lind.
10	**3**	As has been repeatedly noted, in USGS and other studies, only south Ocean Beach is erosional, while north Ocean Beach is notably accretional (as acknowledged later in the staff report by BCDC). It is possible that the volumetric accretion at north Ocean Beach is greater than the erosion at south Ocean Beach. Within the Bay, the beaches from Crissy Beach to San Francisco Marina have been well studied, by Dr. Barry Keller and USGS, and are definitely accretional (and this is what is indicated by the green line of Figure 2 within the staff report). Other small pocket beaches within Central Bay have been studied by Dr. Keller and appear to be locally derived from nearby cliffs and not related to the tidal current bedload sand transport.
11	2&3	**General comment:** we commend the efforts to address questions posed by the Commissioners, it should be clearly noted that volume estimates of sediment entering the Bay system presented were generated by BCDC staff, and not scientists expert in geomorphology. Within these sections, the staff summaries also did not provide sufficient detail on the development of the conceptual model used nor provided any accompanying materials to show the methodology or calculations, making it impossible to peer review the numbers. Hanson and Lind recommend that before numbers formulated by BCDC staff are utilized in policy decision making that BCDC staff formulations and estimates for this complex system should be thoroughly and professional reviewed either by sediment transport experts to address the state of knowledge and review and confirm results from the FEIR. This is an example of information that could be generated through Technical Advisory Committee Study Process.
11	2	This figure represents an attempt to combine various types of modeling estimates and data on suspended load. It does not represent actual measurements of bedload sand transport, which do not exist. It is also noteworthy that transport of sand as bedload downstream from the Delta is presently documented to end at about San Pablo Bay, although some fine sand may be incorporated in silty sand deposits further downstream. Thus, the evidence indicates that bedload sand from the Delta does not presently reach Central Bay.
11	3	Clarification: the volumes of sand referred to here are annual; therefore "19,000 cy of sand" should be "19,000 cy of sand per year"; "58,000 cy" should be "58,000 cy per year:
11	1&2	This figure represents an attempt to combine various types of modeling estimates and

12	1&2	data on suspended load. It does not represent actual measurements of bedload sand transport, which do not exist. It is also noteworthy that transport of sand as bedload downstream from the Delta is presently documented to end at about San Pablo Bay, although some fine sand may be incorporated in silty sand deposits further downstream. Thus, the evidence indicates that bedload sand from the Delta does not presently reach Central Bay. The derived numbers from the references provided as well as text could not be reproduced. The report states that "the average volume of sand entering the Bay as bedload to be 58,000 cy (sand makes up 86 - 90 % of the total bedload)." then goes on to state the 77,000 cy/year sand number. Marineau et all 2014 stated that " 0.83 Mt (million metric tons) was transported from the Delta annually". If BCDC staff used a 2% estimated bedload figure applied to sediment leaving, as well as entering the Delta, this would be 16,600 mt. 1 metric ton = 1.1 "english" ton, so this would be 18,260 tons. The conversion for fine sand is tons X 0.77 = cy, so this would be 14,060 cy. Using BCDC's "86 - 90% proportion", there would be even less. Thus, BCDC's 77,000 number cannot be replicated without further discussion on their assumptions, and the additional derived figures of 375,000 - 400,000 cy figure even more so.
12 13	3 1&2	This section needs clarification: In a USGS study (Chin et al, 2010), Chin and co-workers wrote: "It is not known whether either of the two sand sources [Central Bay and near Richmond] described above is active presently or if the sand masses are made up of reworked, older, relict sediments." Note that word "relict" has a "t" at the end. The USGS study only stated this as a possibility and did not interpret the age of deposition. It made no statements regarding the "majority of deep deposits". In any case, the last ice age (Wisconsin) occurred near the end of Pleistocene time, whereas Holocene time is the past 11,000 years, during which time sea level rose to its present level. As noted, for a recent USGS description of the geologic time scale, see Orndorff (2010). At low sea level stands (Wisconsin and earlier – there were several), the depression of San Francisco Bay was a valley through which ran the ancestral Sacramento River (Keller, 2009, and references therein).
14	3	For both Middle Ground and Suisun Channel the sediment availability was evaluated using the actual Bathymetric data not modeling
14	4	The staff report indicates that "…proposed mining can be expected to further deepen the mining holes within the lease areas, there is potential that these holes will attract and trap more sediment in the future." This in an incorrect reference from the FEIR; the section referenced was talking about Central Bay, NOT Middle Ground.
15	1	During the Science Panel, Dr. Barnard stated that his results addressed the "provenance" of sediment, but not "residence time" – i.e., "where" but not "how fast". Thus, the mineralogical distinctions of "Sierran" vs "Franciscan" do not distinguish between material that is presently being transported in the system and material that is "reworked" (eroded) from older sedimentary deposits. In Dr. Keller's site visits to various Bay beaches, on Angel Island and east Bay, it was his professional opinion that the material appeared to have been locally derived and that the east Bay beaches with which he has studied are not derived from the present day subtidal sands. This is not the case for the sand at Crissy Beach - SF Marina, which is being actively transported by a wave-driven longshore drift littoral process.

16	2	It is not clear how the discussion of Central Bay relates to the Middle Ground permit application or analysis
16	2	Dr. Barnard during the Science Panel stated that there are multiple aggravating factors contributing to the erosion at Southern Ocean Beach. Among them is "1) the fact that the shoreline was built out during the great highway construction in the 1920s. So the beach doesn't want to be where it is right now. 2) there is also an outflow pipe immediately adjacent to the erosional hotspot. The whole area is eroding, and that's in the background. But specifically, there's a hotspot where the city had to spend $5 million to put in a revetment pipe two years ago. There's an outfall pipe which is meant to be buried offshore. There's scour of one to two meters around that rock crown and it's causing this canyon effect and actually driving the hydrodynamics in such a way to basically build a huge rip current in the lee of this scoured out outfall pipe. And so right in that area is where the erosion is most acute. That doesn't speak to the regional issue of sediment supply to the south, but very specifically there are a number of other factors that contribute to erosion in the southern portion of ocean beach."
16	2	While the information included in this paragraph is accurate, it overlooks the fact that it is not known whether the Bar was shrinking prior to 1873, so while there appears to be a temporal correlation with the anthropogenic activities noted, a causal relation cannot be definitely proved. This paragraph does acknowledge that accretion, not erosion, is occurring at the beaches closest to the sand mining leases.
17	1&2	Rather than reporting the contribution from Central Bay it would be more appropriate for this report to describe the Suisun Bay contribution which is more relevant to the analysis
18	1	Reference 47 should be either the FEIR Appendix by CHE (reference 31), or Fenical et al (white paper, reference 45).
18	1	Slumping was not evident in the recent 2014 multibeam bathymetric survey.
20	3	Conclusions made here are mainly related to Central Bay conditions, not Middle Ground. Evidence and opinions should be referenced to applicable technical documents.
22	3	Impingement is not likely to occur, and has not been observed on the fish screen; the screen was designed for a 0.2 ft/sec approach velocity, intended to avoid impingement on the screen and is the approved criteria set by CDFW, USFWS, and NMFS. This velocity is protective of both listed species and other species in general.
23	1	In addition to the negative effects of suspended sediments cited there are also potential benefits to delta smelt for improved prey detection and to some fish from reduced predation risk
23	2	There are no data or analyses to support the speculation that temporary turbidity from a mining event impacts plankton or zooplankton
23	4	Lind does not ballast as described previously, and through consultation with CDFW, USFWS, and NMFS limits priming to reduce potential entrainment
24	2	The report cites delta smelt as endangered; under the ESA and USFWS delta smelt are listed as threatened
24	3	The report cites concerns for delta smelt egg entrainment as the basis for the seasonal depth concerns but the concern was also based on the occurrence of larval smelt in the shallow areas of the water column
25	1	There is no evidence that organisms are impinged on the fish screen; observation are

		made at the end of each mining event; the screen approach velocity of 0.2 ft/sec is intended to avoid impingement
25	2	*Corbula amurensis* has been reclassified as Potamocorbula amurensis
25	3	The report discusses halibut and Dungeness crabs using sandy habitat in the Bay – this is true for Central Bay but rare if ever in Suisun Bay which is the subject of the report
25	3	The report states that benthic disturbance can persist over a long period of time based on observations in Central Bay – this summary should focus on Suisun Bay channel where tidal velocities are higher and salinity gradient and invasive species issues are contributing factors.
26	2	The loss estimates presented here are from the EIR and do not assume the use of a fish screen or other operational avoidance procedures that are now part of the project, and therefore do not reflect current operating conditions; these estimates were based on a mining volume that is different and operational procedures and seasonal restrictions than submitted in the permit application. Additionally, the estimates suggest much higher confidence and accuracy than appropriate.
26	3	The discussion of Dungeness crab losses in Suisun Bay and commercial harvest is not appropriate since Dungeness crabs seldom occur in the lower salinity habitat of Suisun Bay and any loss to mining would be for juvenile lifestages not the adults that are harvested in the commercial fishery – the 0.1% is for Central Bay and not Suisun Bay.
26	3	The estimated loss of 1.2 million shrimp is from the EIR and does not assume the use of a fish screen and does not reflect current operations; comparison to bay-wide abundance and total mining including that in Central Bay is not appropriate for analysis of Suisun Bay mining and does not reflect the current requested mining volume or the application of the fish screen.
26	3	The discussion of losses states these as fact but provides no supporting documentation e.g., "the California Bay shrimp are more heavily entrained"; the loss estimates from the EIR are based on a large number of assumptions that have not been presented, and are not necessarily valid for Suisun Bay mining.
28	1	There is no evidence of slumping in the recent multibeam imagery. Also, the reference to potential "slumping" in the NMFS BO was used very generally about deepening of ALL lease areas, and was not referencing Middle Ground.
30	1	Many of the non-native species were also introduced by importing oysters to the Bay and through intentional introductions of game fish and forage fish
30	2	As stated in previous comments Lind does not ballast their barge with water.
30	3	*Corbula amurensis* has been reclassified as Potamocorbula amurensis
31	3	The discussion of mining effects on X2 location is unnecessary, as the conclusion is the magnitude of this effect will be extremely small (non-detectable). The referenced USFWS BO simply indicated that "The proposed project is not expected to have any effect on salinity, since the river flows will not be affected, thus not affecting the position of X2."
32	1	In addition to turbidity potentially increasing prey detection for delta smelt it also reduces predation risk for some species
33	3	This discussion appears to focus on Hanson's Central Bay operations, and imported sand. As stated previously, Lind Marine does not import sand, has no other alternative sand sources, and the imported sand is not equivalent to the Middle Ground sand.
35	3	USFWS identified Liberty Island as suitable compensatory habitat for longfin smelt and

		delta smelt. All agencies CDFW, USFWS, and NMFS approved this compensatory habitat for these species to fully mitigate for unavoidable impacts.
37	2	General Comment: This entire section appears to be pulled from the Hanson Central Bay report. It cites Central Bay and Hanson several times. This report should be referring to Lind as the applicant and Lind's operations in Suisun Bay.
37	5	The report discusses seasonal constraints as not being applied in Central Bay which is not relevant to the application for Suisun Bay mining where seasonal constraints have been applied but are not discussed here in the report
37	6	The report cites the 10 year volume limit as 12.03 million cy but for this report the correct 10 year volume should be 1.25 million cy for Lind Marine
38	1	The report discusses Hanson abiding by maritime law but this should be for Lind. Lind is in compliance with CDFW OSPR requirements.
39	4	The discussion of the Commission determination should focus on the Suisun Bay Middle Ground lease and not Central Bay.
40	3	Science Review Panel An abridged transcript can be found at http://www.bcdc.ca.gov/dredging/SandMiningSciPanAbridged.pdf How was the transcript abridged, and by whom? What was the criteria for deleting portions of the transcript?
41	Exhibits	The list of exhibits does not correspond to the actual exhibits provided.

RESPONSE COMMENTS TO BCDC STAFF REPORT FOR SUISUN ASSOCIATES

Page:Paragraph	Comments
4:2	Northern California does not receive imported sand from Mexico
4:2	**General Comment 1 –** As noted on multiple submittals to BCDC, the Middle Ground and Suisun Associates sand is Lind's ONLY source of aggregate material for our market. Lind is not in the business of importing aggregates, does not currently import aggregates, nor are we in the business of producing land-based sands. Lind cannot be expected to enter into a new market and abandon our existing business and obtain rights, permits, etc. to enter an entirely different market area as an alternative.
4:2	**General Comment 2** - As to the underlying issues with regard to demand for sands from the Suisun Associates lease area, many alternative sources of "sand " do not provide the same type and quality of sand as that obtained from Suisun Associates. For example, sands imported from British Columbia and some other land-based sources have superior characteristics for use in high strength ready-mix concrete. BC sands are well graded (i.e. they are comprised of a continuous variation of sand sizes) and have a fairly uniform grain size distribution between the 3/8" mesh to the #200 mesh. BC sands are also less water absorptive and thus have a higher strength characteristic, which allows them to be used economically in the high strength concrete applications like the Bay Bridge or tall buildings. The finer sands from Suisun Associates, on the other hand, have a narrower grain size distribution mostly on the finer meshes, with upwards of 70% sitting on the #100 mesh. The sand from Suisun Associates is also more water absorptive, resulting in a lower concrete strength characteristic. Consequently, Suisun Associates sands are not suitable by themselves for high strength concrete applications. Suisun Associates sands, however, are superior for general construction uses. For example, the finer grain sizes make the Suisun Associates sands more suitable for construction fill sands and for use in hot mix asphalt. Thus, due to differences in quality, characteristics, and grain size, Suisun Associates sands and sands imported from BC other land-based sources are not necessarily interchangeable, and Suisun Associates sands provide an important segment of the market for aggregate."
4:3	**General clarification on the difference between sand and suspended sediment.** Suspended transport and bedload transport are due to different and distinct physical mechanisms. Suspended transport occurs when the water column has enough energy, generally characterized as turbulence, to keep small particles from setting out. Near the bottom of the water column, fine sand may be transported as suspended load. In this context, it is important to note that the term “sand”, as defined below from AGI data sheets (below), spans the size range from 0.0625 mm to 2.000 mm, a factor of 32 in diameter. The volume of a spherical grain is proportional to the cube of the diameter, so for a given rock density the largest sand grain weighs 32,768 times as much as the smallest one. This means there is a large difference in the ability of forces in water to lift or suspend material that would be called “sand”. Note that particles finer than “sand” (i.e., the normal suspended load) are called “silt” or “clay”, whereas the BCDC documents frequently use the less preferable term “mud” when these are deposited on the Bay floor. As described by USEPA, “Bedload is that portion of the total sediment in transport

Page:Paragraph	Comments
	that is carried by intermittent contact with the streambed by rolling, sliding, and bouncing." (http://water.epa.gov/scitech/datait/tools/warsss/bedload.cfm) The tractive force (g/m^2) necessary to transport a grain in the "sand" size range varies many orders of magnitude. Thus, transport of coarse sand, such as is mined at Point Knox Shoal, requires much more energy than transport of fine sand. "Suspended sediment" is measured by USGS in the water column of the Delta and Bay using an optical backscatter instrument, at various levels in the water column. It is likely that none of the suspended sediment measured by this method is the fine sand that may be carried in suspension near the bottom. Marineau & Wright (more below) have "estimated" that bedload transported into the Delta is 2% of the measured suspended load, but there is no verification of this estimate.
6:4	There is only one (1) 5,000 gpm pump on the Lind barge J5200.
8:2	Correction / clarification on offload procedures: a conveyor on the Lind barge and a front-end loader OR excavator transport the sand from the barge to the land-side conveying equipment. Also, there is currently NO further processing of the sand at the sites served by Lind.
8:3	Mitigation – the mitigation habitat was for salmon as well as smelt. All agencies CDFW, USFWS, and NMFS approved this compensatory habitat for these species to fully mitigate for unavoidable impacts.
Pgs. 9-10	**General Comment**: This section focuses on Central Bay and does not utilize the information provided by the applicants and the FEIR which focused on Suisun Channel. Furthermore, Figure 1 of the Central Bay was not utilized for the Middle Ground staff summary. It is unclear how this figure is relevant for Suisun Bay or the lease areas? Page 10 Figure 1 - This figure represents an attempt to combine various types of modeling estimates and data on suspended load. It does not represent actual measurements of bedload sand transport, which do not exist. It is also noteworthy that transport of sand as bedload downstream from the Delta is presently documented to end at about San Pablo Bay (Chin et al, 2010, Gilbert, 1917), although some fine sand may be incorporated in silty sand deposits further downstream. Thus, the evidence indicates that bedload sand from the Delta does not presently reach Central Bay.
11:3	**General comment:** We commend the efforts to address questions posed by the Commissioners, it should be clearly noted that volume estimates of sediment entering the Bay system presented were generated by BCDC staff, and not scientists expert in geomorphology. Within these sections, the staff summaries also did not provide sufficient detail on the development of the conceptual model used nor provided any accompanying materials to show the methodology or calculations, making it impossible to peer review the numbers. Hanson and Lind recommend that before numbers formulated by BCDC staff are utilized in policy decision making that BCDC staff formulations and estimates for this complex system should be thoroughly and professional reviewed either by sediment transport experts to address the state of knowledge and review and confirm results from the FEIR. This is an example of information that could be generated through

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	Technical Advisory Committee Study Process. The gradients of the local tributaries are so low that they appear to be transporting silt and clay sized particles, not sand. The other primary source for sand in Central Bay is the cliffs near Golden Gate, as has been documented by USGS and other studies, on the basis of lithologic type and grain size (Keller, 2009, Chin et al, 2010). At Golden Gate, long-term active landslides are presently contributing sediment of Franciscan complex origin (Schlocker, 1974), part of which is transported, or has been in the geologic past, into Central Bay. As noted, the tributaries have very low gradients (slopes) and their beds normally contain only fine sediment, not sand. It is possible that in rare, very large storms, some sand might be transported, but normally is not. The largest drainage for the South Bay is Alameda Creek, which has a wide, flat flood control channel in its lower reach, and diversion for groundwater infiltration, and very rarely, if ever, transports sand size material to the Bay. It should be noted that the Sacramento River also has a low gradient in the Delta, but clearly does transport sand, at least during large floods, so large enough flows can do this.
13:2	This figure represents an attempt to combine various types of modeling estimates and data on suspended load. It does not represent actual measurements of bedload sand transport, which do not exist. It is also noteworthy that transport of sand as bedload downstream from the Delta is presently documented to end at about San Pablo Bay, although some fine sand may be incorporated in silty sand deposits further downstream. Thus, the evidence indicates that bedload sand from the Delta does not presently reach Central Bay. The derived numbers from the references provided as well as text could not be reproduced. The report states that "the average volume of sand entering the Bay as bedload to be 58,000 cy (sand makes up 86 - 90 % of the total bedload)." then goes on to state the 77,000 cy/year sand number. Marineau et all 2014 stated that " 0.83 Mt (million metric tons) was transported from the Delta annually". If BCDC staff used a 2% estimated bedload figure applied to sediment leaving, as well as entering the Delta, this would be 16,600 mt. 1 metric ton = 1.1 "english" ton, so this would be 18,260 tons. The conversion for fine sand is tons X 0.77 = cy, so this would be 14,060 cy. Using BCDC's "86 - 90% proportion", there would be even less. Thus, BCDC's 77,000 number cannot be replicated without further discussion on their assumptions, and the additional derived figures of 375,000 - 400,000 cy figure even more so.
13:2	"The other primary source for sand in the Bay is the local tributaries. In addition to Delta sediments Suisun Bay receives sediment from local streams with Suisun Slough and Montezuma Slough as its main tributaries." This statement is different from what is stated in the Lind Middle Ground staff summary
13:2	"58,000 cy" should be "58,000 cy per year"

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14:2	This section needs clarification: In a USGS study (Chin et al, 2010), Chin and co-workers wrote: "It is not known whether either of the two sand sources [Central Bay and near Richmond] described above is active presently or if the sand masses are made up of reworked, older, relict sediments." Note that word "relict" has a "t" at the end. The USGS study only stated this as a possibility and did not interpret the age of deposition. It made no statements regarding the "majority of deep deposits". In any case, the last ice age (Wisconsin) occurred near the end of Pleistocene time, whereas Holocene time is the past 11,000 years, during which time sea level rose to its present level. As noted, for a recent USGS description of the geologic time scale, see Orndorff (2010). At low sea level stands (Wisconsin and earlier – there were several), the depression of San Francisco Bay was a valley through which ran the ancestral Sacramento River (Keller, 2009, and references therein).
16:2	The beaches both within San Francisco Bay and on the ocean coast have been investigated by Dr. Keller, and information has been provided to BCDC. The beaches within the Bay are local pocket beaches derived by erosion of local cliffs. With the advent of sea level rise, these beaches may reasonably be expected to migrate uphill, whereas mud flats may be expected to be inundated. During the Science Panel, Dr. Barnard stated that his results addressed the "provenance" of sediment, but not "residence time" – i.e., "where" but not "how fast". Thus, the mineralogical distinctions of "Sierran" vs "Franciscan" do not distinguish between material that is presently being transported in the system and material that is "reworked" (eroded) from older sedimentary deposits. In Dr. Keller's site visits to various Bay beaches, on Angel Island and east Bay, it was his professional opinion that the material appeared to have been locally derived - the east Bay beaches with which Dr Keller is familiar are not derived from the present day subtidal sands. Schlocker (1974) describes the Colma formation, and also the derivation of south Ocean Beach sand from the Merced formation, a slightly older Pleistocene sand deposit; his map clearly shows the Colma formation there. This is not the case for the sand at Crissy Beach - SF Marina, which is being actively transported by a wave-driven longshore drift littoral process.
17:2	While the information included in this paragraph is accurate, it overlooks the fact that it is not known whether the Bar was shrinking prior to 1873, so while there appears to be a temporal correlation with the anthropogenic activities noted, a causal relation cannot be definitely proved. This paragraph does acknowledge that accretion, not erosion, is occurring at the beaches closest to the sand mining leases.
17:2	Dr. Barnard during the Science Panel stated that there are multiple aggravating factors contributing to the erosion at Southern Ocean Beach. "Among them is 1) the fact that the shoreline was built out during the great highway construction in the 1920s. So the beach doesn't want to be where it is right now. 2) there is also an outflow pipe immediately adjacent to the erosional hotspot. The whole area is eroding, and that's in the background. But specifically, there's a hotspot where the city had to spend $5 million to put in a revetment pipe two years ago. There's an outfall pipe which is meant to be buried offshore. There's scour of one to two

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	meters around that rock crown and it's causing this canyon effect and actually driving the hydrodynamics in such a way to basically build a huge rip current in the lee of this scoured out outfall pipe. And so right in that area is where the erosion is most acute. That doesn't speak to the regional issue of sediment supply to the south, but very specifically there are a number of other factors"
19:1	It is not clear how or if the discussion of Central Bay relates to the Suisun Associates permit application or analysis
19:last sentence	This is a misleading sentence and should be clarified to include that the 2008-2009 permit was the last permit to authorize any volume (200k total). Mining volumes were reduced over the past 4 years because of the time extension holdover status, artificially deflating the average volume.
10:2 and 20:1	"… for Suisun Associates ….[bathymetric] changes in lease areas were generally small from survey to survey," … "Between 2008 and 2014 Suisun Bay gained more sand than it lost, exhibiting accretion for both the entire survey areas and the lease areas corresponding to 300,000 m^3" **RESPONSE:** As noted above, there is little clear evidence for significant bathymetric changes or resource depletion in this area. It is possible that there is enough sand stored in the bed of the Sacramento River that the effect of the dams will not be seen in the short term. The text of paragraphs following the one cited includes some statements that probably only apply to Central Bay. Page 20 Paragraph 1 - Presenting the 300,000 m^3 in cubic yards would be more appropriate for comparison purposes. This is a global comment on consistency with units of measure.
20:2	The text in this paragraph is an over-simplification. The previously authorized volumes were a total of 750,000 cy for Middleground, and 100,000 cy at Suisun Associates. After consultation with the resource agencies (USFWS, CDFW), the companies have indeed chosen to shift volume from Middle Ground to Suisun Associates, in part to address concerns about concentrated mining in the small area available at Middle Ground, and are significantly reducing authorized volumes to better reflect market conditions and actual mining volumes. As stated above, the last average was low in part due to no new permitted volumes.
22:1	Conclusions made here are mainly related to Central Bay conditions, not Middle Ground. Evidence and opinions should be referenced to applicable technical documents.
23:2	Suisun Bay Habitat – in addition to providing habitat for many native species the area also supports many non-native species
23:4	There is no evidence that fish are being impinged on the fish screen; the screen is inspected following each mining event; the screen was designed for an approach velocity of 0.2 ft/sec to avoid impingement on the screen and is the approved criteria set by CDFW, USFWS, and NMFS. This velocity is protective of both listed species and other aquatic species in general.

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24:1	Potential benefits of increased turbidity such as prey detection by delta smelt and reduced risk of predation should also be discussed
24:2	Given the short period that the plume remains in the water column there is no evidence of impacts to phytoplankton or zooplankton
24:4	Ballasting is not performed by Hanson or Lind and was an early assumption with the EIR. During consultation with CDFW, USFWS, and NMFS entrainment potential was avoided by installation of fish screens and by implementing practice to reduce or eliminate priming above the sediment surface. This information was provided to BCDC in multiple submittals.
25:1	Delta smelt are listed as a “threatened” species under ESA by USFWS, not “endangered”.
25:2	The report cites concerns for delta smelt egg entrainment as the basis for the seasonal depth concerns but the concern was also based on the occurrence of larval smelt in the shallow areas of the water column.
26:2	The report discussed halibut and Dungeness crabs as examples of species using sandy habitat but these species do not inhabit the area of Suisun Bay where Suisun Associates mining would occur and therefore is not relevant. The paragraph states that benthic disturbance can persist over a long period but this is based on observations from Central Bay, not Suisun Bay. This summary should focus on Suisun Bay channel where tidal velocities are higher and salinity gradient and invasive species issues are contributing factors.
27:2	The loss estimates presented here are from the EIR and do not assume the use of a fish screen or other operational avoidance procedures that are now part of the project, and therefore do not reflect current operating conditions; these estimates were based on a mining volume that is different and operational procedures and seasonal restrictions than submitted in the permit application. Additionally, the estimates suggest much higher confidence and accuracy than appropriate.
29:4	Non-native species were also introduced by oyster imports and intentional introductions of game fish and forage species
30:2	The discussion of non-natives in Central Bay is not relevant to the Suisun Associates lease application
30:5	The discussion of mining effects on X2 location is unnecessary, as the conclusion is the magnitude of this effect will be extremely small (non-detectable). The referenced USFWS BO simply indicated that “The proposed project is not expected to have any effect on salinity, since the river flows will not be affected, thus not affecting the position of X2.”
31:3	In addition to improving prey detection increased turbidity can also reduce predation risk; In the same paragraph the report cites core data from Central Bay for clay layers and extrapolates to the Suisun Associates lease area with no support
32:3	The report discusses using freshwater to rinse salt from sand mined in brackish areas of the estuary. It should be noted that Lind does not conduct sand washing of the materials mined from Suisun Associates.
33:2	To be representative the imported sand should be compared to a longer period of mining in all locations of the estuary. As stated previously, Lind Marine does not import sand, has no other alternative sand sources, and the imported sand is not

RESPONSE COMMENTS TO BCDC STAFF REPORT FOR SUISUN ASSOCIATES

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	equivalent to the Suisun Associates sand.
35:2	USFWS identified Liberty Island as suitable compensatory habitat for longfin smelt and delta smelt. All agencies CDFW, USFWS, and NMFS approved this compensatory habitat for these species to fully mitigate for unavoidable impacts.
37:2	The discussion of seasonal limitations in Central Bay is not appropriate and should be revised to reflect the seasonal limitations imposed by the permits for mining in Suisun Bay
39:3	How was the transcript abridged, and by whom?

Appendix A

ENVIRON – Air Quality Analysis



Air Quality Technical Appendix

In support of an Environmental Assessment of the
Hanson Jerico Sand Mining Operations in the
San Francisco Bay Area, for the
US Army Corps of Engineers under the
National Environmental Policy Act

Prepared for:
Downey Brand, LLC
San Francisco, California

On behalf of:
Hanson Marine Operations and Jerico Products, Inc.

Prepared by:
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201 California Street, Suite 1200
San Francisco, California

Date:
December 9, 2013

Project Number:
03-34198A

ENVIRON

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Acronyms and Abbreviations

CAA	Clean Air Act
CalEEMod	California Emissions Estimator Model
CAP	Criteria Air Pollutant
CARB	California Air Resources Board
CFR	Code of Federal Regulations
CH_4	Methane
CO	Carbon Monoxide
CO_2	Carbon Dixoide
CO_2e	Carbon Dioxide Equivalent
CY/yr	Cubic Yards per Year
EI	Emissions Inventory
EIR	Environmental Impact Report
GHG	Greenhouse Gas
HMA	Hot-Mix Asphalt
LF	Load Factor
LGOP	Local Government Operations Protocol
MGO	Marine Gas Oil
N_2O	Nitrous Oxide
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NOx	Nitrogen Oxides
OGV	Ocean-Going Vessel
PG&E	Pacific Gas & Electric
PM	Particulate Matter
$PM_{2.5}$	Particulate Matter with Aerodynamic Diameter 2.5 Micrometers or Less
PM_{10}	Particulate Matter with Aerodynamic Diameter 10 Micrometers or Less
PUP	Power/Utility Protocol
RMC	Ready-Mix Concrete
ROG	Reactive Organic Gas
RPS	Renewable Portfolio Standard
SO_2	Sulfur Dioxide

SOx	Sulfur Oxides
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
VMT	Vehicle Miles Traveled
VOC	Volatile Organic Compound

Executive Summary

This Air Quality Technical Appendix was prepared in support of an Environmental Assessment of the Hanson Marine Operations ("Hanson") and Jerico Products, Inc. ("Jerico") sand mining operations in the San Francisco Bay Area, for the United States Army Corps of Engineers (USACE) under the National Environmental Policy Act (NEPA). Hanson and Jerico's Project objective is to obtain renewal of all necessary permits and approvals to continue mining sand at an economically viable level in San Francisco and Suisun Bay for the next ten years (hereafter referred to as "Project"). In addition to this Project scenario, ENVIRON evaluated two Alternative scenarios: Reduced Project Alternative and No Project Alternative. This Appendix describes the operational emissions sources and the methods and data used to estimate criteria air pollutant (CAP) and greenhouse gas (GHG) emissions from operations associated with the Project, Reduced Project, and No Project scenarios. In addition, this Appendix includes an evaluation of Project compliance with Clean Air Act (CAA) General Conformity requirements.

As described in this Appendix, CAP and GHG emissions from the Project scenario are estimated to be less than the emissions associated with the Reduced Project and No Project scenarios. At full production capacity, the Reduced Project scenario is estimated to generate up to 15 times more emissions than the Project scenario, depending on the pollutant and operational year. The No Project scenario is estimated to generate up to 45 times more emissions than the Project scenario, depending on the pollutant and operational year.

At full production capacity, the No Project scenario requires approximately 20 percent more haul truck round-trips for distribution of sand to customers than the Project scenario (97,941 trips for Project compared to 117,307 trips for No Project). In addition, because several of the No Project Alternative Providers are located farther away from customer sites than the Hanson and Jerico Project offloading sites, the No Project scenario results in over 250 percent more vehicle miles traveled (VMT) than the Project scenario (1,800,071 miles/year for Project compared to 6,526,301 miles/year for No Project).

The remainder of this Appendix is structured as follows:

- Section 1 Introduction and Overview
- Section 2 Emissions Calculation Methodologies
- Section 3 Air Quality and Greenhouse Gas Impacts
- Section 4 General Conformity Evaluation

1 Introduction and Overview

This section provides an overview of the Project, Reduced Project, and No Project scenarios evaluated in this Appendix. It also describes the operational years, pollutants, and emissions sources evaluated for each scenario.

1.1 Project Description and Scenarios Evaluated

The Hanson Marine Operations ("Hanson") and Jerico Products, Inc. ("Jerico") Project's objective is to obtain renewal of all necessary permits and approvals to continue mining sand at an economically viable level in the San Francisco and Suisun Bay for the next ten years. Therefore, Project operations would be similar to current operations, with generally the same mining, offloading, and customer locations, and generally the same or similar equipment used to mine and transport sand. Details of Project operations are described in sections below. Hanson and Jerico currently mine sand from leases in the Central San Francisco Bay, Suisun Bay, and western Sacramento-San Joaquin River Delta Area. The mined marine sand is then transported via barge and tug directly to two customer sites (Petaluma and Napa) or three offloading sites (Oakland Tidewater, San Francisco Pier 92, and Collinsville). **Figure 1** shows the Project lease areas, direct customer sites, and offloading sites. From the Oakland Tidewater, San Francisco Pier 92, and Collinsville offloading sites, sand is transported to customers throughout the San Francisco Bay Area via haul truck. Customers use the marine sand as a raw material for one of three general product types: ready-mix concrete (RMC), hot-mix asphalt (HMA), or fill sand. **Figure 2** presents the customer locations and material flow lines from the two Project offloading sites to customers as well as the three direct customer sites. The color of each flow line indicates the product type, and the width of each flow line indicates the relative amount of sand sent to each customer. **Table 1**, below, presents the approximate annual sand deliveries in cubic yards (CY) and short tons (tons) at the three offloading sites and two direct customer sites.

Table 1: Approximate Annual Sand Deliveries

Year	Offloading Site / Customer	Address	Approximate Annual Sand Deliveries	
			CY/year	tons/year
2014	Oakland Tidewater	4501 Tidewater Ave. Oakland, CA 94601	385,595	539,832
	SF Pier 92	480 Amador St. San Francisco, CA 94214	394,905	552,868
	Collinsville	1285 Collinsville Road, Collinsville, CA 94585	43,271	60,579
	Shamrock Materials (Petaluma)	Landing Way, Petaluma, CA	68,940	96,516
	Syar Industries (Napa)	2301 Napa Vallejo Highway, Napa, CA	102,789	143,904
	Total		**995,500**	**1,393,700**

Table 1: Approximate Annual Sand Deliveries				
2015-2024	Oakland Tidewater	4501 Tidewater Ave. Oakland, CA 94601	859,621	1,203,470
	SF Pier 92	480 Amador St. San Francisco, CA 94214	880,379	1,232,530
	Collinsville	1285 Collinsville Road, Collinsville, CA 94585	60,378	84,529
	Shamrock Materials (Petaluma)	Landing Way, Petaluma, CA	96,196	134,674
	Syar Industries (Napa)	2301 Napa Vallejo Highway, Napa, CA	143,426	200,797
	Total		**2,040,000**	**2,856,000**

Notes:

Conversion factor: 1.4 tons/cubic yard sand, based on the average of the sand densities reported in the 2004 Hanson Environmental Sand Mining Study. (Hanson Environmental, Inc. 2004. Assessment & Evaluation of the Effects of Sand Mining on Aquatic Habitat and Fishery Populations of Central San Francisco Bay and the Sacramento-San Joaquin Estuary. October. Available online at: http://www.hansonenvironmentalinc.com/reports.htm.)

National Environmental Policy Act (NEPA) requires evaluation of Alternatives to the Project. In the absence of the Project marine sand sources, San Francisco Bay Area sand customers would obtain their sand from land-based sand production facilities ("Alternative Providers"). **Figure 3a** presents the locations of these Alternative Providers, which include facilities in the Bay Area as well as a mine in British Columbia, Canada. The British Columbia mine currently supplies RMC-quality sand to the San Francisco Bay Area, via import through San Francisco Pier 94 and the Ports of Redwood City and Richmond. The pie charts in **Figure 3a** depict the relative production capacity of each facility by product type. As shown, several of the Alternative Providers primarily produce aggregate rock products, which are not a suitable replacement for the marine sand currently supplied by Hanson and Jerico. Therefore, **Figure 3b** presents the Alternative Providers production capacities for sand that would replace Project marine sand in the No Project scenario. **Figure 3b** also shows the material flow lines from No Project Alternative Providers to customers.

A third scenario, the Reduced Project scenario, was also evaluated at the request of United States Army Corp of Engineers (USACE). In the Reduced Project scenario, Hanson and Jerico would only be permitted to mine a reduced volume of sand such that Hanson and Jerico (Project sources) would only be able to meet approximately 66 percent of the San Francisco Bay Area customer sand demand that would otherwise be met by Hanson and Jerico under the full Project scenario. The remaining 34 percent of that sand demand would be supplied by Alternative Providers (the No Project sources identified in **Figure 3b**).

Table 2 presents the annual volume of sand to be mined under the Project, Reduced Project, and No Project scenarios for operational years 2014, 2015, and 2024. The differences in emissions calculation methodologies for the three operational years are described in subsequent sections of this Appendix.

Table 2: Scenarios Evaluated

Scenario	Operational Years	Hanson and Jerico Marine Sand	Alternative Providers	*Total*
		Sand Mining Volume (cubic yards / year)		
Project	2014	995,500	0	*995,500*
Reduced Project	2014	995,500	0	*995,500*
No Project	2014	0	995,500	*995,500*
Project	2015 - 2024	2,040,000	0	*2,040,000*
Reduced Project	2015 - 2024	1,346,267	693,733	*2,040,000*
No Project	2015 - 2024	0	2,040,000	*2,040,000*
Scenario	**Operational Years**	**Hanson and Jerico**	**Alternative Providers**	***Total***
		Sand Mining Tonnage (tons / year)		
Project	2014	1,393,700	0	*1,393,700*
Reduced Project	2014	1,393,700	0	*1,393,700*
No Project	2014	0	1,393,700	*1,393,700*
Project	2015 - 2024	2,856,000	0	*2,856,000*
Reduced Project	2015 - 2024	1,884,774	971,226	*2,856,000*
No Project	2015 - 2024	0	2,856,000	*2,856,000*

Under the Project, Hanson and Jerico are requesting to mine 2,040,000 cubic yards per year (CY/yr) of marine sand.[1] Therefore, the No Project scenario evaluates emissions associated with the production of the same volume by land-based Alternative Providers, including imports from British Columbia. As described above, the Reduced Project scenario evaluates emissions

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[1] This is equivalent to 2.856 million tons per year (tons/yr) sand, based on a conversion of 1.4 tons per CY sand. This conversion factor is based on the average of the sand densities reported in the 2004 Hanson Environmental Sand Mining Study. (Hanson Environmental, Inc. 2004. Assessment & Evaluation of the Effects of Sand Mining on Aquatic Habitat and Fishery Populations of Central San Francisco Bay and the Sacramento-San Joaquin Estuary. October. Available online at: http://www.hansonenvironmentalinc.com/reports.htm.)

associated with 66 percent of this volume produced by Hanson and Jerico's marine operations, and the remaining 34 percent of the volume produced by land-based Alternative Provider sand production facilities.

The 2012 Final Environmental Impact Report for the San Francisco Bay and Delta Sand Mining Project[2] presented Project emissions assuming that Hanson would upgrade its barge engines by January 2014. Hanson has ordered the upgraded engines but due to manufacturer delays caused by high demand, installation will not occur until January 2015. Therefore, ENVIRON evaluated a Project emissions inventory for operational year 2014 that assumes existing Hanson barge engines and a maximum combined annual mining volume of 995,500 CY.[3] Jerico already has upgraded engines in place, therefore the existing assumptions with regard to 2014 engine emissions will remain the same for Jerico. For purposes of comparison, ENVIRON also evaluated 2014 No Project and Reduced Project scenarios based on the same sand volume as the 2014 Project scenario (995,500 CY). The 2014 scenarios and associated sand volumes are summarized in Table 2, above.

In addition, Federal and California regulations will generally require vehicle fleets (e.g. haul trucks) and equipment fleets (e.g. off-road equipment, barges, tugs, and ocean-going vessels) to become cleaner each year through controls, fuel, or other operational requirements that reduce the emission factors associated with each hour of operation or gallon of fuel consumed. Therefore, for each of the three scenarios (Project, Reduced Project, and No Project), ENVIRON evaluated emissions inventories for both the first year of full-capacity marine sand mining (2015) and the last year of the permit (2024) in order to present the range of emissions expected over the life of the proposed permit renewal period, where 2015 represents the maximum expected emissions and 2024 represents the minimum expected emissions as the total volume of material and transport distances are identical to 2015; however, the haul truck, offroad equipment and marine fleets are expected to be cleaner in 2024 due to requirements for improved emissions control technologies. The 2015 and 2024 scenarios and associated sand volumes are summarized in Table 2, above.

Table 3, below, presents the annual sand volumes on a per-lease basis. As is described in detail in later sections, each lease is associated with different emissions due to differences in the volume of sand mined at each lease, the proximity of each lease to the offloading and direct customer sites, and the particular operator(s) mining at each lease.

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2 California State Lands Commission. 2012. Final Environmental Impact Report (EIR) for the San Francisco Bay and Delta Sand Mining Project. September.

3 The 2014 volume presented here reflects practical maximum operations in 2014 given the current volume limitations in the permit extensions and needed ramp up time once the final permits are secured from state and federal agencies. This reduction in sand mining volume and associated operations in 2014 will result in reduced air emissions, such that 2014 Project emissions will not exceed the emissions and significance thresholds presented in the 2012 Final EIR.

Table 3: Project Sand Mining by Lease

Year	Lease #	Lease Name	Operator	Proposed Sand Mined		Reduced Sand Mined	
				CY/year	Tons/year	CY/year	Tons/year
2014	PRC 709	Presidio Shoals	Hanson	290,000	406,000	290,000	406,000
	PRC 2036	Point Knox South	Hanson	252,500	353,500	252,500	353,500
	PRC 7779	Point Knox Shoal	Hanson	238,000	333,200	238,000	333,200
	PRC 7780	Alcatraz South Shoal	Hanson	0	0	0	0
	PRC 7781	Suisun Associates	Hanson	0	0	0	0
	PRC 7781	Suisun Associates	Jerico	85,000	119,000	85,000	119,000
	TLS 39	Grossi Middle Ground	Hanson	0	0	0	0
	TLS 39	Grossi Middle Ground	Jerico	130,000	182,000	130,000	182,000
	Total			**995,500**	**1,393,700**	**995,500**	**1,393,700**
2015 - 2024	PRC 709	Presidio Shoals	Hanson	340,000	476,000	290,331	406,463
	PRC 2036	Point Knox South	Hanson	450,000	630,000	252,637	353,692
	PRC 7779	Point Knox Shoal	Hanson	550,000	770,000	390,440	546,616
	PRC 7780	Alcatraz South Shoal	Hanson	200,000	280,000	127,248	178,147
	PRC 7781	Suisun Associates	Hanson	150,000	210,000	42,873	60,022
	PRC 7781	Suisun Associates	Jerico	150,000	210,000	42,873	60,022
	TLS 39	Grossi Middle Ground	Hanson	50,000	70,000	0	0
	TLS 39	Grossi Middle Ground	Jerico	150,000	210,000	199,866	279,812
	Total			**2,040,000**	**2,856,000**	**1,346,268**	**1,884,775**

1.2 Constituents Evaluated

This Appendix presents criteria air pollutant (CAP) and greenhouse gas (GHG) inventories for the Project, Reduced Project, and No Project scenarios. CAPs include particulate matter less than 10 microns in aerodynamic diameter (PM_{10}), particulate matter less than 2.5 microns in aerodynamic diameter ($PM_{2.5}$), nitrogen oxides (NO_X), sulfur oxides (SO_X), carbon monoxide (CO), and reactive organic gas (ROG). GHGs include carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). GHGs are also presented in terms of carbon dioxide equivalent (CO_2e). In this Appendix, CAP emissions are presented in short tons per year (tons/yr), and GHG emissions are presented in metric tonnes per year (tonnes/yr)

1.3 Emissions Sources Evaluated

For the Project, CAPs and GHGs are generated from three main categories of operations:

1. Sand Mining and Production
2. Material Movement at Offloading Sites, and
3. Transport of Sand to Customers.

This section provides an overview of each of these operational emissions categories. Details of the emission calculation methodologies under the Project, Reduced Project, and No Project scenarios are described in subsequent sections of this Appendix.

1.3.1 Sand Mining and Production

ENVIRON evaluated emissions from both marine sand mining and land-based sand mining and production facilities. Descriptions of these two types of sand mining and production operations are provided in this section. Details of the emissions calculations are described later in Section 2 of this Appendix.

1.3.1.1 Marine Sand Mining (Dredging, Cruising, Offloading)

Hanson and Jerico mine marine sand in the San Francisco Central Bay, Suisun Bay, and Delta Area using a dredging process. Dredges contain at least one pump engine and one auxiliary generator engine mounted on a barge. For Hanson, the pump engines are used for both mining and unloading whereas for Jerico, the pump engines are only used during sand mining. Jerico's dredge uses a front-end loader that loads sand onto the barge conveyor and discharges it ashore. Barges are not self-propelled but are moved by tugboats to and from the dredge site or between ports. Tugboats generally have two propulsion engines and one or two auxiliary generator engines. They transit between the mining sites and five offloading sites: Oakland Tidewater and San Francisco Pier 92 for Hanson; and Shamrock Materials (Petaluma), Syar Industries (Napa), and Collinsville Plant (Collinsville) for Jerico. All dredges, tugs, and loaders are diesel-powered and emit CAPs and GHGs.

1.3.1.2 Land-Based Sand Production

In the absence of Hanson and Jerico's marine sand mining operations, San Francisco Bay Area sand customers would obtain their sand from Alternative Providers. These Alternative Providers produce sand through land-based mining and sand manufacturing operations. Typically, raw aggregate materials are extracted from an active mining pit using excavators and scrapers, and then hauled to the plant for washing, crushing and sorting. At the end of the screening and separation process, the sorted aggregate and sand products are lifted via conveyor belts and dumped into fully sorted stockpiles. Emissions sources include CAPs and GHGs from the diesel-powered off-road excavation and hauling equipment, and particulate matter (PM) and indirect GHGs from electrically-powered crushing, sorting, and conveying equipment. In reality, some Alternative Providers may use generators to power the crushing, sorting, and conveying operations, resulting in CAPs from fuel combustion in addition to GHGs.[4] However, for the purposes of this assessment, ENVIRON conservatively assumed that all Alternative Providers use only electrically-powered crushing, sorting, and conveying equipment, which would have a lower emissions profile than a process powered by a generator.

1.3.2 Material Movement at Offloading Sites

After Hanson and Jerico mine sand from the Bay, it is transported via barge to Hanson's or Jerico's offloading sites or directly to Jerico's customers. At the three offloading sites (Oakland Tidewater, San Francisco Pier 92, and Collinsville), a diesel-powered loader is used to move the sand around the site into stockpiles or into haul trucks for distribution to customers. Electrically-powered motors are also used to assist with material movement and stockpiling. Therefore, emissions sources include CAPs and GHGs from the diesel-powered loaders, and indirect GHGs from electrically-powered motors.

Emissions associated with material movement at customer sites (including customers where sand is directly offloaded from Jerico's barges) are regulated under those facilities' air permits, and are outside the scope of this assessment. Emissions associated with material movement at Alternative Provider facilities are accounted for under Land-Based Sand Production, described in the previous section of this Appendix.

1.3.3 Transport of Sand to Customer

ENVIRON evaluated emissions associated with distributing sand to customers by haul truck or by barge and tug, as well as import of sand from British Columbia via ocean-going vessel for distribution to San Francisco Bay Area customers. Descriptions of these three transportation emissions sources are provided in this section.

1.3.3.1 Haul Truck (San Francisco Bay Area)

Most customers receive sand deliveries via heavy-heavy-duty haul truck. Sand is loaded onto the haul trucks at the Hanson offloading or Alternative Provider sites, weighed, and then delivered to various customer locations throughout the San Francisco Bay Area. CAP and GHG emissions associated with this distribution activity include idling emissions (during vehicle queuing and weighing and loading of sand), running emissions, and PM from brakewear and tirewear.

[4] For example, DI Aggregates operations on Decker Island are powered by diesel-fired generators.

1.3.3.2 Barge and Tug (San Francisco Bay Area)

In the Project scenario, Hanson's and Jerico's offloading sites and Jerico's two direct-delivery customers are located along the bay or rivers which allow sand to be delivered by tug and barge. Oakland Tidewater and San Francisco Pier 92 are served by Hanson's fleet, while Shamrock Materials in Petaluma, Syar Industries in Napa, and the Collinsville Plant/offloading site in Collinsville are served by Jerico's tug and barge fleet. In the No Project scenario, only Petaluma would continue to be served by tug and barge, taking sand from either (a) a land-based mine site on Decker Island in the Delta, which is barged through the Delta, Bay, and Petaluma River, or (b) from a land-based mine in British Columbia, where it is loaded onto an ocean-going vessel, shipped to the San Francisco Bay Area, lightered to a barge at Anchorages 8/9 (just South of the San Francisco-Oakland Bay Bridge), and barged up the Bay and Petaluma River. The Napa customer would receive sand deliveries by truck from Alternative Providers in the nearby Cache Creek area, and use of the Collinsville terminal operated by Jerico would likely be discontinued in the absence of the Project.

Emissions sources from the barge and tug sand delivery operations include CAPs and GHGs from the marine engines during cruising and mining and from the loaders during offloading.

1.3.3.3 Ocean-Going Vessel (British Columbia to San Francisco Bay Area)

In the No Project and Reduced Project scenarios, a fraction of the sand would be imported from Polaris mine in British Columbia via ocean-going vessels (OGVs) and either offloaded at San Francisco Pier 94 or lightered onto barges at Anchorages 8/9 in the Bay. The OGVs to be used in this case are expected to be from the CSL Trillium class vessel fleet. The modes of operation include crusing between Vancouver, British Columbia and the Bay Area and hoteling and anchorage within the Bay. In the 2014 analysis year, the OGV is assumed to use 0.5% sulfur content marine gas oil (MGO) fuel cruising between British Columbia and the Bay Area but switch to 0.1% sulfur MGO during the time operating within the Bay. By 2024, it is assumed to use 0.1% sulfur MGO throughout the entire trip. Emissions associated with OGV operation include CAPs and GHGs from the main engine during cruising between ports, and auxiliary engines boilers during hoteling and anchorage at port.

2 Emissions Calculation Methodologies

This section describes the calculation methodologies and data sources used to estimate CAP and GHG emissions for the operational sources described in the previous section of this Appendix.

Table 4 presents the emissions sources evaluated for the Project, Reduced Project, and No Project scenarios:

Table 4: Emissions Sources Evaluated

Activity[1]		Equipment	Project (Hanson and Jerico)	Reduced Project	No Project (Alternative Providers)
Sand Mining and Production	Marine Sand Mining (Dredging, Cruising, Offloading)[2]	Barges, tugs, loaders	X	X	
	Land-Based Sand Production	Off-road equipment electric equipment		X	X
Material Movement at Offloading Sites	Material Movement at Offloading Sites	loader, electric equipment	X	X	
Transport of Sand to Customers	via Haul Truck (in San Francisco Bay Area)	haul trucks	X	X	X
	via Barge and Tug - from DI Aggregates (Decker Island) to Shamrock (Petaluma) - from San Francisco Bay Anchorages 8/9 to Shamrock (Petaluma)	barges, tugs, loaders		X	X
	via Ocean-Going Vessel (British Columbia to San Francisco Bay Area)	ocean-going vessels		X	X

Notes:

[1] Emissions-generating activities associated with the mining and delivery of sand for all scenarios, as discussed with Hanson Marine Operations and Jerico Products, Inc.

[2] This includes cruising and offloading emissions associated with Jerico delivering sand to two customers directly via barge and tug (Shamrock in Petaluma and Syar Industries in Napa).

The emissions calculations follow the general equation:

E = Activity x EF x C

where:

E =	emissions (such as tons pollutant / year)
Activity =	activity metric (such as hours of operation / year)
EF =	emission factor (such as tons pollutant / hour of operation)
C =	Unit conversion factor (if needed)

The activity metric used in the emissions calculations varies between sources, and may include parameters such as hours of operation, vehicle miles traveled, and tons of sand delivered. Where project-specific data was not available, ENVIRON used activity data, emission factors, and/or other operational data obtained from well-established and industry-standard models, databases, and protocols developed by the California Air Resources Board (CARB). The following sections of this Appendix identify the specific CARB models used for each of the emissions source types, as well as describe how each of the models were used in ENVIRON's emissions calculations.

2.1 Project

Table P.1 in **Attachment A** provides a summary of the emissions calculation methodology for the Project scenario. Project emissions sources include the following operations:

- Marine Sand Mining
- Offloading Site Material Movement
- Transport of Sand to Customer via Haul Truck, and
- Transport of Sand to Customer via Barge and Tug

The following sections detail the specific data sources, activity data, and calculation methods used to estimate emissions associated with Project operations.

2.1.1 Marine Sand Mining (Dredging, Cruising, Offloading)

Marine sand mining consists of three types of operations: dredging, cruising, and offloading. This section describes the emissions calculation methodologies associated with these three operational modes. **Tables P.2 – P.8** present the activities, emission factors, and emissions associated with these operations. Engine characteristics (e.g. model year, horsepower) and activity level (e.g. hours per mining event, number of trips to achieve the annual throughput) were provided by Hanson and Jerico based on standard industry practices for various parameters related to mining, transportation, and processing.

2.1.1.1 Dredging

As mentioned above, Hanson and Jerico mine marine sand using a dredging process. A main pump engine is used to mine sand onto the barge while an auxiliary generator is also run to provide additional power. They are modeled as Pumps and Generators, respectively, using CARB's Barge and Dredge Emissions Inventory (EI) Database,[5,6,7] as follows:

Equation 1: $E = EF_0 * FC * \left(1 + DE * \frac{A}{UL}\right) * HP * LF * Hr * C$

Where:

EF_0 – Horsepower and model year specific zero-hour emission factor [g/hp-hr]
FC – Fuel correction factors for using low sulfur content diesel fuels
DE – Deterioration rate of engine obtained from the CARB Barge and Dredge EI Database
A – Age of the engine as provided by Hanson and Jerico
UL – Useful life of the engine obtained from Barge and Dredge EI Database
HP – Engine horsepower as provided by Hanson and Jerico
LF – Engine load factor obtained from Barge and Dredge EI Database
Hr – Engine hours as calculated from given information
C – Conversion constants

The dredge boat model years and horsepower information were provided by Hanson and Jerico based on the existing fleet and anticipated engine upgrades, as shown in **Table P.2**. The hours per mining event and the capacity of the barges were provided by Hanson and Jerico based on historical operational data, as shown in **Table P.3**. The number of trips per year is the total annual throughput divided by the capacity of one barge. The total hours of operation per year is calculated as the hours per mining event times the number of trips.

2.1.1.2 Cruising/Transporting

Although barges are used to house the marine sand dredge equipment, they are not self-propelled but are pushed by tugboats to and from the mine sites and offloading customer

5 CARB. Barge and Dredge Emissions Inventory Database. Available online at: http://www.arb.ca.gov/msei/categories.htm#chc_category.

6 CARB. 2010. Appendix C: Emission Inventory Methodology. Available online at: http://www.arb.ca.gov/regact/2010/chc10/appc.pdf

7 CARB developed the Barge and Dredge EI Database and the Harbor Craft EI Database in 2007 and revised them in 2010 in support of regulatory analysis for the Regulation to Reduce Emissions from Diesel Engines on Commerical Harbor Craft Operated within California Waters and 24 Nautical Miles of the California Baseline ("the harbor craft regulation") and subsequent amendments. Currently, barge and dredge vessels are not regulated under this regulation, but CARB collected information on these vessels and included them in the Barge and Dredge EI Database for potential future regulatory development purposes. Per CARB, the databases were developed based on the best information and methodologies available at the time, using data from various sources including the U.S. Coast Guard, the California Department of Fish and Game, the CARB Harbor Craft Survey, and information from emission inventories generated for the Port of Los Angeles. Data gathered and used in the development of the database include vessel and engine types, age, size, annual hours of operation, and annual fuel use. Future years were forecasted based on estimated vessel and engine activity growth and age profiles, taking into account decreasing fuel sulfur content and increasing emission rates with engine age and use.

locations. Tugs are modeled using **Equation 1** above, except that parameters DE, UL, and LF are obtained from CARB's Harbor Craft EI Database.[8,9,10]

The tug boat model years and horsepower information were provided by Hanson and Jerico based on the existing fleet and anticipated engine upgrades, as shown in **Table P.4**. The hours per trip between mining and offloading sites and the capacity of the barges were provided by Hanson and Jerico based on historical operating data, as shown in **Table P.5**. The number of trips per year is the total annual throughput divided by the capacity of one barge. The total hours of operation per year is calculated as the hours per trip times the number of trips.

During sand transport between mining sites and offloading locations, a thruster pump and an auxiliary generator onboard Hanson's barge are also operated to provide additional power. They are modeled as Pumps and Generators using CARB's Barge and Dredge EI Database by a similar method as describe above.

2.1.1.3 Offloading

For Hanson, the main pump on the barge is used for both dredging sand, as described in Section 2.1.1.1, as well as offloading sand. Emissions from offloading sand from the barge to the customer locations are estimated by the same methodology as that in Section 2.1.1.1. For Jerico, shore power and a front-end loader are used to load sand onto the barge conveyor and discharge it ashore. Emissions associated with electricity usage from shore powering are described in a later section. The front-end loader is modeled as a rubber tired loader using CARB's OFFROAD model,[11,12,13,14] as follows:

Equation 2: $E = EF * HP * LF * Hr * C$

Where,

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[8] CARB. Harbor Craft Emissions Inventory Database. Available online at: http://www.arb.ca.gov/msei/categories.htm#chc_category.

[9] See previous footnote regarding CARB's development of the Barge and Dredge EI Database and Harbor Craft EI Database.

[10] CARB. 2010. Appendix C: Emission Inventory Methodology. Available online at: http://www.arb.ca.gov/regact/2010/chc10/appc.pdf

[11] CARB. OFFROAD2011 and OFFROAD2007 models. Available online at: http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

[12] CARB. 2010. Appendix D: OSM and Summary of Off-Road Emissions Inventory Update. Available online at: http://www.arb.ca.gov/regact/2010/offroadlsi10/offroadappd.pdf

[13] CARB. 2007. Appendix E: Emissions Inventory Methodology and Results. Available online at: http://www.arb.ca.gov/regact/2007/ordiesl07/tsdappe.pdf

[14] CARB's OFFROAD model estimates the activity and emissions of off-road mobile emissions sources, such as construction equipment. OFFROAD contains a database of default values for horsepower, load factor, and hours per day of operation, and is used to estimate the activity and emissions for a project's equipment fleet and year of use. Data sources used to develop the OFFROAD database include CARB's Diesel Off-road On-line Reporting System (DOORS) vehicle database, Assembly Bill 8 2x (AB 8 2x), USEPA and other federal agencies, studies conducted by contracted private firms, and additional input gathered from stakeholders.

EF – Adjusted emission factor [g/hp-hr]
HP – Engine horsepower as provided by Hanson and Jerico
LF – Engine load factor obtained from OFFROAD model
Hr – Engine hours as calculated from given information
C – Conversion constants

Emission factors are derived from CARB's OFFROAD 2011 model except for CO, SO_X, and GHGs which are derived from CARB's OFFROAD 2007 model. This is because emission factors for these constituents are not available in the newer OFFROAD model.

The hours per offloading event and the capacity of the barges were provided by Hanson and Jerico based on historical operating data, as shown in **Table P.6**. The number of trips per year is the total annual throughput divided by the capacity of one barge. The total hours of offloading operation per year is the hours per event times the number of trips, as shown in **Table P.7**.

Table P.8 summarizes Project emissions from dredging, cruising/transporting, and offloading.

2.1.2 Material Movement at Offloading Sites

At the three offloading sites (Oakland Tidewater, San Francisco Pier 92, and Collinsville), a diesel-powered loader is used to move the sand around the site into stockpiles or into haul trucks for distribution to customers. **Tables P.9 – P.10** show the activity, emission factors, and emissions associated with loader operations. Emissions were calculated according to Equation 2 above using emission factors and load factors from CARB's OFFROAD model and actual equipment model and horsepower provided by Hanson and Jerico. Emissions were calculated based on actual estimated operational hours (for Hanson, 40 hours per week at 50 weeks per year; for Jerico, 2 hours per week at 52 weeks per year).

In addition to the diesel loaders, electrically-powered motors are also used to assist with material movement and stockpiling at the three offloading sites. Indirect GHG emissions from electricity usage were calculated as shown in **Tables P.11 – P.13**. Hanson and Jerico provided the total horsepower of the conveyors currently in use at the sites. Emission factors were obtained from Pacific Gas and Electric's (PG&E) Power/Utility Protocol (PUP) Report[15] and CARB's Local Government Operations Protocol (LGOP).[16] As detailed in the tables, ENVIRON adjusted the CO_2 emission factor to account for the California Renewable Portfolio Standard (RPS), which requires utilities to increase procurement from renewable energy resources to 20% of total procurement by 2010, and 33% by 2020. ENVIRON applied the 20% RPS to Project operational years 2014 and 2015, and 33% RPS to operational year 2024. Emissions were calculated based on actual estimated operational hours (for Hanson, 40 hours per week at 50 weeks per year; for Jerico, 160 hours per year)..

[15] Pacific Gas and Electric (PG&E). 2008 Power/Utility Protocol (PUP) Report. http://www.climateregistry.org/tools/carrot/carrot-public-reports.html.

[16] CARB. 2010. Local Government Operations Protocol (LGOP). Version 1.1. Appendix G. http://www.arb.ca.gov/cc/protocols/localgov/pubs/lgo_protocol_v1_1_2010-05-03.pdf

Table P.14 presents the overall CAP and GHG emissions associated with the the Oakland Tidewater, San Francisco Pier 92, and Collinsville offloading sites.

2.1.3 Transport of Sand to Customer

In the Project scenario, Hanson and Jerico's customers continue to receive sand deliveries as they currently do, via haul truck or via barge and tug. The following sections provide the emissions calculation details for each of these modes of transport.

2.1.3.1 Haul Truck (San Francisco Bay Area)

With the exception of one customer that is located adjacent to Hanson's Oakland Tidewater facility such that sand can be delivered via electric conveyor, customers served by the Oakland Tidewater, San Francisco Pier 92, and Collinsville offloading sites receive sand deliveries via haul truck. At the offloading sites, sand is loaded onto haul trucks, weighed, and then delivered to various customer locations throughout the San Francisco Bay Area. **Tables P.15 – P.19** show the activity, emission factors, and emissions associated with these haul truck deliveries. Customer locations, truck routes, and amount of sand delivered were provided by Hanson and Jerico based on historical records of marine sand sales and deliveries. The number of truck trips to each customer was calculated based on the amount of sand delivered (tons per year) and truck capacity (tons per trip), which was assumed to be 23 tons per truck round-trip for most trucks. Per Hanson, two customers adjacent to Hanson's San Francisco Pier 92 offloading site are permitted to use overweight trucks of capacity 30 tons per truck round-trip. For each truck round-trip, ENVIRON assumed 30 minutes of idling time for queuing and weighing, based on data provided by Hanson and standard industry practices for sand deliveries via haul truck. CAP and GHG emission factors for idling and running, and PM emission factors for brakewear and tirewear were obtained from CARB's EMFAC 2011 model.[17,18,19] For operational years 2014, 2015, and 2024, ENVIRON used the San Francisco Bay Area aggregated emission factors which are representative of diesel heavy-heavy-duty trucks in the San Francisco Bay Area, with fleet-wide average aggregate model years and speeds.

2.1.3.2 Barge and Tug (San Francisco Bay Area)

Jerico delivers sand to its Collinsville offloading site and two direct customers in Petaluma and Napa via barge and tug. Emissions associated with these deliveries are accounted for under the cruising / transport emissions described in Section 2.1.1.2 above.

[17] CARB. 2011. EMission FACtor Model, EMFAC2011. Available online at: http://www.arb.ca.gov/msei/categories.htm#onroad_motor_vehicles.

[18] CARB. 2011. EMFAC 2011 Technical Documentation. Available online at: http://www.arb.ca.gov/msei/emfac2011-technical-documentation-final-updated-0712-v03.pdf

[19] CARB's EMFAC model compiles real fleet data on the county-level for the state of California, including vehicle model year distributions, vehicle class (e.g., light-duty auto versus heavy-heavy-duty truck) distributions, and emission rate information. EMFAC generates fleet-average emission factors based on user inputs including the vehicle class, fuel type, year of operation, and region within California.

2.2 Reduced Project

Since the 2014 Project scenario is based on a sand volume that is well below the USACE-proposed Reduced Project scenario (995,500 CY/yr compared to 1,346,267 CY/yr), there is no need to further reduce the sand volumes in 2014 and therefore for purposes of this assessment, the 2014 Reduced Project scenario is equivalent to the 2014 Project scenario.

In the 2015 and 2024 Reduced Project scenarios, Hanson and Jerico would only be permitted to mine a reduced volume of sand such that Hanson and Jerico (Project sources) would only be able to meet approximately 66 percent of the San Francisco Bay Area customer sand demand that would otherwise be met by Hanson and Jerico under the full Project scenario. The remaining 34 percent of that sand demand would be supplied by Alternative Providers (the No Project sources). Therefore, emissions for the Reduced Project scenario were estimated by scaling the Project and Alternative Providers/No Project emissions based on total sand volume.

Emissions for each lease were evaluated separately. The sand volume attributed to each lease is presented in **Table 5** below. The “Hanson and Jerico Marine Sand” column presents the amount of sand that would be mined at each lease by Hanson and/or Jerico in the Reduced Project scenario. The “Total Sand” column presents the total amount of sand attributed to each lease for purposes of this assessment, such that the total amount of sand in the Reduced Project scenario is equivalent to the total amount of sand in the Project scenario. Alternative Providers would supply the balance of the sand, as shown in the “Alternative Providers” column. For example, in years 2015 through 2024, Hanson would mine 85% of sand at lease PRC 709, with the remaining 15% of sand supplied by Alternative Providers. For lease PRC 7781, Hanson and Jerico collectively would mine 29% of sand with the remaining 71% supplied by Alternative Providers.

Emissions for each lease are calculated accordingly, based on the volume of sand and operator(s) mining at each particular lease. As described earlier, the Middle Ground and Suisun/Delta leases are associated with longer cruising times for barges, resulting in greater marine emissions on a per-CY basis. Further, Hanson and Jerico have different barge and tug fleets, offloading equipment, and operating hours. All of these factors contribute to different emissions for each lease, but in summary, emissions are calculated based on the sand volume for each lease using the methodologies described in the Project sections above and the No Project sections below. The emissions associated with the 2014, 2015, and 2024 Reduced Project scenarios are summarized in Section 3.6 below.

Table 5: Reduced Project Calculation Method								
Year	**Lease #**	**Lease Name**	**Operator**	**Hanson and Jerico Marine Sand**		**Alternative Providers**		**Total Sand**
				CY/year	**% Total**	**CY/year**	**% Total**	**CY/year**
2014	PRC 709	Presidio Shoals	Hanson	290,000	100%	0	0%	290,000
	PRC 2036	Point Knox South	Hanson	252,500	100%	0	0%	252,500
	PRC 7779	Point Knox Shoal	Hanson	238,000	100%	0	0%	238,000
	PRC 7780	Alcatraz South Shoal	Hanson	0	0%	0	0%	0
	PRC 7781	Suisun Associates	Both	85,000	100%	0	0%	85,000
	TLS 39	Grossi Middle Ground	Both	130,000	0	0	0%	130,000
	Total			**995,500**	**100%**	**0**	**0%**	**995,500**
2015 - 2024	PRC 709	Presidio Shoals	Hanson	290,331	85%	49,669	15%	340,000
	PRC 2036	Point Knox South	Hanson	252,637	56%	197,363	44%	450,000
	PRC 7779	Point Knox Shoal	Hanson	390,440	71%	159,560	29%	550,000
	PRC 7780	Alcatraz South Shoal	Hanson	127,248	64%	72,752	36%	200,000
	PRC 7781	Suisun Associates	Both	85,746	29%	214,254	71%	300,000
	TLS 39	Grossi Middle Ground	Both	199,866	100%	134	0%	200,000
	Total			**1,346,268**	**66%**	**693,732**	**34%**	**2,040,000**

2.3 No Project

Table NP.1 provides a summary of the emissions calculation methodology for the No Project scenario. No Project emissions sources include the following operations:

- Land-Based Sand Production
- Transport of Sand to Customer via Haul Truck
- Transport of Sand to Customer via Barge and Tug, and
- Transport of Sand to San Francisco Bay Area from British Columbia via Ocean-Going Vessel

The following sections detail the specific data sources, activity data, and calculation methods used to estimate emissions associated with No Project operations.

2.3.1 Land-Based Sand Production

Emissions sources at the Alternative Provider land-based sand production facilities include CAPs and GHGs from diesel-powered off-road excavation and hauling equipment, and PM and indirect GHGs from electrically-powered crushing, sorting, and conveying equipment. For the No Project scenario, it is assumed that all sand originates from land based quarries, either in California or British Columbia. In the absence of detailed activity and emissions information for each of the ten Alternative Providers, ENVIRON estimated emissions by scaling emissions presented in the 2012 SMP-30 Sunol Valley Aggregate Quarry Environmental Impact Report ("Sunol EIR"), which evaluated emissions for an aggregate mining and aggregate/sand production facility.[20] This is expected to be a conservative comparison because the typical Alternative Provider is likely an older plant with more energy-intensive and emissions-intensive equipment and operations.

To estimate No Project off-road equipment emissions, ENVIRON used the equipment fleet, horsepower, and hours of operation used in the Sunol EIR, and emission factors obtained from the same data sources as were used for the Project scenario (CalEEMod and OFFROAD 2011). ENVIRON then multiplied the resulting emissions by a factor of 2.38, which is the ratio of No Project sand production (2.856 million tons per year) to Sunol EIR total aggregate production (1.2 million tons per year). Details of this calculation are presented in **Tables NP.2 – NP.3**.

To estimate No Project emissions from electrically-powered equipment, ENVIRON used the kilowatt-hours presented in the Sunol EIR, and the same emission factors as were used for the Project scenario, described earlier. ENVIRON then multiplied the resulting emissions by a factor of 2.38, which is the ratio of No Project sand production to Sunol EIR total aggregate production. Details of this calculation are presented in **Table NP.4**.

Table NP.5 presents the overall CAP and GHG emissions associated with the Alternative Provider land-based sand production facilities.

2.3.2 Transport of Sand to Customer

As in the Project scenario, in the No Project scenario customers receive sand deliveries either via haul truck or via barge and tug. The No Project scenario also includes emissions associated

[20] Lamphier - Gregory. 2012. SMP-30 Revised Use Permit Sunol Valley Aggregate Quarry Project: Draft Environmental Impact Report. April. (Consistent with the Final EIR, published June 2012.)

with importing sand from British Columbia to the San Francisco Bay Area via ocean-going vessel.

2.3.2.1 Haul Truck (San Francisco Bay Area)

No Project emissions from haul trucks are calculated using the same method as the Project, except that the vehicle miles traveled (VMT) are based on Alternative Provider locations and truck routes as provided by Hanson. Details of the activity, emission factors, and overall emissions are presented in **Tables NP.6 – NP.8**.

2.3.2.2 Barge (San Francisco Bay Area)

Similar to the Project scenario, tugs and barges are used to transport sand between mine / transfer sites to the end customer. In the No Project scenario, sand that requires marine transport comes from two locations: (1) DI Aggregate, a land-based mine site on Decker Island in the Delta; and (2) Polaris mine in British Columbia. Unlike the Project scenario, Shamrock Materials in Petaluma would be the only customer to receive sand taken in by barge and tug, and Jerico would be the sole service provider. CAP and GHG emissions from tugs are estimated using a similar method as that for the Project scenario.

As in the Project scenario, a loader is used by Jerico to discharge sand from the barge to the customer offloading site. In the No Project scenario, however, only sand from Decker Island is required to use a loader to offload at Shamrock Materials in Petaluma. Sand coming from the Polaris mine in British Columbia is lightered onto barges at Anchorage 8/9 in the Bay and then transported to Petaluma, and therefore a loader is not needed. CAPs and GHGs emissions are estimated by the same method as in the Project scenario.

Details of the activity, emission factors, and overall emissions are presented in **Tables NP.9 – NP.16**.

2.3.2.3 Ocean-Going Vessel (British Columbia to San Francisco Bay Area)

In the Reduced Project and No Project scenarios, a portion of the sand would be imported from the Polaris mine in British Columbia via OGVs to San Francisco Pier 94 or Anchorage 8/9 in the San Francisco Bay. Emissions associated with the CSL Trillium class OGV include: (1) main engine cruising emissions between British Columbia and San Francisco, (2) auxiliary engine and auxiliary boiler emissions during hoteling within San Francisco Bay, and (3) auxiliary engine and auxiliary boiler emissions during anchorage within San Francisco Bay. The CSL Trillium vessels are bulk carriers and their emissions are estimated using **Equation 2** above, except that parameter HP is obtained from published literature for CSL Trillium class vessels, and parameter LF is obtained from CARB's Marine Emissions Model.[21,22,23] Details of the OGV emissions calculations are presented in **Tables NP.12 – NP.13**.

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[21] CARB's Marine Emissions Model. Available online at http://www.arb.ca.gov/msei/categories.htm#ogv_category

[22] CARB. 2011. Appendix D: Emissions Estimation Methodology for Ocean-Going Vessels. Available online at: http://www.arb.ca.gov/regact/2011/ogv11/ogv11appd.pdf

The distance between Vancouver, British Columbia and San Francisco, California was estimated using Google Earth. Assuming an eco-speed of 12.5 knots, the hours for cruising is calculated by dividing the travel distance by the speed. The hours for hoteling and anchorage are 66 hours and 11 hours, respectively, as obtained from CARB's published document "Emissions Estimation Methodology for Ocean-Going Vessels."[24]

In the 2014 analysis year, the OGV is assumed to use 0.5% sulfur content MGO fuel cruising between British Columbia and the Bay Area but switch to 0.1% sulfur MGO during the time operating within the Bay. By 2024, it is assumed to use 0.1% sulfur MGO throughout the entire trip. Emissions associated with OGV operation include CAPs and GHGs from the main engine, auxiliary engine, and auxiliary boiler during cruising between British Columbia and the Bay, and hoteling and anchorage within the San Francisco Bay.

2.3.3 Fugitive Dust

Fugitive dust (PM_{10} and $PM_{2.5}$) emissions are generated from haul trucks and off-road equipment traveling on paved roads such as highways and surface streets, and unpaved roads at offloading sites and land-based sand production facilities. While these emissions were not included in the overall emissions inventories presented in this Appendix, PM_{10} from fugitive dust can be expected to be roughly 10 times the PM_{10} exhaust emissions associated with haul trucks and off-road equipment for the No Project scenario, and 100 times the exhaust emissions associated with the Project scenario. Fugitive dust associated with the Project scenario would be approximately 2.5 times lower than that expected from the No Project scenario.

[23] CARB's Marine Emissions Model was developed from real vessel and port call data collected from comprehensive state-wide sources including the California Lands Commission, the USACE National Waterway Network, the Marine Exchange of Southern California, the U.S. Coast Guard Vessel Traffic Service, logs and inventories for multiple California ports, and various published studies.

[24] CARB. 2011. Appendix D: Emissions Estimation Methodology for Ocean-Going Vessels. Available online at: http://www.arb.ca.gov/regact/2011/ogv11/ogv11appd.pdf

3 Air Quality and Greenhouse Gas Impacts

This section presents the overall CAP and GHG emissions inventories associated with the Project, Reduced Project, and No Project scenarios. CAP emissions (ROG, CO, NOx, Sox, PM_{10}, and $PM_{2.5}$) are presented in short tons per year (tons/yr), and GHG emissions (CO_2, CH_4, N_2O, and CO_2e) are presented in metric tonnes per year (tonnes/yr). A lease-by-lease analysis is also presented at the end of this section.

3.1 Project

Tables 6, 7, and 8 present the Project scenario emissions for operational years 2014, 2015, and 2024, respectively. As shown, emissions in 2024 are expected to be lower than in 2015 due to the implementation of Federal and California regulations that will result in vehicle and equipment fleets becoming cleaner each year through controls, fuel, or other operational requirements that reduce the emission factors associated with each hour of operation or gallon of fuel consumed.

Table 6: Project Summary Emissions 2014

Activity	Equipment	Emissions (tons/yr)						Emissions (tonnes/yr)			
		ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
Marine Sand Mining (Cruising, Mining, Offloading)	barges, tug boats	10	30	77	0.040	4.0	3.9	3,884	0.8	0.13	3,941
Offloading Site (Hanson SF Pier 92, Oakland Tidewater, and Jerico Collinsville)	loader, electric conveyors	0.12	0.7	1.5	0.0031	0.057	0.052	339	0.05	0.0033	341
Transport from Offloading Site to Customer by Truck	trucks	0.48	2.3	10	0.018	0.26	0.19	1,681	0.02	0.05	1,698
Total	**All**	**10**	**33**	**89**	**0.06**	**4.3**	**4.1**	**5,904**	**0.9**	**0.19**	**5,980**

Table 7: Project Summary Emissions 2015												
Activity	Equipment	Emissions (tons/yr)						Emissions (tonnes/yr)			
		ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
Marine Sand Mining (Cruising, Mining, Offloading)	barges, tug boats	7.2	26	71	0.085	3.2	3.1	8,242	0.59	0.28	8,340
Offloading Site (Hanson SF Pier 92, Oakland Tidewater, and Jerico Collinsville)	loader, electric conveyors	0.27	1.5	3.2	0.0031	0.12	0.11	751	0.11	0.0074	755
Transport from Offloading Site to Customer by Truck	trucks	0.92	4.5	18	0.037	0.44	0.30	3,416	0.039	0.108	3,450
Total	**All**	**8.4**	**32**	**92**	**0.12**	**3.8**	**3.5**	**12,408**	**0.74**	**0.39**	**12,546**

Table 8: Project Summary Emissions 2024												
Activity	Equipment	Emissions (tons/yr)						Emissions (tonnes/yr)			
		ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
Marine Sand Mining (Cruising, Mining, Offloading)	barges, tug boats	6.7	38	48	0.085	1.1	1.1	8,242	0.55	0.28	8,340
Offloading Site (Hanson SF Pier 92, Oakland Tidewater, and Jerico Collinsville)	loader, electric conveyors	0.13	0.86	1.1	0.0031	0.040	0.037	677	0.11	0.0074	682
Transport from Offloading Site to Customer by Truck	trucks	0.83	4.2	6.3	0.036	0.34	0.20	3,109	0.035	0.108	3,143
Total	**All**	**7.7**	**43**	**56**	**0.12**	**1.5**	**1.3**	**12,029**	**0.70**	**0.39**	**12,165**

3.2 Reduced Project

As described earlier, since the 2014 Project scenario is based on a sand volume that is well below the USACE-proposed Reduced Project scenario (995,500 CY/yr compared to 1,346,267 CY/yr), there is no need to further reduce the sand volumes in 2014 and therefore for purposes of this assessment, the 2014 Reduced Project scenario is equivalent to the 2014 Project scenario. **Table 9** presents the Reduced Project scenario emissions for 2015 and 2024. As shown, emissions in 2024 are expected to be lower than in 2015 due to the implementation of Federal and California regulations that will result in vehicle and equipment fleets becoming cleaner each year.

Table 9: Reduced Project Summary Emissions: 2015 and 2024

Year	Emissions (tons/yr)						Emissions (tonnes/yr)			
	ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
2014	10	33	89	0.06	4.3	4.1	5,904	0.9	0.19	5,980
2015	12	40	182	1.9	6.9	4.7	18,479	1.5	0.51	18,668
2024	11	44	133	1.9	4.9	2.7	17,438	1.4	0.51	17,626

3.3 No Project

Tables 10, 11, and 12 present the No Project scenario emissions for 2014, 2015, and 2024, respectively. As shown, emissions in 2024 are expected to be lower than in 2015 due to the implementation of Federal and California regulations that will result in vehicle and equipment fleets becoming cleaner each year.

Table 10: No Project Summary Emissions 2014

Activity	Equipment	Emissions (tons/yr)						Emissions (tonnes/yr)			
		ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
Land-Based Sand Production	offroad, electric equipment	1.9	12	24	0.023	3.8	1.2	5,227	0.87	0.045	5,259
Transport from Offloading Site to Customer by Truck	trucks	1.4	6	33	0.06	0.9	0.7	5,875	0.06	0.19	5,849
Transport from Offloading Site to Customer (Shamrock in Petaluma) by Barge and Tug - from DI Aggregates (Decker Island) to Shamrock (Petaluma) - from SF Bay Anchorages 8/9 to Shamrock (Petaluma)	barges, tug boats	0.7	2.4	5.2	0.005	0.24	0.23	448	0.06	0.015	454
Import of Sand from British Columbia to SF Pier 94 or SF Bay Anchorages 8/9	ocean-going vessels	5.1	7.3	111	12	2.4	2.2	3,623	0.43	0.11	3,666
Total	**All**	**9**	**29**	**174**	**12**	**7**	**4.3**	**15,174**	**1.4**	**0.36**	**15,228**

Table 11: No Project Summary Emissions 2015

Activity	Equipment	Emissions (tons/yr)						Emissions (tonnes/yr)			
		ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
Land-Based Sand Production	offroad, electric equipment	3.9	24	48	0.047	7.6	2.4	10,196	1.6	0.093	10,259
Transport from Offloading Site to Customer by Truck	trucks	2.5	12	57	0.12	1.5	1.0	11,568	0.11	0.39	11,692
Transport from Offloading Site to Customer (Shamrock in Petaluma) by Barge and Tug - from DI Aggregates (Decker Island) to Shamrock (Petaluma) - from SF Bay Anchorages 8/9 to Shamrock (Petaluma)	barges, tug boats	1.0	3.4	7.3	0.006	0.34	0.33	621	0.08	0.021	629
Import of Sand from British Columbia to SF Pier 94 or SF Bay Anchorages 8/9	ocean-going vessels	11	16	242	5.3	3.6	3.3	7,875	1.0	0.24	7,970
Total	**All**	**18**	**55**	**355**	**5.5**	**13**	**7.1**	**30,260**	**2.9**	**0.74**	**30,550**

Table 12: No Project Summary Emissions 2024

Activity	Equipment	Emissions (tons/yr)						Emissions (tonnes/yr)			
		ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
Land-Based Sand Production	offroad, electric equipment	2.1	14	20	0.047	6.5	1.3	8,920	1.6	0.09	8,983
Transport from Offloading Site to Customer by Truck	trucks	2.1	10	18	0.12	1.2	0.73	10,521	0.09	0.39	10,643
Transport from Offloading Site to Customer (Shamrock in Petaluma) by Barge and Tug - from DI Aggregates (Decker Island) to Shamrock (Petaluma) - from SF Bay Anchorages 8/9 to Shamrock (Petaluma)	barges, tug boats	0.94	4.7	4.8	0.006	0.11	0.10	621	0.08	0.021	629
Import of Sand from British Columbia to SF Pier 94 or SF Bay Anchorages 8/9	ocean-going vessels	11	16	242	5.3	3.6	3.3	7,875	1.0	0.24	7,970
Total	**All**	**16**	**45**	**284**	**5.5**	**11**	**5.5**	**27,936**	**2.8**	**0.74**	**28,225**

3.4 No Project – Increased British Columbia Contribution

Imports of sand from British Columbia are projected to potentially increase in future years. As a sensitivity test to analyze outcomes of this potential scenario, ENVIRON evaluated an additional No Project scenario – Increased British Columbia Contribution. In this scenario, imports of sand from British Columbia were doubled and the net increase was offset by an equivalent decrease in sand deliveries from San Francisco Bay Area land-based sand production facilities, such that the total sand tonnage is the same as in the full-capacity No Project scenario (2.040 million CY per year, or 2.856 million tons per year). These sand volumes are presented in **Table 13**, below.

Table 13: No Project - Increased British Columbia Contribution

Scenario	Alternative Provider	Sand Delivered (tons/yr)
Original No Project	British Columbia	723,116
	All Land Based	2,132,884
	Total	**2,856,000**
Increased British Columbia	British Columbia	1,446,232
	All Land Based	1,409,768
	Total	**2,856,000**

The same emissions sources as in the No Project scenario were evaluated:

- Land-Based Sand Production
- Transport of Sand to the San Francisco Bay Area from British Columbia via OGVs
- Transport of Sand to Customer via Barge and Tug, and
- Transport of Sand to Customer via Haul Truck

Emissions associated with land-based sand production were assumed to remain unchanged. The British Columbia sand is provided by a land-based sand production facility, and for purposes of this analysis the increase in British Columbia sand was offset by an equivalent decrease in sand provided by San Francisco Bay Area land-based sand production facilities.

Emissions associated with transport of sand from British Columbia to the San Francisco Bay Area via ocean-going vessel were doubled from the No Project scenario.

Emissions associated with the transport of sand to customer via barge and tug were assumed to remain unchanged. In the No Project scenario, the vast majority of British Columbia sand is transported to customers via truck rather than barge and tug. Therefore, for purposes of this analysis, emissions associated with the transport of additional British Columbia sand within the San Francisco Bay Area are accounted for under the haul truck emissions, described below.

For purposes of estimating emissions from haul truck routes for this scenario, ENVIRON assumed that the customers receiving British Columbia sand in the No Project scenario would receive double the amount of sand in the No Project – Increased British Columbia Contribution scenario, and the net increase would be offset by a decrease in sand deliveries to customers not receiving British Columbia sand. In reality, individual customer demand for sand may be different than what is presented here. However, this method is conservative (when comparing No Project emissions to Project emissions) because emissions are based on haul truck trip lengths, and the majority of customers receiving British Columbia sand via import through San Francisco Pier 94 are located in San Francisco or the Peninsula. In reality, more British Columbia/ San Francisco Pier 94 sand may be routed to customers in the East Bay, which would result in longer haul truck trip lengths (and greater emissions as compared to the Project scenario). **Table NPIBC.1** in Attachment A presents the calculation of emissions associated with haul trucks.

Tables 14 and 15 present the No Project – Increased British Columbia Contribution scenario emissions for operational years 2015 and 2024, respectively. As shown in these tables, this No Project – Increased British Columbia Contribution scenario is estimated to generate up to 2 times more emissions than the No Project scenario, depending on the pollutant and operational year.

Table 14: No Project - Increased British Columbia Contribution Summary Emissions: 2015												
Activity		**Equipment**	**Emissions (tons/yr)**						**Emissions (tonnes/yr)**			
			ROG	**CO**	**NOx**	**SOx**	**PM_{10}**	**$PM_{2.5}$**	**CO_2**	**CH_4**	**N_2O**	**CO_2e**
Sand Mining and Production	Land-Based Sand Production	off-road equipment, electric equipment	3.9	24	48	0.047	7.6	2.4	10,196	1.6	0.093	10,259
Transport of Sand to Customers	via Haul Truck (in SF Bay Area)	haul trucks	1.8	8.6	40	0.086	1.06	0.71	7,972	0.077	0.27	8,056
	via Barge and Tug - from DI Aggregates (Decker Island) to Shamrock (Petaluma) - from SF Bay Anchorages 8/9 to Shamrock (Petaluma)	barges, tugs, loaders	1.0	3.4	7.3	0.0065	0.34	0.33	621	0.078	0.021	629
	via Ocean-Going Vessel (British Columbia to SF Bay Area)	ocean-going vessels	22.2	32	483	11	7.2	6.7	15,750	2.1	0.47	15,939
Total: No Project - Increased British Columbia Contribution			**28.8**	**68**	**579**	**11**	**16**	**10**	**34,539**	**3.8**	**0.85**	**34,884**
Total: No Project			**18.4**	**55**	**355**	**5.5**	**13**	**7.1**	**30,260**	**2.9**	**0.74**	**30,550**
(No Project-Increased British Columbia Contribution) / (No Project)			**1.6**	**1.2**	**1.6**	**2.0**	**1.2**	**1.4**	**1.1**	**1.4**	**1.2**	**1.1**

Table 15: No Project - Increased British Columbia Contribution Summary Emissions: 2024												
Activity		**Equipment**	**Emissions (tons/yr)**						**Emissions (tonnes/yr)**			
			ROG	**CO**	**NOx**	**SOx**	**PM_{10}**	**$PM_{2.5}$**	**CO_2**	**CH_4**	**N_2O**	**CO_2e**
Sand Mining and Production	Land-Based Sand Production	off-road equipment, electric equipment	2.1	14	20	0.047	6.5	1.3	8,920	1.6	0.093	8,983
Transport of Sand to Customers	via Haul Truck (in SF Bay Area)	haul trucks	1.5	8	13	0.08	0.8	0.5	7,252	0.1	0.26	7,336
	via Barge and Tug - from DI Aggregates (Decker Island) to Shamrock (Petaluma) - from SF Bay Anchorages 8/9 to Shamrock (Petaluma)	barges, tugs, loaders	0.94	4.7	4.8	0.006	0.11	0.10	621	0.1	0.02	629
	via Ocean-Going Vessel (British Columbia to SF Bay Area)	ocean-going vessels	22	32	483	11	7.2	6.7	15,750	2.1	0.47	15,939
Total: No Project - Increased British Columbia Contribution			**27**	**58**	**521**	**11**	**15**	**8.6**	**32,543**	**3.8**	**0.9**	**32,887**
Total: No Project			**16**	**45**	**284**	**5.5**	**11**	**5.5**	**27,936**	**2.8**	**0.74**	**28,225**
(No Project-Increased British Columbia Contribution) / (No Project)			**1.7**	**1.3**	**1.8**	**2.0**	**1.3**	**1.6**	**1.2**	**1.4**	**1.2**	**1.2**

3.5 Summary

As shown in **Table 16**, CAP and GHG emissions from the Project scenario are estimated to be less than the emissions associated with the Reduced Project and No Project scenarios. At full production capacity (in years 2015 through 2024), the Reduced Project scenario is estimated to generate up to 15 times more emissions than the Project scenario, depending on the pollutant and operational year. The No Project scenario is estimated to generate up to 45 times more emissions than the Project scenario, depending on the pollutant and operational year.

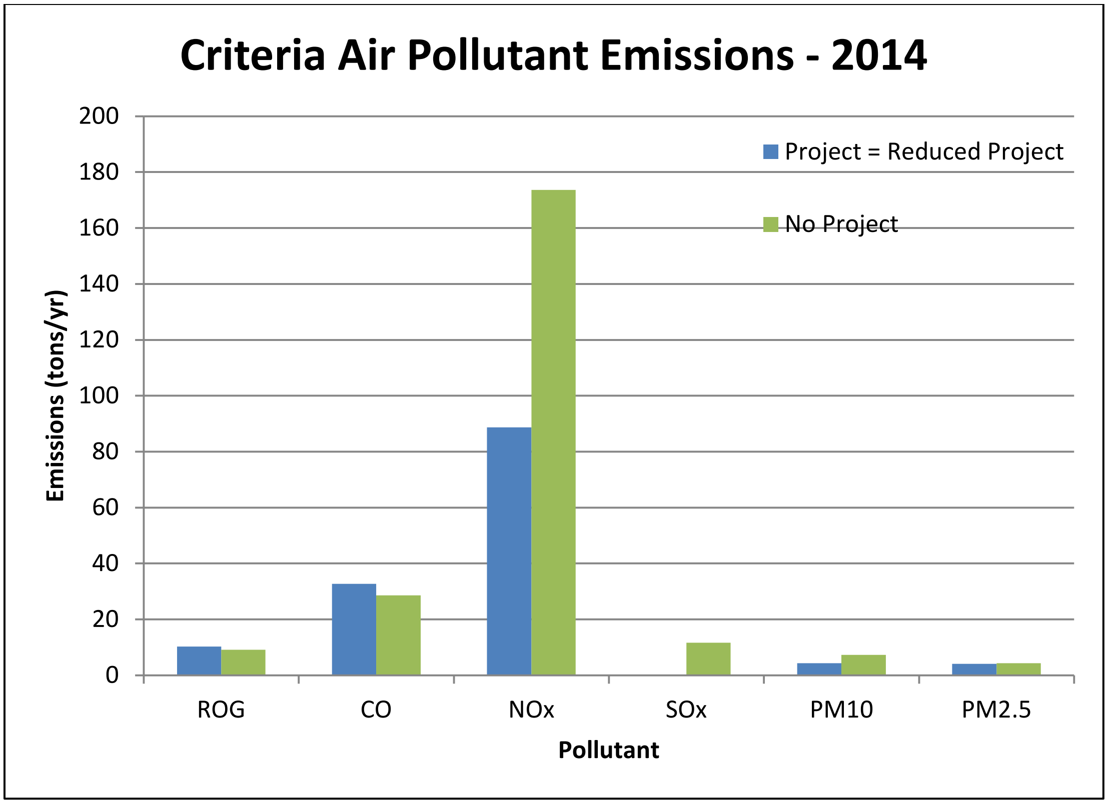
Table 16: Summary and Comparison of Project, Reduced Project, and No Project Emissions

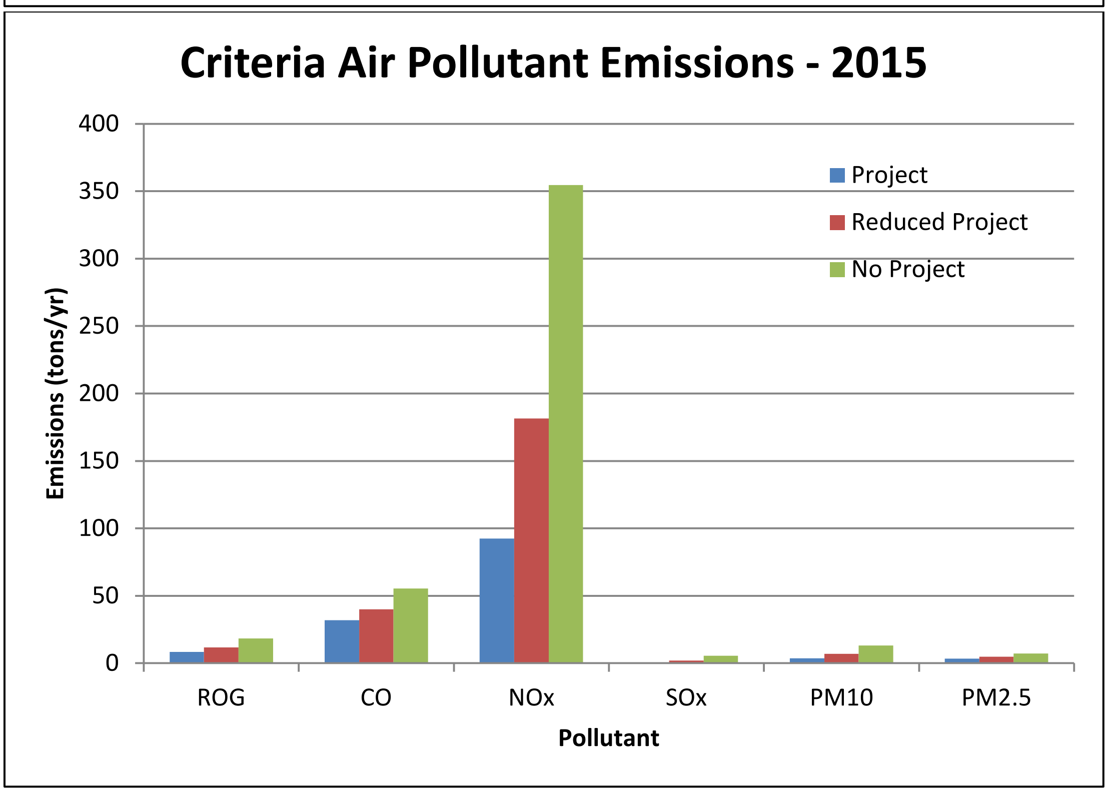
Year	Scenario	Emissions (tons/yr)						Emissions (tonnes/yr)			
		ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
2014	Project	10	33	89	0.06	4.3	4.1	5,904	0.87	0.19	5,980
	Reduced Project	10	33	89	0.06	4.3	4.1	5,904	0.9	0.19	5,980
	Reduced Project / Project	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*
	No Project	9.1	29	174	12	7.3	4.3	15,174	1.4	0.36	15,228
	No Project / Project	*0.9*	*0.9*	*2.0*	*191*	*1.7*	*1.0*	*2.6*	*1.6*	*1.9*	*2.5*
2015	Project	8.4	32	92	0.12	3.8	3.5	12,408	0.74	0.39	12,546
	Reduced Project	12	40	182	1.9	6.9	4.7	18,479	1.5	0.51	18,668
	Reduced Project / Project	*1.4*	*1.2*	*2.0*	*15.6*	*1.9*	*1.3*	*1.5*	*2.0*	*1.3*	*1.5*
	No Project	18	55	355	5.5	13.1	7.1	30,260	2.9	0.74	30,550
	No Project / Project	*2.2*	*1.7*	*3.8*	*44*	*3.5*	*2.0*	*2.4*	*3.9*	*1.9*	*2.4*
2024	Project	7.7	43	56	0.12	1.5	1.3	12,029	0.70	0.39	12,165
	Reduced Project	11	44	133	1.9	4.9	2.7	17,438	1.4	0.51	17,626
	Reduced Project / Project	*1.4*	*1.0*	*2.4*	*16*	*3.3*	*2.1*	*1.4*	*2.0*	*1.3*	*1.4*
	No Project	16	45	284	5.5	11.4	5.5	27,936	2.8	0.74	28,225
	No Project / Project	*2.1*	*1.0*	*5.1*	*44*	*7.7*	*4.2*	*2.3*	*4.0*	*1.9*	*2.3*

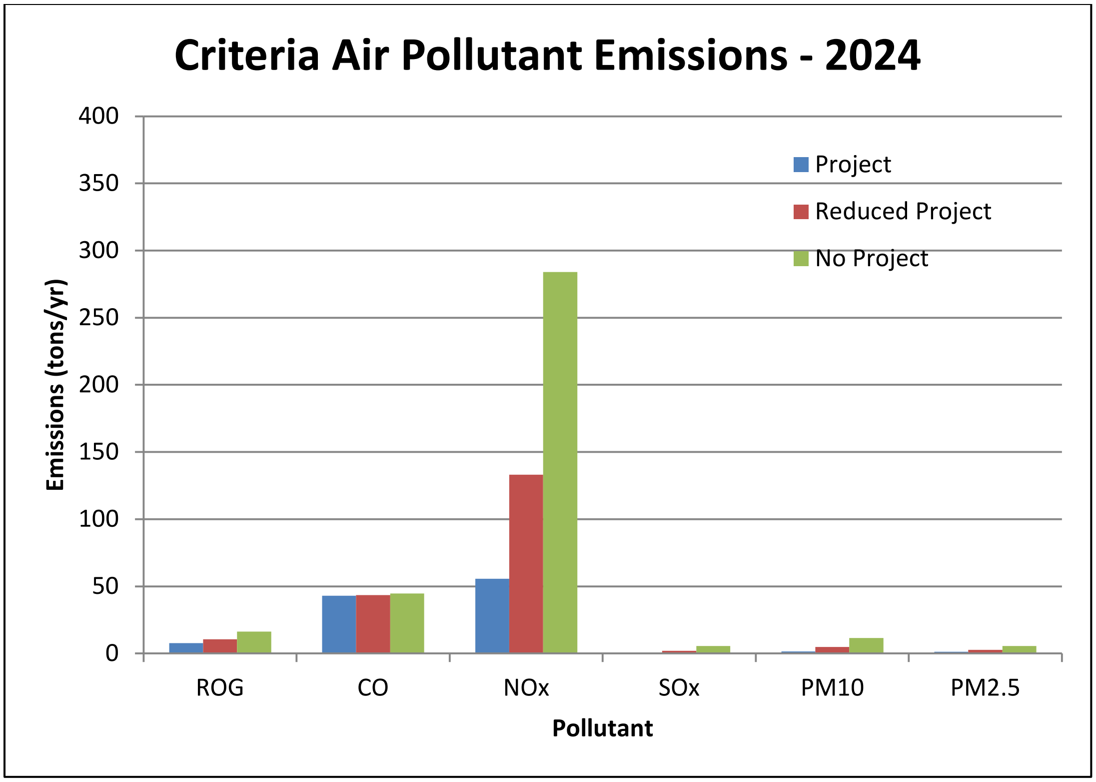
For the Project scenarios, the majority of emissions for each pollutant are attributed to marine activities including cruising, dredging, and offloading (e.g. over 75 percent of NOx emissions and over 65 percent of CO_2e emissions for years 2015 and 2024 in which full-capacity sand volumes were evaluated). Emissions associated with transport of sand to customers via haul truck account for less than 30 percent of total emissions for each pollutant (e.g. less than 20 percent of NO_X emissions and 30 percent of CO_2e emissions).

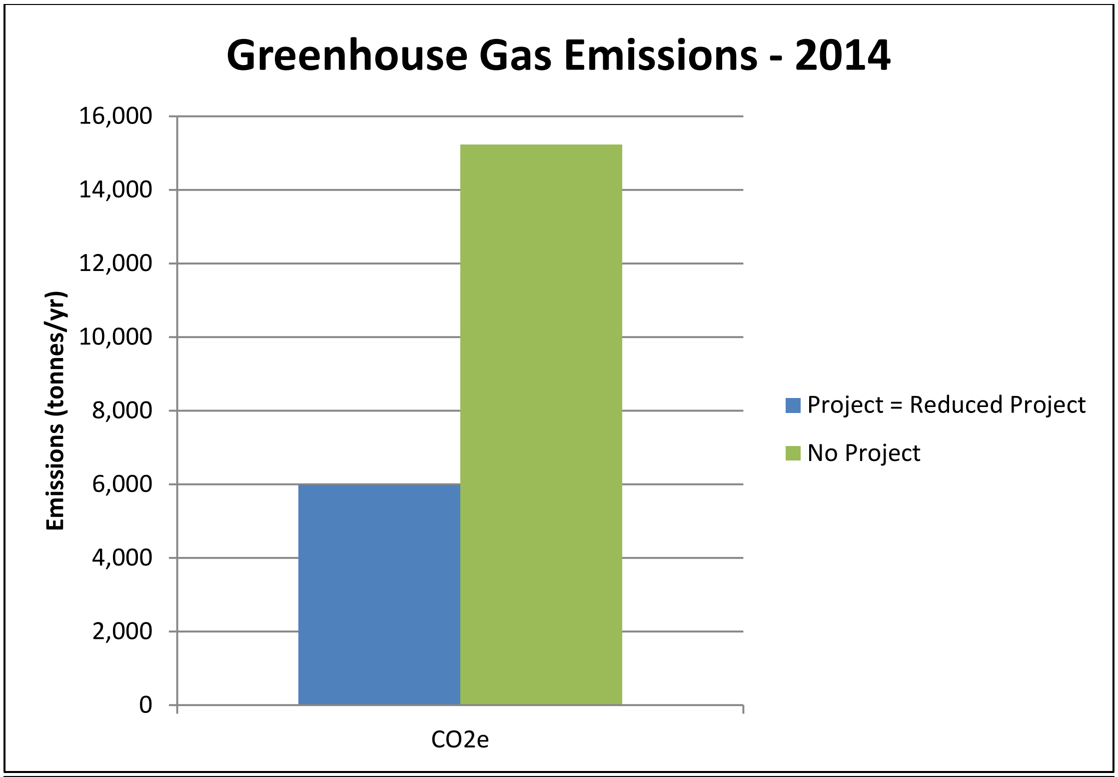
For the No Project scenarios, CO_2e emissions are distributed approximately evenly between land-based sand production, transport of sand to customers by haul truck, and import of sand from British Columbia to the San Francisco Bay Area. The majority of ROG, SO_X and NO_X emissions are attributed to import of sand from British Columbia. The largest contributor of PM_{10} emissions is land-based sand production. Transport of sand to customers by barge and tug is a relatively small contributor to overall emissions.

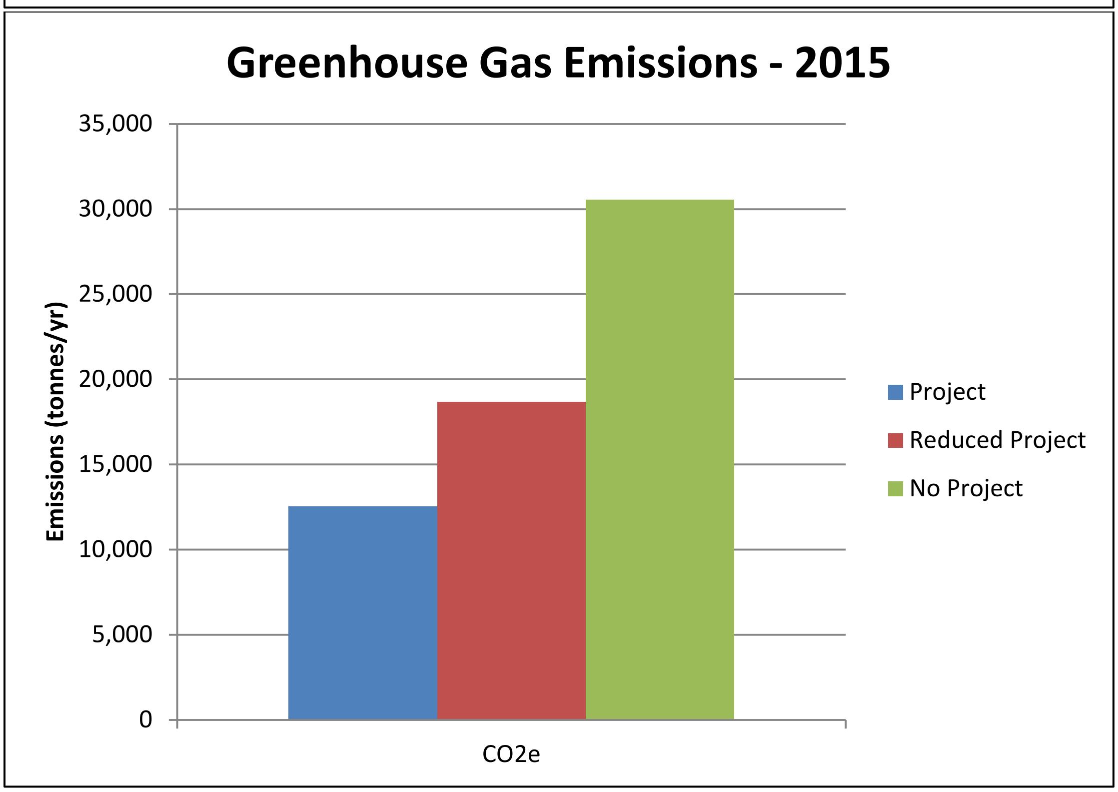
At full production capacity, the No Project scenario requires approximately 20 percent more haul truck round-trips for distribution of sand to customers than the Project scenario (97,941 trips for Project compared to 117,307 trips for No Project). In addition, because several of the No Project Alternative Providers are located farther away from customer sites than the Hanson and Jerico Project offloading sites, the No Project scenario results in over 250 percent more vehicle miles traveled (VMT) than the Project scenario (1,800,071 miles/year for Project compared to 6,526,301 miles/year for No Project).

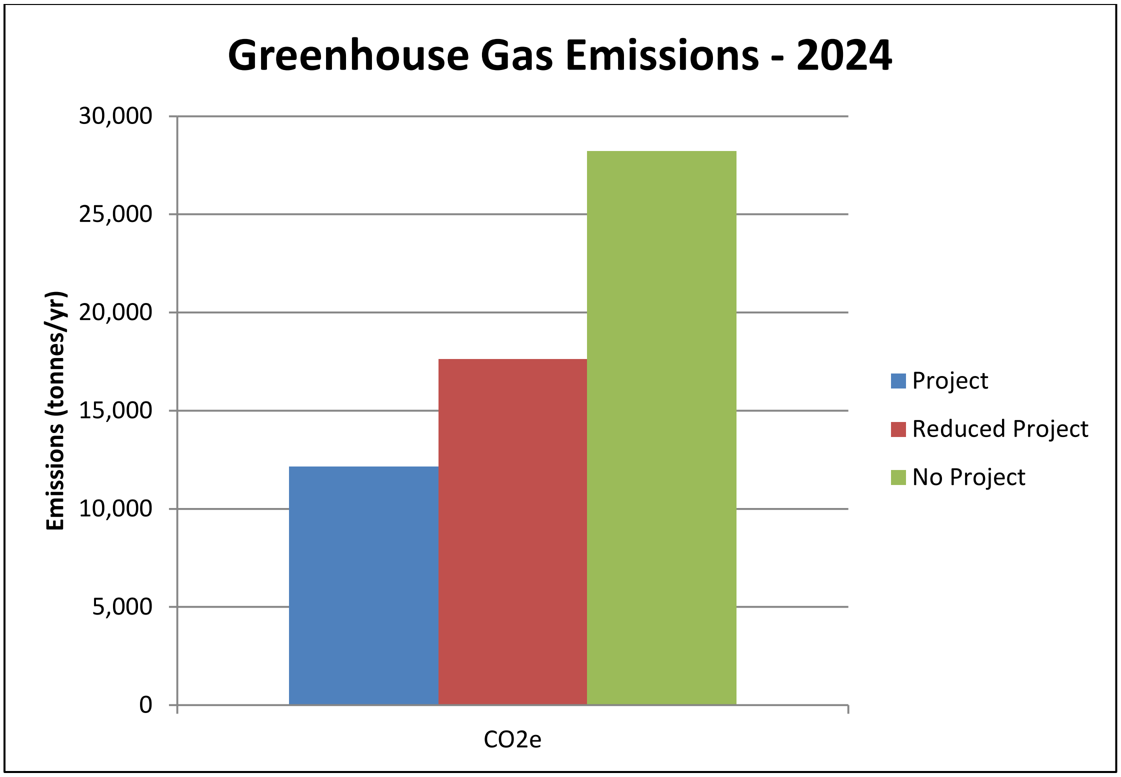

Criteria Air Pollutant Emissions - 2014
Emissions (tons/yr)
200
180
160
140
120
100
80
60
40
20
0
Project = Reduced Project
No Project
ROG
CO
NOx
SOx
PM10
PM2.5
Pollutant


Criteria Air Pollutant Emissions - 2015
Emissions (tons/yr)
400
350
300
250
200
150
100
50
0
Project
Reduced Project
No Project
ROG
CO
NOx
SOx
PM10
PM2.5
Pollutant


Criteria Air Pollutant Emissions - 2024
Emissions (tons/yr)
400
350
300
250
200
150
100
50
0
Project
Reduced Project
No Project
ROG
CO
NOx
SOx
PM10
PM2.5
Pollutant


Greenhouse Gas Emissions - 2014
Emissions (tonnes/yr)
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
CO2e
Project = Reduced Project
No Project


Greenhouse Gas Emissions - 2015
Emissions (tonnes/yr)
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
CO2e
Project
Reduced Project
No Project


Greenhouse Gas Emissions - 2024
Emissions (tonnes/yr)
30,000
25,000
20,000
15,000
10,000
5,000
0
CO2e
Project
Reduced Project
No Project

3.6 Summary: Lease-by-Lease

Tables 17, 18, and 19, summarize emissions on a lease-by-lease basis for each of the three operational years evaluated (2014, 2015, and 2024) and three scenarios evaluated (Project, Reduced Project, and No Project). Emissions were calculated according to the methodologies described earlier, and details are presented in **Tables PLBL.1 – PLBL.9** of the Attachment.

Table 17: Project Lease-by-Lease Summary Emissions

Year	Lease		Operator	Offloading	Emissions (tons/yr)						Emissions (tonnes/yr)			
				CY/yr	ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
2014	PRC 709	Presidio Shoals	Hanson	290,000	3.3	10.3	28	0.017	1.41	1.35	1,746	0.28	0.05	1,769
	PRC 2036	Point Knox South	Hanson	252,500	2.9	9.0	25	0.015	1.23	1.18	1,525	0.25	0.05	1,545
	PRC 7779	Point Knox Shoal	Hanson	238,000	2.7	8.5	23	0.014	1.16	1.11	1,433	0.23	0.04	1,452
	PRC 7780	Alcatraz South Shoal	Hanson	0	0	0	0	0	0	0	0	0	0	0
	PRC 7781	Suisun Associates	Hanson	0	0	0	0	0	0	0	0	0	0	0
	PRC 7781	Suisun Associates	Jerico	85,000	0.53	1.9	4.7	0.005	0.21	0.19	473	0.04	0.02	479
	TLS 39	Grossi Middle Ground	Hanson	0	0	0	0	0	0	0	0	0	0	0
	TLS 39	Grossi Middle Ground	Jerico	130,000	0.87	3.2	7.8	0.009	0.34	0.32	829	0.07	0.02	838
	Total			**995,500**	**10**	**33**	**89**	**0.06**	**4.3**	**4.1**	**6,007**	**0.87**	**0.19**	**6,083**
2015	PRC 709	Presidio Shoals	Hanson	340,000	1.2	4.7	14	0.020	0.55	0.51	2,039	0.11	0.06	2,061
	PRC 2036	Point Knox South	Hanson	450,000	1.6	6.2	19	0.027	0.73	0.68	2,703	0.14	0.08	2,733
	PRC 7779	Point Knox Shoal	Hanson	550,000	1.9	7.6	23	0.033	0.89	0.83	3,302	0.17	0.10	3,338
	PRC 7780	Alcatraz South Shoal	Hanson	200,000	0.69	2.8	8.3	0.012	0.33	0.30	1,206	0.06	0.04	1,219
	PRC 7781	Suisun Associates	Hanson	150,000	0.83	2.9	9.0	0.011	0.39	0.37	1,108	0.07	0.04	1,121
	PRC 7781	Suisun Associates	Jerico	150,000	0.96	3.4	8.2	0.009	0.37	0.34	836	0.08	0.03	846
	TLS 39	Grossi Middle Ground	Hanson	50,000	0.29	1.0	3.1	0.004	0.13	0.13	377	0.02	0.01	382

Table 17: Project Lease-by-Lease Summary Emissions

Year	Lease		Operator	Offloading	Emissions (tons/yr)						Emissions (tonnes/yr)			
				CY/yr	ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
	TLS 39	Grossi Middle Ground	Jerico	150,000	1.02	3.7	8.8	0.010	0.40	0.37	954	0.09	0.03	965
	Total			**2,040,000**	**8.4**	**32**	**93**	**0.13**	**3.8**	**3.5**	**12,527**	**0.75**	**0.39**	**12,664**
2024	PRC 709	Presidio Shoals	Hanson	340,000	1.1	6.3	8.6	0.020	0.23	0.20	1,974	0.10	0.06	1,996
	PRC 2036	Point Knox South	Hanson	450,000	1.4	8.3	11.4	0.027	0.30	0.27	2,616	0.14	0.08	2,645
	PRC 7779	Point Knox Shoal	Hanson	550,000	1.8	10.2	13.9	0.033	0.37	0.33	3,196	0.17	0.10	3,231
	PRC 7780	Alcatraz South Shoal	Hanson	200,000	0.65	3.7	5.1	0.012	0.14	0.12	1,168	0.06	0.04	1,181
	PRC 7781	Suisun Associates	Hanson	150,000	0.77	4.2	5.3	0.011	0.13	0.12	1,079	0.07	0.04	1,092
	PRC 7781	Suisun Associates	Jerico	150,000	0.86	4.3	4.7	0.009	0.13	0.12	814	0.07	0.03	824
	TLS 39	Grossi Middle Ground	Hanson	50,000	0.26	1.5	1.8	0.004	0.05	0.04	368	0.02	0.01	372
	TLS 39	Grossi Middle Ground	Jerico	150,000	0.93	4.6	5.3	0.010	0.17	0.15	933	0.08	0.03	943
	Total			**2,040,000**	**7.8**	**43**	**56**	**0.13**	**1.5**	**1.3**	**12,147**	**0.71**	**0.39**	**12,284**

Table 18: Reduced Project Lease-by-Lease Summary Emissions

Year	Lease		Operator	Project	Alternative	Emissions (tons/yr)						Emissions (tonnes/yr)			
				CY/yr	CY/yr	ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
2014	PRC 709	Presidio Shoals	Hanson	290,000	0	3.3	10	28	0.017	1.41	1.35	1,746	0.28	0.05	1,769
	PRC 2036	Point Knox South	Hanson	252,500	0	2.9	9.0	25	0.015	1.23	1.18	1,525	0.25	0.05	1,545
	PRC 7779	Point Knox Shoal	Hanson	238,000	0	2.7	8.5	23	0.014	1.16	1.11	1,433	0.23	0.04	1,452
	PRC	Alcatraz	Hanson	0	0	0	0	0	0	0	0	0	0	0	0

Table 18: Reduced Project Lease-by-Lease Summary Emissions

Year	Lease		Operator	Project	Alternative	Emissions (tons/yr)						Emissions (tonnes/yr)			
				CY/yr	CY/yr	ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
	7780	South Shoal													
	PRC 7781	Suisun Associates	Hanson	0	0	0	0	0	0	0	0	0	0	0	0
	PRC 7781	Suisun Associates	Jerico	85,000	0	0.53	1.9	4.7	0.005	0.21	0.19	473	0.04	0.02	479
	TLS 39	Grossi Middle Ground	Hanson	0	0	0	0	0	0	0	0	0	0	0	0
	TLS 39	Grossi Middle Ground	Jerico	130,000	0	0.87	3.2	7.8	0.009	0.34	0.32	829	0.07	0.02	838
	Total			**995,500**	**0**	**10**	**33**	**89**	**0.06**	**4.3**	**4.1**	**6,007**	**0.87**	**0.19**	**6,083**
2015	PRC 709	Presidio Shoals	Hanson	290,331	49,669	1.4	5.3	21	0.151	0.79	0.61	2,478	0.16	0.07	2,504
	PRC 2036	Point Knox South	Hanson	252,637	197,363	2.7	8.8	45	0.546	1.68	1.07	4,445	0.36	0.12	4,490
	PRC 7779	Point Knox Shoal	Hanson	390,440	159,560	2.8	9.7	44	0.452	1.66	1.14	4,711	0.35	0.13	4,759
	PRC 7780	Alcatraz South Shoal	Hanson	127,248	72,752	1.1	3.7	17.9	0.203	0.68	0.45	1,847	0.14	0.05	1,865
	PRC 7781	Suisun Associates	Hanson	42,873	107,127	1.2	3.7	21.2	0.291	0.80	0.48	1,906	0.17	0.05	1,925
	PRC 7781	Suisun Associates	Jerico	42,873	107,127	1.2	3.9	21.0	0.291	0.80	0.47	1,828	0.17	0.05	1,846
	TLS 39	Grossi Middle Ground	Hanson	0	50,000	0.45	1.4	8.7	0.134	0.32	0.17	742	0.07	0.02	749

Table 18: Reduced Project Lease-by-Lease Summary Emissions

Year	Lease		Operator	Project	Alternative	Emissions (tons/yr)						Emissions (tonnes/yr)			
				CY/yr	CY/yr	ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
	TLS 39	Grossi Middle Ground	Jerico	199,866	-49,866	0.91	3.6	3.1	-0.121	0.21	0.32	532	0.05	0.02	539
	Total			**1,346,268**	**693,732**	**12**	**40**	**181**	**1.9**	**6.9**	**4.7**	**18,488**	**1.5**	**0.51**	**18,676**
2024	PRC 709	Presidio Shoals	Hanson	290,331	49,669	1.3	6.4	14.2	0.151	0.47	0.31	2,365	0.16	0.07	2,391
	PRC 2036	Point Knox South	Hanson	252,637	197,363	2.4	9.0	33.9	0.546	1.27	0.68	4,172	0.35	0.12	4,216
	PRC 7779	Point Knox Shoal	Hanson	390,440	159,560	2.5	10.7	32.1	0.452	1.16	0.66	4,454	0.34	0.13	4,501
	PRC 7780	Alcatraz South Shoal	Hanson	127,248	72,752	0.99	4.0	13.4	0.203	0.49	0.27	1,739	0.14	0.05	1,758
	PRC 7781	Suisun Associates	Hanson	42,873	107,127	1.1	3.6	16.4	0.291	0.64	0.32	1,775	0.17	0.05	1,794
	PRC 7781	Suisun Associates	Jerico	42,873	107,127	1.1	3.6	16.3	0.290	0.64	0.32	1,700	0.17	0.05	1,718
	TLS 39	Grossi Middle Ground	Hanson	0	50,000	0.40	1.1	7.0	0.134	0.28	0.13	685	0.07	0.02	692
	TLS 39	Grossi Middle Ground	Jerico	199,866	-49,866	0.85	5.1	0.2	-0.121	-0.06	0.06	560	0.04	0.02	567
	Total			**1,346,268**	**693,732**	**11**	**43**	**133**	**1.9**	**4.9**	**2.8**	**17,450**	**1.4**	**0.51**	**17,637**

Note:

For 2015-2024 at the Grossi Middle Ground lease, Jerico operations will increase above the project volume while Hanson operations will decrease. Net sand mined from the lease will remain below the proposed volume of 200,000 cubic yards per year.

Table 19: No Project Lease-by-Lease Summary Emissions

Year	Lease		Operator	Project	Alternative	Emissions (tons/yr)						Emissions (tonnes/yr)			
				CY/yr	CY/yr	ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
2014	PRC 709	Presidio Shoals	Hanson	0	290,000	2.65	8.3	51	3.400	2.14	1.25	4,420	0.41	0.11	4,436
	PRC 2036	Point Knox South	Hanson	0	252,500	2.31	7.3	44	2.960	1.86	1.09	3,849	0.36	0.09	3,862
	PRC 7779	Point Knox Shoal	Hanson	0	238,000	2.17	6.8	42	2.790	1.75	1.03	3,628	0.34	0.09	3,641
	PRC 7780	Alcatraz South Shoal	Hanson	0	0	0	0	0	0	0	0	0	0	0	0
	PRC 7781	Suisun Associates	Hanson	0	0	0	0	0	0	0	0	0	0	0	0
	PRC 7781	Suisun Associates	Jerico	0	85,000	0.78	2.4	14.8	0.997	0.63	0.37	1,296	0.12	0.03	1,300
	TLS 39	Grossi Middle Ground	Hanson	0	0	0	0	0	0	0	0	0	0	0	0
	TLS 39	Grossi Middle Ground	Jerico	0	130,000	1.19	3.7	22.7	1.524	0.96	0.56	1,981	0.18	0.05	1,989
	Total			**0**	**995,500**	**9**	**29**	**174**	**12**	**7.3**	**4.3**	**15,174**	**1.4**	**0**	**15,228**
2015	PRC 709	Presidio Shoals	Hanson	0	340,000	3.07	9.2	59	0.914	2.19	1.18	5,043	0.48	0.12	5,092
	PRC 2036	Point Knox South	Hanson	0	450,000	4.06	12.2	78	1.210	2.90	1.57	6,675	0.63	0.16	6,739
	PRC 7779	Point Knox Shoal	Hanson	0	550,000	4.97	14.9	96	1.479	3.55	1.91	8,158	0.77	0.20	8,236
	PRC 7780	Alcatraz South Shoal	Hanson	0	200,000	1.81	5.4	34.8	0.538	1.29	0.70	2,967	0.28	0.07	2,995
	PRC 7781	Suisun Associates	Hanson	0	150,000	1.35	4.1	26.1	0.403	0.97	0.52	2,225	0.21	0.05	2,246
	PRC	Suisun	Jerico	0	150,000	1.35	4.1	26.1	0.403	0.97	0.52	2,225	0.21	0.05	2,246

Table 19: No Project Lease-by-Lease Summary Emissions

Year	Lease		Operator	Project	Alternative	Emissions (tons/yr)						Emissions (tonnes/yr)			
				CY/yr	CY/yr	ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
	7781	Associates													
	TLS 39	Grossi Middle Ground	Hanson	0	50,000	0.45	1.4	8.7	0.134	0.32	0.17	742	0.07	0.02	749
	TLS 39	Grossi Middle Ground	Jerico	0	150,000	1.35	4.1	26.1	0.403	0.97	0.52	2,225	0.21	0.05	2,246
	Total			**0**	**2,040,000**	**18**	**55**	**355**	**5.5**	**13**	**7.1**	**30,260**	**2.9**	**0.74**	**30,550**
2024	PRC 709	Presidio Shoals	Hanson	0	340,000	2.70	7.5	47.3	0.914	1.90	0.91	4,656	0.47	0.12	4,704
	PRC 2036	Point Knox South	Hanson	0	450,000	3.58	9.9	62.6	1.210	2.52	1.21	6,162	0.62	0.16	6,226
	PRC 7779	Point Knox Shoal	Hanson	0	550,000	4.37	12.1	76.6	1.478	3.07	1.48	7,532	0.76	0.20	7,610
	PRC 7780	Alcatraz South Shoal	Hanson	0	200,000	1.59	4.4	27.8	0.538	1.12	0.54	2,739	0.28	0.07	2,767
	PRC 7781	Suisun Associates	Hanson	0	150,000	1.19	3.3	20.9	0.403	0.84	0.40	2,054	0.21	0.05	2,075
	PRC 7781	Suisun Associates	Jerico	0	150,000	1.19	3.3	20.9	0.403	0.84	0.40	2,054	0.21	0.05	2,075
	TLS 39	Grossi Middle Ground	Hanson	0	50,000	0.40	1.1	7.0	0.134	0.28	0.13	685	0.07	0.02	692
	TLS 39	Grossi Middle Ground	Jerico	0	150,000	1.19	3.3	20.9	0.403	0.84	0.40	2,054	0.21	0.05	2,075
	Total			**0**	**2,040,000**	**16**	**45**	**284**	**5.5**	**11**	**5.5**	**27,936**	**2.8**	**0.74**	**28,225**

4 General Conformity Evaluation

The CAA General Conformity Rule (40 CFR Parts 51 and 93) applies to all federal actions, and requires specific procedures or analyses in order to ensure that the federal action does not cause or contribute to new violations of the National Ambient Air Quality Standards (NAAQS), or worsen existing violations, or delay attainment with the NAAQS. If a federal action such as approval of the Project would result in emissions that exceed the thresholds established in 40 CFR Part 93 §153(b), a conformity determination would be required. The following Project scenario emissions are included in the inventory for comparison to the General Conformity thresholds:

- Marine Sand Mining – barges, tugs, loaders
- Marine Transport of Sand to Customer – barges, tugs, loaders

For purposes of this assessment, total proposed Project emissions were compared to the General Conformity thresholds without subtracting emissions associated with existing activities. As shown in **Table 20**, Project emissions in 2014, 2015, and 2024 do not exceed the General Conformity thresholds.

Table 20: Comparison to General Conformity Thresholds

		Pollutant (tons / yr)						
		VOC	**NOx**	**NO_2**	**CO**	**SO_2**	**PM_{10}**	**$PM_{2.5}$**
San Francisco Bay Area Air Basin Attainment Status under Federal Standard		Marginal Nonattainment for Ozone, Nonattainment for $PM_{2.5}$	Marginal Nonattainment for Ozone, Nonattainment for $PM_{2.5}$	Unclassified/ Attainment	Attainment	Attainment for SO_2, Nonattainment for $PM_{2.5}$	Unclassified	Nonattainment
General Conformity Threshold		100	100	N/A	N/A	100	N/A	100
Project Emissions	2014	10	77	77	30	0.04	4.0	3.9
Project Emissions	2015	7	71	71	26	0.08	3.2	3.1
Project Emissions	2024	7	48	48	38	0.08	1.1	1.1
Project Exceed Threshold?		No	No	No	No	No	No	No

Notes:
The following Project scenario emissions are included in the inventory for comparison to the General Conformity thresholds:

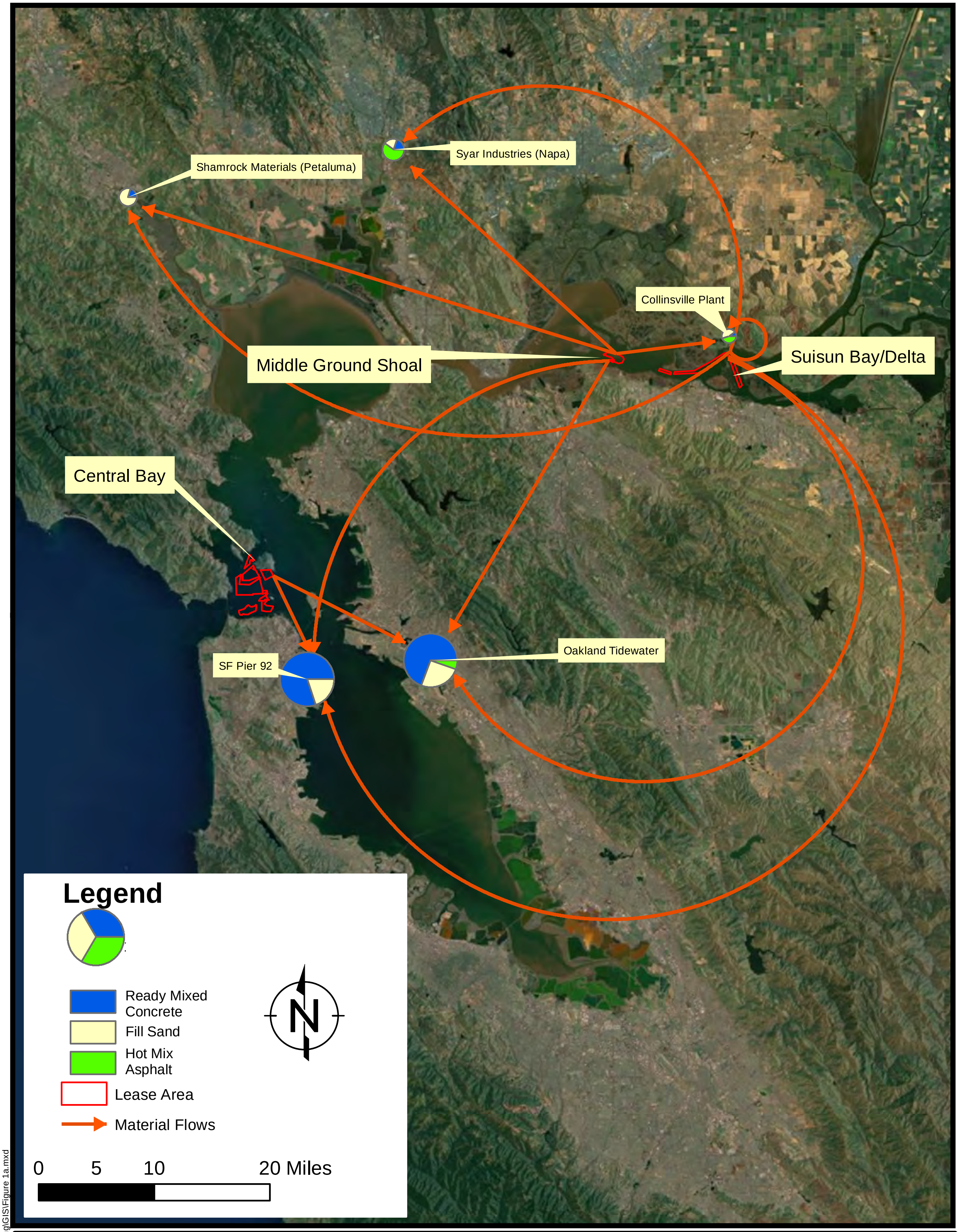
- Marine Sand Mining – barges, tugs, loaders
- Marine Transport of Sand to Customer – barges, tugs, loaders

The following conservative assumptions were made for purposes of this assessment:

- NO_2 is assumed to be equivalent to NO_X, and SO_2 is assumed to be equivalent to SO_X.
- Total proposed Project emissions are compared to the General Conformity thresholds without subtracting emissions associated with existing activities.

References:
Clean Air Act General Conformity Rule: 40 CFR Part 93 §153(b)
CARB. Area Designations Maps / State and National. http://www.arb.ca.gov/desig/adm/adm.htm
USEPA. The Green Book Nonattainment Areas for Criteria Pollutants. http://www.epa.gov/airquality/greenbk/

Figures



ENVIRON

DRAFTED BY: DPHONG | DATE: 11/19/2013

Locations of Hanson's and Jerico's Offloading Sites, and Leasing Areas

Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area, CA

FIGURE
1

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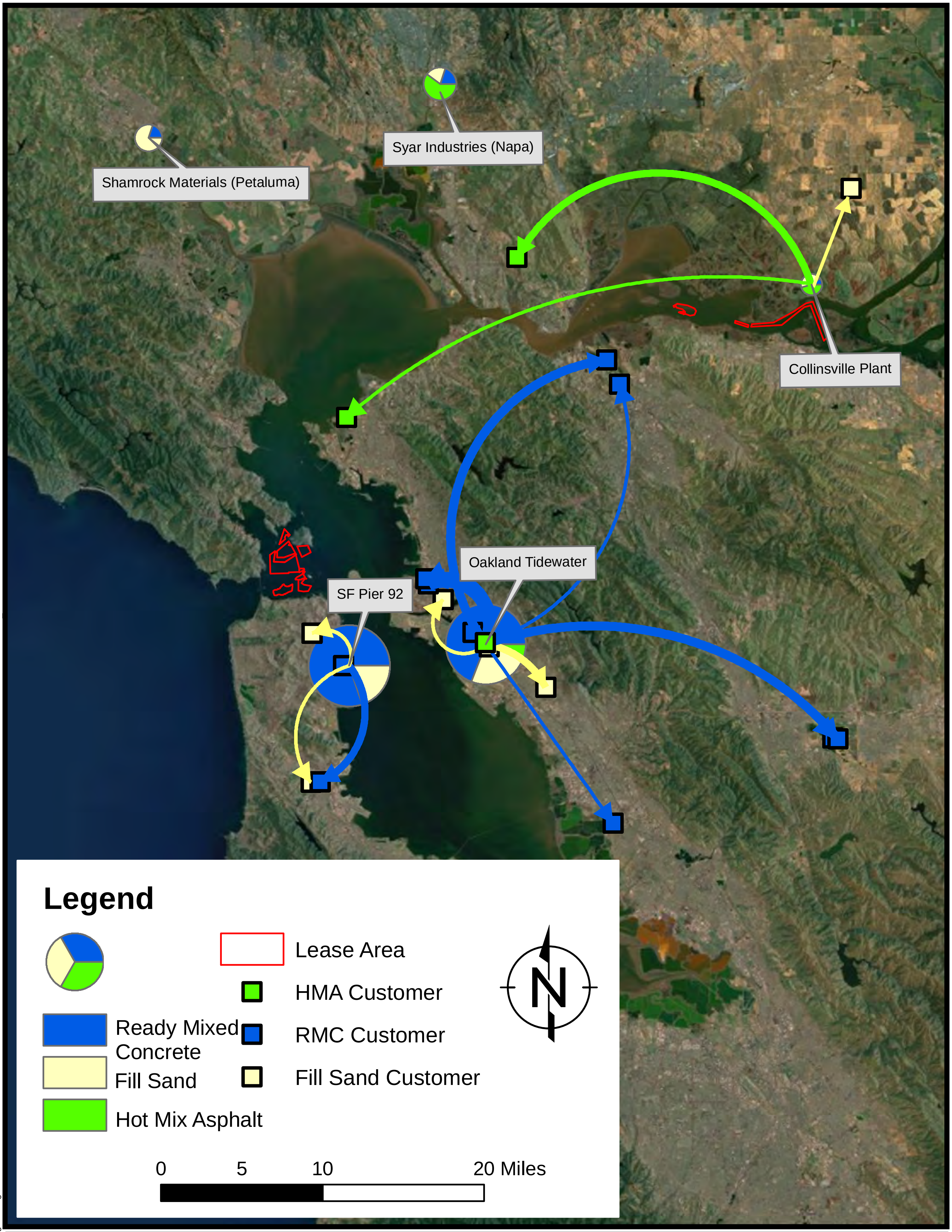


ENVIRON

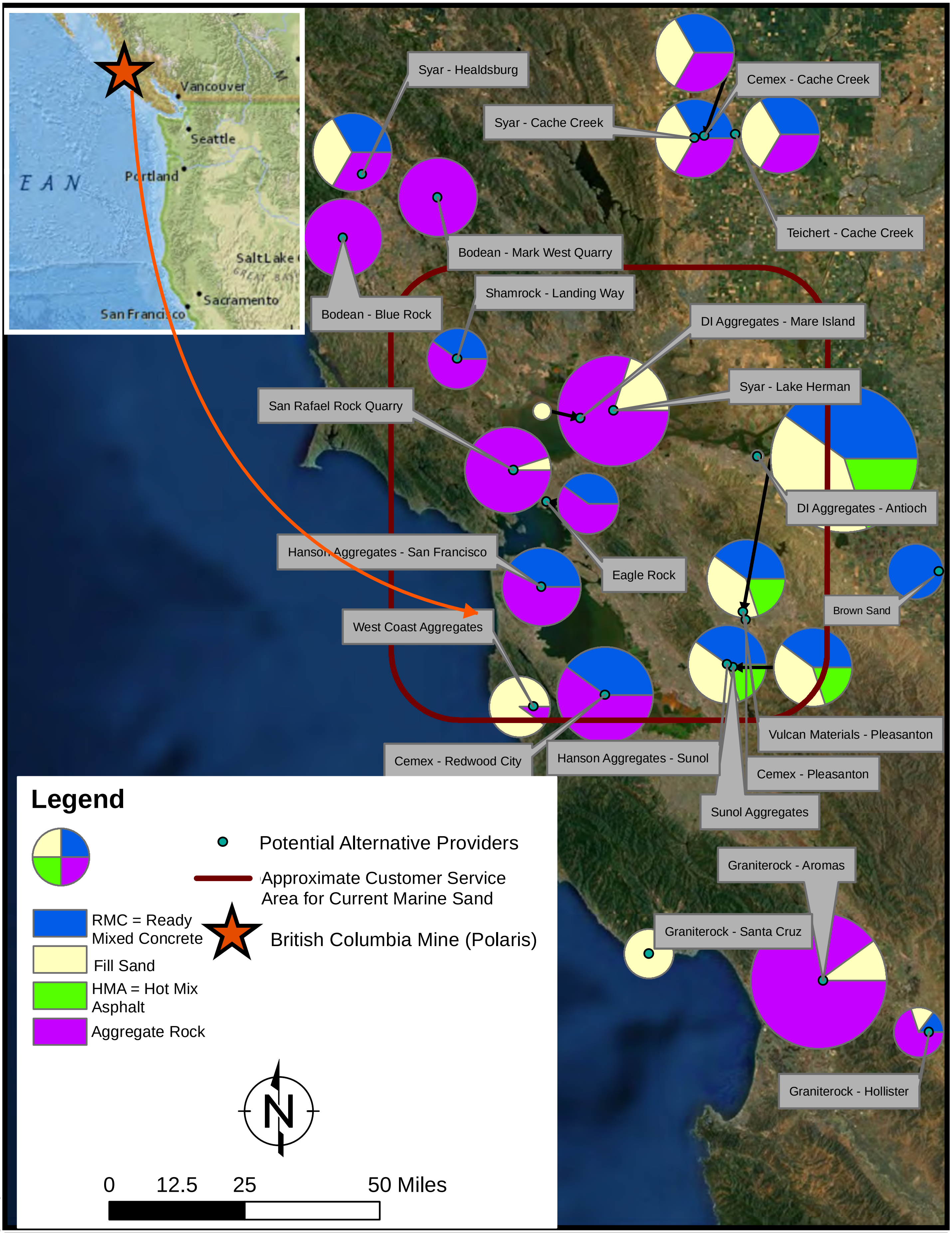
DRAFTED BY: DPHONG | DATE: 12/2/2013

Locations of Hanson's and Jerico's Offloading Sites, and Hanson's Customers

Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area, CA

FIGURE
2

U:\Hanson Jerico Sand Mining\GIS\Figure 2.mxd



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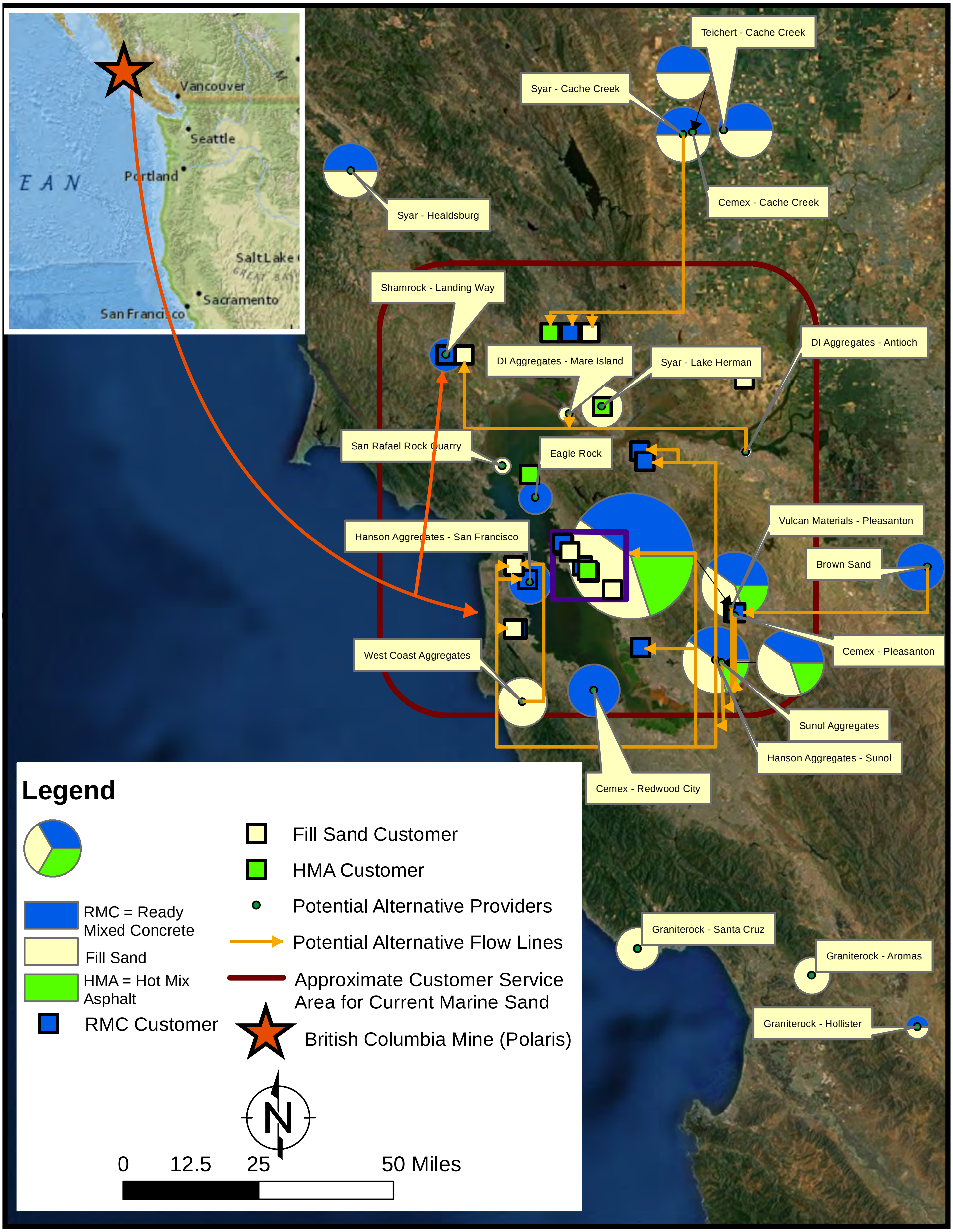
ENVIRON

DRAFTED BY: DPHONG | DATE: 12/2/2013

Locations of Alternative Providers
Hanson Marine Operations and Jerico Product, Inc.
San Francisco Bay Area, CA

FIGURE
3a



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ENVIRON

DRAFTED BY: DPHONG

DATE: 11/19/2013

Locations of Alternative Providers - Sand Only

Hanson Marine Operations and Jerico Products, Inc.

San Francisco Bay Area, CA

FIGURE

3b

Attachment A

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Hanson Jerico Sand Mining NEPA
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Table P.1
Project: Overview of Emissions Calculation Methodology
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Activity[1]		Equipment	Activity Data[3]	Emission Factor[3]
Sand Mining and Production	Marine Sand Mining (Dredging, Cruising, Offloading)[2]	barges, tugs, loaders	Hanson and Jerico	CARB Emissions Databases: Harbor Craft Emissions Inventory, Barge and Dredge Emissions Inventory, OFFROAD 2007 and 2011
	Land-Based Sand Production	off-road equipment, electric equipment	N/A	
Material Movement at Offloading Sites	Material Movement at Offloading Sites	loader, electric equipment	Hanson and Jerico	CalEEMod and CARB OFFROAD 2011, PG&E electricity emission factor, adjusted for RPS
Transport of Sand to Customers	via Haul Truck (in SF Bay Area)	haul trucks	Hanson and Jerico	CARB EMFAC 2011
	via Barge and Tug - from DI Aggregates (Decker Island) to Shamrock (Petaluma) - from SF Bay Anchorages 8/9 to Shamrock (Petaluma)	barges, tugs, loaders	N/A	
	via Ocean-Going Vessel (British Columbia to SF Bay Area)	ocean-going vessels	N/A	

\

Abbreviations:

CARB - California Air Resources Board
CalEEMod - California Emissions Estimator Model
EMFAC - EMission FACtors Model
N/A - not applicable
PG&E - Pacific Gas and Electric
RPS - California Renewables Portfolio Standard

Notes:

1. Emissions-generating activities associated with the mining and delivery of sand for all scenarios, as discussed with Hanson Marine Operations and Jerico Products, Inc.
2. This includes cruising and offloading emissions associated with Jerico delivering sand to three customers directly via barge and tug (Shamrock in Petaluma, Syar Industries in Napa, and its own Collinsville Plant).
3. Emissions are calculated as: Emissions = Activity Data x Emission Factor

Sources:

California Air Resources Board (CARB). Harbor Craft Emissions Inventory Database; available at http://www.arb.ca.gov/msei/categories.htm#chc_category
California Air Resources Board (CARB). Barge and Dredge Emissions Inventory Database; available at http://www.arb.ca.gov/msei/categories.htm#chc_category
California Air Resources Board (CARB). 2011. In-use Off-road Equipment Inventory Model. OFFROAD 2011. http://www.arb.ca.gov/msei/categories.htm#offroad_motor_vehicles
California Air Resources Board (CARB). 2011. EMission FACtor Model, EMFAC2011. http://www.arb.ca.gov/msei/categories.htm#onroad_motor_vehicles
ENVIRON. 2013. California Emissions Estimator Model (CalEEModTM). http://www.caleemod.com/
Pacific Gas and Electric (PG&E). 2008 Power/Utility Protocol (PUP) Report. http://www.climateregistry.org/tools/carrot/carrot-public-reports.html

Table P.2
Project Dredge Emission Factors
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Project Year[1]	Operator	Equipment[2]	Engine Type	Model Year[2]	Horsepower[2]	Emission Factors (g/bhp-hr)[3]							
						ROG	CO	NOx	SO_2	PM_{10}	$PM_{2.5}$	CO_2	CH_4
2014	Hanson	Dredge	Pump	1983	1000	1.15	4.2	12.0	N/A	0.53	0.51	593	0.10
	Hanson	Dredge	Gen	1984	265	1.09	4.2	11.0	N/A	0.53	0.51	593	0.10
	Hanson	Dredge	Pump	1984	304	1.09	4.2	11.0	N/A	0.53	0.51	593	0.10
	Jerico	Dredge	Gen	2004	99	0.56	3.2	5.6	N/A	0.39	0.38	709	0.05
	Jerico	Dredge	Pump	2001	230	0.82	2.7	8.2	N/A	0.38	0.37	680	0.07
2015	Hanson	Dredge	Pump	2014	1000	0.08	0.9	2.4	N/A	0.06	0.06	593	0.01
	Hanson	Dredge	Gen	2014	265	0.08	0.9	1.4	N/A	0.01	0.01	593	0.01
	Hanson	Dredge	Pump	2014	304	0.08	0.9	1.4	N/A	0.01	0.01	593	0.01
	Jerico	Dredge	Gen	2004	99	0.56	3.2	5.6	N/A	0.39	0.38	709	0.05
	Jerico	Dredge	Pump	2001	230	0.82	2.7	8.2	N/A	0.38	0.37	680	0.07
2024	Hanson	Dredge	Pump	2014	1000	0.08	0.9	2.4	N/A	0.06	0.06	593	0.01
	Hanson	Dredge	Gen	2014	265	0.08	0.9	1.4	N/A	0.01	0.01	593	0.01
	Hanson	Dredge	Pump	2014	304	0.08	0.9	1.4	N/A	0.01	0.01	593	0.01
	Jerico	Dredge	Gen	2004	99	0.56	3.2	5.6	N/A	0.39	0.38	709	0.05
	Jerico	Dredge	Pump	2017	230	0.08	0.9	1.4	N/A	0.01	0.01	680	0.01

Abbreviations:

µm - micrometer
BSFC - Brake Specific Fuel Consumption
CARB - California Air Resources Board
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
g/bhp-hr - grams per brake horsepower hour
g/hp-hr - grams per horsepower hour
N/A - not applicable
NOx - nitrogen oxides
PM_{10} - particulate matter having a diameter ≤ 10 µm
$PM_{2.5}$ - particulate matter having a diameter ≤ 2.5 µm
ppm - parts per million
ROG - reactive organic gases
SO_2 - sulfur dioxide

Notes:

1. This analysis is for the proposed period of sand mining from 2014 to 2024.
2. Dredge boat model years and horsepower info are provided by Hanson and Jerico.
3. Emission factors were obtained from CARB's Barge and Dredge Emissions Inventory Database
   SO_2 emissions factors are derived from fuel consumption, assuming BSFC of 184 g/hp-hr and the use of 15 ppm sulfur fuel

Sources:

California Air Resources Board (CARB). Barge and Dredge Emissions Inventory Database; available at http://www.arb.ca.gov/msei/categories.htm#chc_category

Table P.3
Project Dredge Emissions
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Project Year[1]	Equipment	Operator[2]	Annual Hours by Operator[2]	Emissions (tons/yr)[3]						Emissions (tonnes/yr)[3,4]			
				ROG	CO	NOx	SO_2	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
2014	Pump	Hanson	3,278	4.88	14.79	37.6	1.4E-02	1.953	1.894	1,384	0.398	0.047	1,407
	Generator	Hanson	4,313	1.62	5.26	12.3	5.2E-03	0.679	0.658	505	0.133	0.017	513
	Pump	Hanson	173	0.07	0.23	0.5	2.3E-04	0.031	0.030	22	0.006	0.001	23
	Generator	Jerico	593	0.03	0.17	0.3	2.7E-04	0.018	0.017	31	0.002	0.001	31
	Pump	Jerico	593	0.11	0.33	0.9	5.9E-04	0.046	0.045	66	0.009	0.002	67
		Total		6.7	21	52	2.0E-02	2.7	2.6	2,009	0.55	0.067	2,041
2015	Pump	Hanson	7,325	0.50	5.35	13.0	3.2E-02	0.303	0.294	3,093	0.041	0.104	3,126
	Generator	Hanson	9,863	0.19	2.00	2.8	1.2E-02	0.019	0.018	1,156	0.015	0.039	1,168
	Pump	Hanson	386	0.01	0.09	0.1	5.1E-04	0.001	0.001	49	0.001	0.002	50
	Generator	Jerico	831	0.04	0.24	0.4	3.7E-04	0.026	0.025	43	0.003	0.001	44
	Pump	Jerico	831	0.16	0.47	1.3	8.3E-04	0.066	0.064	93	0.013	0.003	94
		Total		0.89	8.1	18	4.5E-02	0.41	0.40	4,434	0.073	0.15	4,482
2024	Pump	Hanson	7,325	0.59	5.92	14.1	3.2E-02	0.388	0.376	3,093	0.048	0.104	3,126
	Generator	Hanson	9,863	0.22	2.20	3.0	1.2E-02	0.024	0.023	1,156	0.018	0.039	1,168
	Pump	Hanson	386	0.01	0.09	0.1	5.1E-04	0.001	0.001	49	0.001	0.002	50
	Generator	Jerico	831	0.05	0.25	0.4	3.7E-04	0.029	0.028	43	0.004	0.001	44
	Pump	Jerico	831	0.01	0.15	0.2	8.3E-04	0.002	0.002	93	0.001	0.003	93
		Total		0.88	8.6	18	0.0453	0.44	0.43	4,434	0.072	0.15	4,482

Abbreviations:

µm - micrometer
CARB - California Air Resources Board
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
g/hp-hr - grams per horsepower hour
N_2O - nitrous oxide
NOx - nitrogen oxides
PM_{10} - particulate matter having a diameter $\leq$ 10 µm
$PM_{2.5}$ - particulate matter having a diameter $\leq$ 2.5 µm
ROG - reactive organic gases
SO_2 - sulfur dioxide
yr - year

Notes:

1. This analysis is for the proposed period of sand mining from 2014 to 2024.
2. Tug boat hours of operation are provided by Hanson and Jerico.
3. Emissions were estimated as follows: E = EF0 * FC * (1 + DE * A/UL) * HP * LF * Hr * C

   where,
   EF0 - zero-hour emission factor [g/hp-hr] as shown in the previous table
   FC - fuel correction factors for using low sulfur content diesel fuels
   DE - deterioration rate of engine
   A - age of the engine
   UL - useful life of the engine
   HP - equipment horsepower as provided by Jerico
   LF - equipment load factor obtained from Barge and Dredge EI Database
   Hr - equipment hours were provided by Jerico
   C - conversion constants

4. CO_2e emissions include the sum of CO_2 and CH_4 emissions multiplied by their respective global warming potentials, as follows: $CO_2e = (CO_2 \times 1) + (CH_4 \times 21) + (N_2O \times 310)$. Global warming potentials are from Appendix E of California Air Resources Board's (CARB's) Local Government Operations Protocol. As specified in the Protocol, the Intergovernmental Panel on Climate Change (IPCC)'s Second Assessment Report (SAR) global warming potentials are still used by international convention and in the United States, and are therefore used here.

Sources:

California Air Resources Board (CARB). Barge and Dredge Emissions Inventory Database; available at http://www.arb.ca.gov/msei/categories.htm#chc_category

Table P.4
Project Tug Emission Factors
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Project Year[1]	Operator	Equipment[2]	Engine Type	Model Year[2]	Horsepower[2]	Emission Factors (g/bhp-hr)[3]							
						ROG	CO	NOx	SO_2	PM_{10}	$PM_{2.5}$	CO_2	CH_4
2014	Hanson	Tug	Main	2001	2600	0.68	1.97	7.31	N/A	0.36	0.35	587	0.06
	Hanson	Tug	Aux	1998	92	1.18	3.59	8.75	N/A	0.58	0.56	587	0.11
	Hanson	Tug	Aux	1998	92	1.18	3.59	8.75	N/A	0.58	0.56	587	0.11
	Jerico	Tug	Main	2001	1060	0.68	1.97	7.31	N/A	0.36	0.35	587	0.06
	Jerico	Tug	Aux	2000	64	1.18	3.59	7.31	N/A	0.58	0.56	587	0.11
	Jerico	Tug	Main	2013	1320	0.68	3.73	3.99	N/A	0.08	0.08	587	0.06
	Jerico	Tug	Aux	2000	64	1.18	3.59	7.31	N/A	0.58	0.56	587	0.11
2015	Hanson	Tug	Main	2001	2600	0.68	1.97	7.31	N/A	0.36	0.35	587	0.06
	Hanson	Tug	Aux	1998	92	1.18	3.59	8.75	N/A	0.58	0.56	587	0.11
	Hanson	Tug	Aux	1998	92	1.18	3.59	8.75	N/A	0.58	0.56	587	0.11
	Jerico	Tug	Main	2001	1060	0.68	1.97	7.31	N/A	0.36	0.35	587	0.06
	Jerico	Tug	Aux	2000	64	1.18	3.59	7.31	N/A	0.58	0.56	587	0.11
	Jerico	Tug	Main	2013	1320	0.68	3.73	3.99	N/A	0.08	0.08	587	0.06
	Jerico	Tug	Aux	2000	64	1.18	3.59	7.31	N/A	0.58	0.56	587	0.11
2024	Hanson	Tug	Main	2015	2600	0.68	3.73	4.09	N/A	0.08	0.08	587	0.06
	Hanson	Tug	Aux	2015	92	1.18	3.73	5.32	N/A	0.22	0.21	587	0.11
	Hanson	Tug	Aux	2015	92	1.18	3.73	5.32	N/A	0.22	0.21	587	0.11
	Jerico	Tug	Main	2017	1060	0.68	3.73	3.99	N/A	0.08	0.08	587	0.06
	Jerico	Tug	Aux	2015	64	1.18	3.73	5.32	N/A	0.22	0.21	587	0.11
	Jerico	Tug	Main	2013	1320	0.68	3.73	3.99	N/A	0.08	0.08	587	0.06
	Jerico	Tug	Aux	2015	64	1.18	3.73	5.32	N/A	0.22	0.21	587	0.11

Abbreviations:

µm - micrometer
BSFC - Brake Specific Fuel Consumption
CARB - California Air Resources Board
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
g/bhp-hr - grams per brake horsepower hour
g/hp-hr - grams per horsepower hour
N/A - not applicable
NOx - nitrogen oxides
PM_{10} - particulate matter having a diameter $\leq$ 10 µm
$PM_{2.5}$ - particulate matter having a diameter $\leq$ 2.5 µm
ppm - parts per million
ROG - reactive organic gases
SO_2 - sulfur dioxide

Notes:

1. This analysis is for the proposed period of sand mining from 2014 to 2024.
2. Tug boat model years and horsepower info are provided by Hanson and Jerico.
3. Emission factors were obtained from ARB's Harbor Craft Emissions Inventory Database
   SO_2 emissions factors are derived from fuel consumption, assuming BSFC of 184 g/hp-hr and the use of 15 ppm sulfur fuel

Sources:

California Air Resources Board (CARB). Harbor Craft Emissions Inventory Database; available at http://www.arb.ca.gov/msei/categories.htm#chc_category

Table P.5
Project Tug Emissions
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Project Year[1]	Equipment	Operator[2]	Annual Hours by Operator[2]	Emissions (tons/yr)[3]						Emissions (tonnes/yr)[3,4]			
				ROG	CO	NOx	SO_2	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
2014	Tug	Hanson	1,035	1.7	4.6	16	0.011	0.8	0.8	1,074	0.14	0.037	1,089
	Tug	Jerico - Shamrock	2,070	0.13	0.4	0.8	0.000	0.05	0.05	48	0.010	0.002	49
	Tug	Jerico - Syar Industries	1,524	1.05	3.7	8.2	0.007	0.37	0.35	698	0.086	0.024	707
	Tug	Jerico - Collinsville	1,524	0.06	0.18	0.35	0.000	0.03	0.03	25	0.005	0.001	25
	Tug	Total		3.0	9	25	0.019	1.3	1.2	1,845	0.24	0.06	1,870
2015	Tug	Hanson	2,538	4.4	11	39	0.027	2.1	2.0	2,635	0.36	0.090	2,670
	Tug	Jerico - Shamrock	5,076	0.32	0.9	2.0	0.001	0.14	0.13	118	0.026	0.004	120
	Tug	Jerico - Syar Industries	2,136	1.49	5.3	11.7	0.010	0.52	0.51	978	0.122	0.033	991
	Tug	Jerico - Collinsville	2,136	0.09	0.26	0.49	0.000	0.04	0.04	35	0.007	0.001	35
	Tug	Total		6.3	18	53	0.039	2.8	2.7	3,765	0.51	0.13	3,816
2024	Tug	Hanson	2,538	4.0	20	21	0.027	0.43	0.42	2,635	0.33	0.090	2,669
	Tug	Jerico - Shamrock	5,076	0.29	0.9	1.2	0.001	0.05	0.05	118	0.024	0.004	120
	Tug	Jerico - Syar Industries	2,136	1.47	7.5	7.5	0.010	0.16	0.15	978	0.120	0.033	991
	Tug	Jerico - Collinsville	2,136	0.085	0.26	0.35	0.000	0.01	0.01	35	0.007	0.001	35
	Tug	Total		5.8	29	30	0.039	0.66	0.64	3,765	0.48	0.13	3,815

Abbreviations:

µm - micrometer
CARB - California Air Resources Board
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
g/hp-hr - grams per horsepower hour
N_2O - nitrous oxide
NOx - nitrogen oxides
PM_{10} - particulate matter having a diameter $\leq$ 10 µm
$PM_{2.5}$ - particulate matter having a diameter $\leq$ 2.5 µm
ROG - reactive organic gases
SO_2 - sulfur dioxide
yr - year

Notes:

1. This analysis is for the proposed period of sand mining from 2014 to 2024.
2. Tug boat hours of operation are provided by Hanson and Jerico.
3. Emissions were estimated as follows: E = EF0 * FC * (1 + DE * A/UL) * HP * LF * Hr * C

where,
EF0 - zero-hour emission factor [g/hp-hr] as shown in the previous table
FC - fuel correction factors for using low sulfur content diesel fuels
DE - deterioration rate of engine
A - age of the engine
UL - useful life of the engine
HP - equipment horsepower as provided by Jerico
LF - equipment load factor obtained from Harbor Craft EI Database
Hr - equipment hours were provided by Jerico
C - conversion constants

4. CO_2e emissions include the sum of CO_2 and CH_4 emissions multiplied by their respective global warming potentials, as follows: CO_2e = (CO_2 x 1) + (CH_4 x 21) + (N_2O x 310). Global warming potentials are from Appendix E of California Air Resources Board's (CARB's) Local Government Operations Protocol. As specified in the Protocol, the Intergovernmental Panel on Climate Change (IPCC)'s Second Assessment Report (SAR) global warming potentials are still used by international convention and in the United States, and are therefore used here.

Sources:

California Air Resources Board (CARB). Harbor Craft Emissions Inventory Database; available at http://www.arb.ca.gov/msei/categories.htm#chc_category

Table P.6
Project Marine Loader Emission Factors
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Project Year[1]	Equipment[2]	OFFROAD2011 Equipment Name[2]	Horsepower[2]	Emission Factors (g/bhp-hr)[3]							
				ROG	CO	NOx	SO_2	PM_{10}	$PM_{2.5}$	CO_2	CH_4
2014	Loader	Rubber Tired Loaders	195	0.25	1.2	2.6	0.0064	0.13	0.12	568	0.039
2015	Loader	Rubber Tired Loaders	195	0.27	1.2	2.6	0.0064	0.13	0.12	568	0.042
2024	Loader	Rubber Tired Loaders	195	0.30	1.2	2.7	0.0064	0.14	0.13	569	0.043

Abbreviations:

µm - micrometer
CARB - California Air Resources Board
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
g/bhp-hr - grams per brake horsepower hour
HP - horsepower
NOx - nitrogen oxides
PM_{10} - particulate matter having a diameter $\leq$ 10 µm
$PM_{2.5}$ - particulate matter having a diameter $\leq$ 2.5 µm
ROG - reactive organic gases
SO_2 - sulfur dioxide

Notes:

1. This analysis is for the proposed period of sand mining from 2014 to 2024.
2. Loaders aboard the dredge barge are model year 2007 and have an estimated power of 195 HP.
3. Emission factors were derived from CARB's OFFROAD2011 and OFFROAD2007 models.

Sources:

OFFROAD2011 and OFFROAD2007 models; available at http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

Table P.7
Project Marine Loader Emissions
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Project Year[1]	Equipment[2]	Horsepower[2]	Load Factor[2]	Total Annual Hours of Operation[2]	Emissions (tons/yr)[3]						Emissions (tonnes/yr)[3,4]		
					ROG	CO	NOx	SO_2	PM_{10}	$PM_{2.5}$	CO_2	CH_4	CO_2e
2014	Loader	195	0.3618	762	0.015	0.07	0.15	3.8E-04	0.008	0.007	31	2.1E-03	31
2015	Loader	195	0.3618	1,068	0.023	0.10	0.22	5.3E-04	0.011	0.010	43	3.2E-03	43
2024	Loader	195	0.3618	1,068	0.025	0.10	0.22	5.3E-04	0.012	0.011	43	3.3E-03	43

Abbreviations:

µm - micrometer
CARB - California Air Resources Board
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
g/hp-hr - grams per horsepower hour
HP - horsepower
NOx - nitrogen oxides
PM_{10} - particulate matter having a diameter ≤ 10 µm
$PM_{2.5}$ - particulate matter having a diameter ≤ 2.5 µm
ROG - reactive organic gases
SO_2 - sulfur dioxide
yr - year

Notes:

1. This analysis is for the proposed period of sand mining from 2014 to 2024.
2. Loaders aboard the dredge barge are model year 2007 and have an estimated power of 195 HP.
3. Emissions were estimated as follows: E = EF * HP * LF * Hr * C

    where,

    EF - emission factor [g/hp-hr] as shown in the previous table

    HP - equipment horsepower as provided by Jerico

    LF - equipment load factor obtained from OFFROAD2011 model

    Hr - equipment hours were provided by Jerico

    C - conversion constants

4. CO_2e emissions include the sum of CO_2 and CH_4 emissions multiplied by their respective global warming potentials, as follows: $CO_2e = (CO_2 \times 1) + (CH_4 \times 21)$. Global warming potentials are from Appendix E of CARB's Local Government Operations Protocol. As specified in the Protocol, the Intergovernmental Panel on Climate Change (IPCC)'s Second Assessment Report (SAR) global warming potentials are still used by international convention and in the United States, and are therefore used here.

Sources:

OFFROAD2011 and OFFROAD2007 models; available at http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

Table P.8
Project Marine Summary Emissions
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Project Year	Project Marine Source	Emissions (tons/yr)						Emissions (tonnes/yr)			
		ROG	CO	NOx	SO_2	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
2014	Dredge Activities	6.7	21	52	0.020	2.7	2.6	2,009	0.55	0.07	2,041
	Tug Activities	3.0	9	25	0.019	1.3	1.2	1,845	0.24	0.06	1,870
	Loader Activities	0.02	0.07	0.15	0.000	0.01	0.01	31	0.00	N/A	31
	Total	10	30	77	0.040	4.0	3.9	3,884	0.8	0.13	3,941
2015	Dredge Activities	0.9	8.1	18	0.045	0.41	0.40	4,434	0.07	0.15	4,482
	Tug Activities	6.3	18	53	0.039	2.8	2.7	3,765	0.51	0.13	3,816
	Loader Activities	0.02	0.10	0.22	0.001	0.011	0.010	43	0.00	N/A	43
	Total	7.2	26	71	0.085	3.2	3.1	8,242	0.59	0.28	8,340
2024	Dredge Activities	0.9	8.6	18	0.045	0.44	0.43	4,434	0.07	0.15	4,482
	Tug Activities	5.8	29	30	0.039	0.66	0.64	3,765	0.48	0.13	3,815
	Loader Activities	0.03	0.1	0.2	0.001	0.01	0.01	43	0.00	N/A	43
	Total	6.7	38	48	0.085	1.1	1.1	8,242	0.55	0.28	8,340

Abbreviations:

µm - micrometer
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
N/A - not applicable
N_2O - nitrous oxide
NOx - nitrogen oxides
PM_{10} - particulate matter having a diameter ≤ 10 µm
$PM_{2.5}$ - particulate matter having a diameter ≤ 2.5 µm
ROG - reactive organic gases
SO_2 - sulfur dioxide
yr - year

Table P.9
Project Offloading Site Off-Road Equipment Emission Factors
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Project Year[1]	Operator[2]	Equipment[2]	OFFROAD2011 Equipment Name[2]	Horsepower[2]	Emission Factors (g/bhp-hr)[3]							
					ROG	CO	NOx	SO_2	PM_{10}	$PM_{2.5}$	CO_2	CH_4
2014	Hanson	Loader 980 H	Rubber Tired Loaders	393	0.421	2.41	5.19	0.0048	0.196	0.180	513	0.152
	Jerico	Loader Komatsu	Rubber Tired Loaders	232	0.407	1.49	5.50	0.0048	0.187	0.172	514	0.152
2015	Hanson	Loader 980 H	Rubber Tired Loaders	393	0.415	2.33	5.02	0.0048	0.190	0.174	506	0.151
	Jerico	Loader Komatsu	Rubber Tired Loaders	232	0.406	1.48	5.37	0.0048	0.183	0.169	509	0.152
2024	Hanson	Loader 980 H	Rubber Tired Loaders	393	0.209	1.35	1.70	0.0048	0.063	0.058	469	0.152
	Jerico	Loader Komatsu	Rubber Tired Loaders	232	0.197	1.16	1.81	0.0049	0.060	0.056	470	0.152

Abbreviations:

µm - micrometer
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
g/bhp-hr - grams per brake horsepower hour
NOx - nitrogen oxides
PM_{10} - particulate matter having a diameter $\leq$ 10 µm
$PM_{2.5}$ - particulate matter having a diameter $\leq$ 2.5 µm
ROG - reactive organic gases
SO_2 - sulfur dioxide

Notes:

1. This analysis is for the proposed period of sand mining from 2014 to 2024.
2. Hanson operates a loader at both the Tidewater and Pier 92 offloading sites with an estimated maximum 393 horsepower. Jerico operates a loader at the Collinsville offloading site which is equipped with a Tier 3 engine. Use of fleet average emission factors are generally conservative estimates for 2014 and 2015 and representative of 2024 emissions.
3. Emission factors were obtained from Table 3.4 of supporting Appendix D for the California Emission Estimator Model (CalEEMod).

Sources:

CalEEMod. 2013. California Emission Estimator Model (CalEEMod): Appendix D - Default Data Tables. September. Available online at: http://www.caleemod.com/

Table P.10
Project Offloading Site Off-Road Equipment Emissions
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Project Year[1]	Operator[2]	Equipment[2]	Horsepower[2]	Load Factor[2]	Quantity[2]	Annual Hours of Operation (per Equipment)[3]	Emissions (tons/yr)[4]						Emissions (tonnes/yr)[4,5]		
							ROG	CO	NOx	SO_2	PM_{10}	$PM_{2.5}$	CO_2	CH_4	CO_2e
2014	Hanson	Loader 980 H	393	0.3618	2	897	0.12	0.7	1.5	1.3E-03	0.06	0.05	131	0.04	132
	Jerico	Loader Komatsu	232	0.3618	1	115	4.3E-03	0.016	0.058	5.1E-05	2.0E-03	1.8E-03	4.9	1.5E-03	5.0
2015	Hanson	Loader 980 H	393	0.3618	2	2000	0.26	1.5	3.1	3.0E-03	0.12	0.11	291	0.09	293
	Jerico	Loader Komatsu	232	0.3618	1	160	6.0E-03	0.022	0.079	7.1E-05	2.7E-03	2.5E-03	6.9	2.0E-03	6.9
2024	Hanson	Loader 980 H	393	0.3618	2	2000	0.13	0.8	1.1	3.0E-03	0.04	0.04	291	0.09	293
	Jerico	Loader Komatsu	232	0.3618	1	160	2.9E-03	0.017	0.027	7.3E-05	8.9E-04	8.2E-04	6.9	2.0E-03	6.9

Abbreviations:

µm - micrometer
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
g/hp-hr - grams per horsepower hour
NOx - nitrogen oxides
PM_{10} - particulate matter having a diameter $\leq$ 10 µm
$PM_{2.5}$ - particulate matter having a diameter $\leq$ 2.5 µm
ROG - reactive organic gases
SO_2 - sulfur dioxide
yr - year

Notes:

1. This analysis is for the proposed period of sand mining from 2014 to 2024.
2. Hanson operates a loader at both the Tidewater and Pier 92 offloading sites with an estimated maximum 393 horsepower. Jerico operates a loader at the Collinsville offloading site which is equipped with a Tier 3 engine. Use of fleet average emission factors are generally conservative estimates for 2014 and 2015 and representative of 2024 emissions.
3. Hours of operation for 2015 - 2024 for Hanson were estimated as 40 hrs/week for 50 weeks/year. Hours of operation at the Collinsville site for 2015-2024 were estimated at 160 hours/year. Hours for 2014 were adjusted based on the throughput presented for 2014 in Table 1.
4. Emissions were estimated as follows: E = EF * HP * LF * Hr * Q * C

   where,
   EF - emission factor [g/hp-hr] as shown in the previous table
   HP - equipment horsepower as provided by Hanson
   LF - equipment load factor provided in OFFROAD
   Hr - equipment hours were estimated as 40 hrs/week for 50 weeks/year
   Q - equipment quantity as provided by Hanson
   C - conversion constants

5. CO_2e emissions include the sum of CO_2 and CH_4 emissions multiplied by their respective global warming potentials, as follows: $CO_2e = (CO_2 \times 1) + (CH_4 \times 21)$. Global warming potentials are from Appendix E of California Air Resources Board's (CARB's) Local Government Operations Protocol. As specified in the Protocol, the Intergovernmental Panel on Climate Change (IPCC)'s Second Assessment Report (SAR) global warming potentials are still used by international convention and in the United States, and are therefore used here.

Sources:

California Air Resources Board (CARB). 2011. In-use Off-road Equipment Inventory Model. OFFROAD 2011.
http://www.arb.ca.gov/msei/categories.htm#offroad_motor_vehicles.

Table P.11
Project Carbon Dioxide Emission Factor for Electricity Usage
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

	2008	Units
Total Energy Delivery[1]	81,935,164	MWh
from renewables[2]	9,798,137	MWh
from non-renewables	72,137,027	MWh
% of Total Energy From Renewables[2]	12%	N/A
Total CO_2 Emissions[1]	23,835,723	metric tonnes CO_2
CO_2 Emissions per Total Energy Delivered	641	lbs CO_2/MWh delivered
CO_2 Emissions per Total Non-Renewable Energy[3]	728	lbs CO_2/MWh delivered
Estimated Emission Factors for Total Energy Delivered[4]		
2014 RPS (20%)	583	lbs CO_2/MWh delivered
2024 RPS (33%)	488	lbs CO_2/MWh delivered

Abbreviations:

CO_2 - carbon dioxide
lbs - pounds
MWh - megawatt-hour
N/A - not applicable
RPS - Renewables Portfolio Standard

Notes:

1. Total energy delivery and total CO_2 emissions are provided in PG&E's Pacific Gas and Electric's (PG&E's) Power/Utility Protocol (PUP) Reports available at: https://www.climateregistry.org/CARROT/public/reports.aspx
2. Renewable energy delivered is the sum of biogenic, geothermal and other renewable generations in PUP reports.
3. The emissions metric presented here is calculated based on the total CO_2 emissions divided by the energy delivered from non-renewable sources.
4. The emission factors for total energy delivered are estimated by multiplying the percentage of energy delivered from non-renewable energy by the CO_2 emissions per total non-renewable energy metric calculated above. Two emission factors are presented here for the current 20% Renewables Portfolio Standard (RPS) goal for 2014/2015 and the presumed 33% RPS for 2024. The estimate provided here and the PUP reports issued by PG&E assume that renewable energy sources do not result in any CO_2 emissions. This is not necessarily true for biogas- and biomass-sourced energy but some consider these sources to be "carbon neutral."

Table P.12

Project Offloading Site Electrical Equipment

Hanson Marine Operations and Jerico Products, Inc.

San Francisco Bay Area

Project Year[1]	Offloading Site	Equipment Type[2]	Fuel Type	Total HP[2]	Annual Operational Hours[3]	Annual Electricity Usage (kWh)[4]
2014	Tidewater	Misc. Motors	Electric	350	897	334,446
	SF Pier 92	Misc. Motors	Electric	450	897	430,003
	Collinsville	Conveyors	Electric	40	115	4,900
2015 - 2024	Tidewater	Misc. Motors	Electric	350	2,000	745,700
	SF Pier 92	Misc. Motors	Electric	450	2,000	958,757
	Collinsville	Conveyors	Electric	40	160	6,818

Abbreviations:

HP - horsepower

kWh - kilowatt hour

Misc. - Miscellaneous

Notes:

1. This analysis is for the proposed period of sand mining from 2014 to 2024.

2. At both Tidewater and Pier 92 Hanson operates a variety of electric motors to assist in the offloading of sand. At Collinsville, Jerico uses shore power to power barge offloading conveyors.

3. Hours of operation for 2015 - 2024 for Hanson were estimated as 40 hrs/week for 50 weeks/year. Hours of operation at the Collinsville site for 2015-2024 were estimated at 160 hours/year. Hours for 2014 were adjusted based on the throughput presented for 2014 in Table 1.

4. Annual electricity usage was calculated with a conversion factor of 0.75 kilowatt per HP and an assumption of 70% equipment efficiency.

Table P.13
Project Offloading Site Electrical Equipment Emissions
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Year	Source	Electricity Usage	Emission Factors (tones/kWh)[1]			Emissions (tonnes/yr)[2]			
		kWh	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O	CO_2e
2014	Electric Equipment	769,349	2.6E-04	1.4E-08	4.3E-09	203	0.010	3.3E-03	205
2015	Electric Equipment	1,711,275	2.6E-04	1.4E-08	4.3E-09	452	0.023	7.4E-03	455
2024	Electric Equipment	1,711,275	2.2E-04	1.4E-08	4.3E-09	379	0.023	7.4E-03	382

Abbreviations:

CARB - California Air Resources Board
CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalents
kWh - kilowatt hour
N_2O - nitrous oxide
PG&E - Pacific Gas and Electric Company
yr - year

Notes:

1. CH_4 and N_2O emission factors are the average of 2006 and 2007 emission factors from the California Air Resources Board (CARB) Local Goverrnment Operations Protocol (LGOP), Table G.7. The emission factor for CO_2 is as presented in a previous table.
2. CO_2e emissions include the sum of CO_2, CH_4, and N_2O multiplied by their respective global warming potentials, as follows: $CO_2e = (CO_2 \times 1) + (CH_4 \times 21) + (N_2O \times 310)$. Global warming potentials are from Appendix E of California Air Resources Board's (CARB's) Local Government Operations Protocol (LGOP). As specified in the Protocol, the Intergovernmental Panel on Climate Change (IPCC)'s Second Assessment Report (SAR) global warming potentials are still used by international convention and in the United States, and are therefore used here.

Sources:

CARB LGOP, Version 1.1. Appendix G. Accessed October 2013. Available at: http://www.arb.ca.gov/cc/protocols/localgov/pubs/lgo_protocol_v1_1_2010-05-03.pdf
PG&E. 2008. Power/Utility Protocol (PUP) Report. Available online at: https://www.climateregistry.org/CARROT/public/reports.aspx

Table P.14
Project Offloading Site Emissions Summary
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Project Year	Emission Source	Emissions (tons/yr)						Emissions (tonnes/yr)			
		ROG	CO	NOx	SO_2	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
2014	Electric Equipment	N/A	N/A	N/A	N/A	N/A	N/A	203	0.01	3.3E-03	205
	Offroad Equipment	0.12	0.7	1.5	1.4E-03	0.06	0.05	136	0.04	0	137
	Total	0.12	0.7	1.5	1.4E-03	0.06	0.05	339	0.05	3.3E-03	341
2015	Electric Equipment	N/A	N/A	N/A	N/A	N/A	N/A	452	0.023	7.4E-03	455
	Offroad Equipment	0.27	1.5	3.2	3.1E-03	0.12	0.11	298	0.09	0	300
	Total	0.27	1.5	3.2	3.1E-03	0.12	0.11	751	0.11	7.4E-03	755
2024	Electric Equipment	N/A	N/A	N/A	N/A	N/A	N/A	379	0.023	7.4E-03	382
	Offroad Equipment	0.13	0.86	1.1	3.1E-03	0.040	0.037	298	0.09	0	300
	Total	0.13	0.86	1.1	3.1E-03	0.040	0.037	677	0.11	7.4E-03	682

Abbreviations:

µm - micrometer
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
N/A - not applicable
N_2O - nitrous oxide
NOx - nitrogen oxides
PM_{10} - particulate matter having a diameter ≤ 10 µm
$PM_{2.5}$ - particulate matter having a diameter ≤ 2.5 µm
ROG - reactive organic gases
SO_2 - sulfur dioxide
yr - year

Table P.15

Project Emissions Methodology On-Road Mobile Activities

Hanson Marine Operations and Jerico Products, Inc.

San Francisco Bay Area

Source	Emission Category	Methodology and Formula	Reference
On-Road Mobile Sources[1]	Exhaust - Running	$E_R = \Sigma_i(EF_{Ri} * VMT_i * C)$, where VMT_i = Trip $Length_i$ * Trip $Number_i$	EMFAC2011
	Brakewear and Tirewear - Running	$Ew = \Sigma_i(EF_{Wi} * VMT_i * C)$, where VMT_i = Trip $Length_i$ * Trip $Number_i$	EMFAC2011
	Exhaust - Idling	$E_I = \Sigma(EF_{Ii}$ * Trip $Number_i)$	EMFAC2011

Abbreviations:

CARB - California Air Resources Board

EMFAC - EMission FACtors Model

g - gram

hr - hour

lb - pound

T7 - EMFAC Category for Heavy Heavy Duty Truck

VMT - vehicle miles traveled

E_R - running eshaust emissions

EF_{Ri} - running emission factor (g/mile) for vehicle i

E_W - running brakewear and tirewear emissions (lb)

EF_{Wi} - brakewear and tirewear emission factor (g/mile) for vehicle i

E_I - vehicle idling emissions (lb)

EF_I - vehicle idling emission factor (g/trip) for vehicle i

C - unit conversion factor (lb/g)

Notes:

1. On-road mobile sources include hauling trucks from offloading sites or quarries to customers Emissions associated with mobile sources were calculated using equations above and the following parameters and assumptions:

E_R: running exhaust emissions (lb).

EF_{Ri}: running emission factor (g/mile) for vehicle i. From EMFAC2011 online "Emission Rates Database", for all model years of vehicle class T7 in the San Francisco Air Basin in 2014 for future and in 2024.

Assumed "AllSpeeds"

VMT_i: vehicle miles traveled for vehicle i

The calculation involves the following data and assumptions:

(1) Trucks are heavy-heavy duty trucks (EMFAC Category T7).

(2) Trip $Length_i$: The one-way trip length depends on the the vehicle's starting/ending point.

E_W: running brakewear and tirewear emissions (lb).

EF_{Wi}: brakewear and tirewear emission factor (g/mile) for vehicle i. From EMFAC2011 online "Emission Rates Database", for all model years of vehicle class T7 in the San Francisco Air Basin in 2014 for future and in 2024.

Assumed "AllSpeeds"

VMT_i: vehicle miles traveled for vehicle i

The calculation involves the same data and assumptions used in E_R calculations.

E_I: vehicle idling emissions (lb).

EF_I: vehicle idling emission factor (g/trip) for vehicle i. From EMFAC2011, which reports emission factors in g/hr-vehicle. The emission factor is calculated to assume an average idling time per trip. It was assumed that two 15-minute idling occurs for a one-way truck trip, based on communication with Hanson and Jerico.

C: unit conversion factor (lb/g).

Sources:

CARB. Heavy-Duty Vehicle Idling Emission Reduction Program. Available at: http://www.arb.ca.gov/msprog/truck-idling/truck-idling.htm. Accessed October 2013.

CARB. 2011. EMFAC2011. September. Available at: http://www.arb.ca.gov/msei/modeling.htm

Table P.16
Project Haul Truck Trips and Emissions: 2014
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Offloading Location	Customer ID	Sand Delivered (tons/yr)[1]	Number of Round Trips (trips/yr)[2]	One Way Trip Length (miles)[3]	Emissions (tons/yr)[4]						Emissions (tonnes/yr)[4,5,6]			
					ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
Collinsville	C029	1,672	73	5	0.00	0.00	0.0	0.0000	0.000	0.000	2	0.0000	0.0000	2
Collinsville	C030	53,019	2,305	36	0.07	0.32	1.7	0.0032	0.048	0.034	297	0.0029	0.0100	300
Collinsville	C031	5,888	256	50	0.01	0.05	0.3	0.0005	0.007	0.005	45	0.0004	0.0015	46
Oakland	C014	18,968	825	5	0.01	0.03	0.1	0.0002	0.003	0.002	17	0.0003	0.0005	17
Oakland	C001	62,225	2,705	32	0.07	0.34	1.7	0.0033	0.049	0.035	306	0.0031	0.0103	309
Oakland	C002	134,987	5,869	8	0.05	0.26	1.1	0.0019	0.026	0.019	175	0.0023	0.0054	177
Oakland	C003	3,048	133	30	0.00	0.02	0.1	0.0002	0.002	0.002	14	0.0001	0.0005	14
Oakland	C013	28,384	0	0	0.00	0.00	0.0	0.0000	0.000	0.000	0	0.0000	0.0000	0
Oakland	C018	49,626	2,158	0	0.01	0.04	0.1	0.0001	0.001	0.001	10	0.0003	0.0001	10
Oakland	C024	24,435	1,062	5	0.01	0.04	0.1	0.0002	0.003	0.002	22	0.0003	0.0006	22
Oakland	C008	26,823	1,166	28	0.03	0.13	0.7	0.0013	0.019	0.013	118	0.0012	0.0039	119
Oakland	C011	44,878	1,951	6	0.02	0.08	0.3	0.0005	0.007	0.005	47	0.0007	0.0014	48
Oakland	C012	49,503	2,152	2	0.01	0.05	0.2	0.0002	0.002	0.002	19	0.0004	0.0004	20
Oakland	C009	68,912	2,996	26	0.07	0.32	1.6	0.0030	0.045	0.032	280	0.0029	0.0093	282
Oakland	C010	18,332	797	17	0.01	0.06	0.3	0.0005	0.008	0.005	48	0.0005	0.0016	49
Oakland	C017	9,711	422	8	0.00	0.02	0.1	0.0001	0.002	0.001	13	0.0002	0.0004	13
SF Pier 92	C007	261,198	8,707	0	0.03	0.17	0.4	0.0004	0.003	0.003	39	0.0014	0.0003	39
SF Pier 92	C026	4,404	191	5	0.00	0.01	0.0	0.0000	0.001	0.000	4	0.0001	0.0001	4
SF Pier 92	C006	36,756	1,598	10	0.02	0.08	0.4	0.0006	0.009	0.007	59	0.0007	0.0019	60
SF Pier 92	C004	132,044	4,401	0	0.02	0.09	0.2	0.0002	0.002	0.001	20	0.0007	0.0002	20
SF Pier 92	C005	13,410	583	10	0.01	0.03	0.1	0.0002	0.003	0.002	22	0.0003	0.0007	22
SF Pier 92	C022	9,471	412	5	0.00	0.01	0.1	0.0001	0.001	0.001	9	0.0001	0.0002	9
SF Pier 92	C020	19,843	863	5	0.01	0.03	0.1	0.0002	0.003	0.002	18	0.0003	0.0005	18
SF Pier 92	C021	19,843	863	10	0.01	0.05	0.2	0.0004	0.005	0.004	33	0.0004	0.0010	33
SF Pier 92	C023	19,623	853	5	0.01	0.03	0.1	0.0002	0.003	0.002	18	0.0003	0.0005	18
SF Pier 92	C025	19,623	853	10	0.01	0.04	0.2	0.0003	0.005	0.004	33	0.0004	0.0010	33
SF Pier 92	C015	8,562	372	5	0.00	0.01	0.1	0.0001	0.001	0.001	8	0.0001	0.0002	8
SF Pier 92	C016	8,090	352	5	0.00	0.01	0.0	0.0001	0.001	0.001	7	0.0001	0.0002	7
Total		1,153,278	44,918		0.48	2.3	10	0.018	0.26	0.19	1,681	0.020	0.053	1,698

Table P.16
Project Haul Truck Trips and Emissions: 2014
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Abbreviations:

µm - micrometer	NOx - nitrogen oxides
CARB - California Air Resources Board	N_2O - nitrous oxide
CH_4 - methane	PM_{10} - particulate matter having a diameter $\leq$ 10 µm
CO - carbon monoxide	$PM_{2.5}$ - particulate matter having a diameter $\leq$ 2.5 µm
CO_2 - carbon dioxide	ROG - reactive organic gases
CO_2e - carbon dioxide equivalent	SO_x - sulfur oxides
EMFAC - EMission FACtors Model	yr - year

Notes:

1. Sand delivered to each customer are approximations provided by Hanson. Masses do not include material offloaded from barge directly at customer site.
2. Round trips calculated by dividing the annual sand delivery to each customer by the average truck capacity of 23 tons.
3. One way trip length was the Google Maps recommended route from the alternative provider to the customer.
4. Annual emissions were calculated based on the methodology described in previous tables.
5. CO_2 emissions were calculated using the CO_2-Pavley emission factor presented in EMFAC 2011. This emission factor accounts for reductions in greenhouse gas (GHG) emissions expected as a result of California Assembly Bill 1493 ("Pavley"), which requires GHG reductions in new passenger vehicles from 2009 through 2016.
6. CO_2e emissions include the sum of CO_2, CH_4, and N_2O multiplied by their respective global warming potentials, as follows: $CO_2e = (CO_2 \times 1) + (CH_4 \times 21) + (N_2O \times 310)$. Global warming potentials are from Appendix E of California Air Resources Board's (CARB's) Local Government Operations Protocol (LGOP). As specified in the Protocol, the Intergovernmental Panel on Climate Change (IPCC)'s Second Assessment Report (SAR) global warming potentials are still used by international convention and in the United States, and are therefore used here.

Sources:

CARB LGOP, Version 1.1. Appendix G. Accessed October 2013. Available at: http://www.arb.ca.gov/cc/protocols/localgov/pubs/lgo_protocol_v1_1_2010-05-03.pdf

Table P.17
Project Haul Truck Trips and Emissions: 2015
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Offloading Location	Customer ID	Sand Delivered (tons/yr)[1]	Number of Round Trips (trips/yr)[2]	One Way Trip Length (miles)[3]	Emissions (tons/yr)[4]						Emissions (tonnes/yr)[4,5,6]			
					ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
Collinsville	C029	2,333	102	5	0.00	0.00	0.0	0.0000	0.000	0.000	2	0.0000	0.0001	2
Collinsville	C030	73,980	3,216	36	0.09	0.40	2.0	0.0044	0.055	0.037	407	0.0036	0.0139	412
Collinsville	C031	8,216	358	50	0.01	0.06	0.3	0.0007	0.008	0.006	63	0.0005	0.0022	63
Oakland	C014	42,285	1,838	5	0.01	0.06	0.2	0.0004	0.005	0.003	38	0.0005	0.0011	38
Oakland	C001	138,721	6,031	32	0.14	0.67	3.3	0.0073	0.090	0.061	673	0.0060	0.0229	680
Oakland	C002	300,932	13,084	8	0.11	0.54	2.1	0.0042	0.049	0.033	385	0.0046	0.0119	389
Oakland	C003	6,796	295	30	0.01	0.03	0.2	0.0003	0.004	0.003	31	0.0003	0.0010	31
Oakland	C013	63,277	0	0	0.00	0.00	0.0	0.0000	0.000	0.000	0	0.0000	0.0000	0
Oakland	C018	110,633	4,810	0	0.02	0.10	0.2	0.0002	0.001	0.001	21	0.0008	0.0002	21
Oakland	C024	54,474	2,368	5	0.02	0.08	0.3	0.0005	0.006	0.004	49	0.0007	0.0014	49
Oakland	C008	59,798	2,600	28	0.06	0.26	1.3	0.0028	0.035	0.023	259	0.0024	0.0088	262
Oakland	C011	100,049	4,350	6	0.03	0.16	0.6	0.0011	0.013	0.009	104	0.0014	0.0031	105
Oakland	C012	110,359	4,798	2	0.02	0.11	0.3	0.0005	0.004	0.003	43	0.0009	0.0009	43
Oakland	C009	153,628	6,679	26	0.13	0.63	3.0	0.0066	0.082	0.055	615	0.0057	0.0208	621
Oakland	C010	40,869	1,777	17	0.03	0.12	0.5	0.0011	0.014	0.009	106	0.0011	0.0035	108
Oakland	C017	21,648	941	8	0.01	0.04	0.2	0.0003	0.004	0.002	28	0.0003	0.0009	29
SF Pier 92	C007	582,300	19,410	0	0.07	0.38	0.8	0.0009	0.006	0.005	86	0.0030	0.0007	87
SF Pier 92	C026	9,817	427	5	0.00	0.01	0.1	0.0001	0.001	0.001	9	0.0001	0.0003	9
SF Pier 92	C006	81,942	3,563	10	0.03	0.17	0.7	0.0014	0.017	0.011	130	0.0015	0.0042	132
SF Pier 92	C004	294,372	9,812	0	0.04	0.19	0.4	0.0005	0.003	0.002	44	0.0015	0.0004	44
SF Pier 92	C005	29,895	1,300	10	0.01	0.06	0.3	0.0005	0.006	0.004	48	0.0005	0.0015	48
SF Pier 92	C022	21,114	918	5	0.01	0.03	0.1	0.0002	0.002	0.002	19	0.0003	0.0006	19
SF Pier 92	C020	44,238	1,923	5	0.01	0.06	0.2	0.0004	0.005	0.003	39	0.0005	0.0012	40
SF Pier 92	C021	44,238	1,923	10	0.02	0.09	0.4	0.0008	0.009	0.006	72	0.0008	0.0023	73
SF Pier 92	C023	43,746	1,902	5	0.01	0.06	0.2	0.0004	0.005	0.003	39	0.0005	0.0011	39
SF Pier 92	C025	43,746	1,902	10	0.02	0.09	0.4	0.0008	0.009	0.006	72	0.0008	0.0023	72
SF Pier 92	C015	19,087	830	5	0.01	0.03	0.1	0.0002	0.002	0.001	17	0.0002	0.0005	17
SF Pier 92	C016	18,035	784	5	0.01	0.03	0.1	0.0002	0.002	0.001	16	0.0002	0.0005	16
Total		2,520,528	97,941		0.92	4.5	18	0.037	0.44	0.30	3,416	0.039	0.108	3,450

Table P.17
Project Haul Truck Trips and Emissions: 2015
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Abbreviations:

µm - micrometer	NOx - nitrogen oxides
CARB - California Air Resources Board	N_2O - nitrous oxide
CH_4 - methane	PM_{10} - particulate matter having a diameter $\leq$ 10 µm
CO - carbon monoxide	$PM_{2.5}$ - particulate matter having a diameter $\leq$ 2.5 µm
CO_2 - carbon dioxide	ROG - reactive organic gases
CO_2e - carbon dioxide equivalent	SO_x - sulfur oxides
EMFAC - EMission FACtors Model	yr - year

Notes:

1. Sand delivered to each customer are approximations provided by Hanson. Mass do not include material offloaded from barge directly at customer site.
2. Round trips calculated by dividing the annual sand delivery to each customer by the average truck capacity of 23 tons.
3. One way trip length was the Google Maps recommended route from the alternative provider to the customer.
4. Annual emissions were calculated based on the methodology described in previous tables.
5. CO_2 emissions were calculated using the CO_2-Pavley emission factor presented in EMFAC 2011. This emission factor accounts for reductions in greenhouse gas (GHG) emissions expected as a result of California Assembly Bill 1493 ("Pavley"), which requires GHG reductions in new passenger vehicles from 2009 through 2016.
6. CO_2e emissions include the sum of CO_2, CH_4, and N_2O multiplied by their respective global warming potentials, as follows: $CO_2e = (CO_2 \times 1) + (CH_4 \times 21) + (N_2O \times 310)$. Global warming potentials are from Appendix E of California Air Resources Board's (CARB's) Local Government Operations Protocol (LGOP). As specified in the Protocol, the Intergovernmental Panel on Climate Change (IPCC)'s Second Assessment Report (SAR) global warming potentials are still used by international convention and in the United States, and are therefore used here.

Sources:

CARB LGOP, Version 1.1. Appendix G. Accessed October 2013. Available at: http://www.arb.ca.gov/cc/protocols/localgov/pubs/lgo_protocol_v1_1_2010-05-03.pdf

Table P.18

Project Haul Truck Trips and Emissions: 2024

Hanson Marine Operations and Jerico Products, Inc.

San Francisco Bay Area

Alternative Provider	Customer ID	Sand Delivered (tons/yr)[1]	Number of Round Trips (trips/yr)[2]	One Way Trip Length (miles)[3]	Emissions (tons/yr)[4]						Emissions (tonnes/yr)[4,5,6]			
					ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
Collinsville	C029	2,333	102	5	0.00	0.00	0.0	0.0000	0.000	0.000	2	0.0000	0.0001	2
Collinsville	C030	73,980	3,216	36	0.07	0.33	0.6	0.0043	0.043	0.026	370	0.0029	0.0138	375
Collinsville	C031	8,216	358	50	0.01	0.05	0.1	0.0007	0.007	0.004	57	0.0004	0.0021	58
Oakland	C014	42,285	1,838	5	0.01	0.06	0.1	0.0004	0.003	0.002	34	0.0005	0.0011	35
Oakland	C001	138,721	6,031	32	0.12	0.55	1.0	0.0071	0.071	0.043	612	0.0049	0.0228	619
Oakland	C002	300,932	13,084	8	0.10	0.52	0.7	0.0041	0.037	0.023	351	0.0043	0.0119	354
Oakland	C003	6,796	295	30	0.01	0.03	0.0	0.0003	0.003	0.002	28	0.0002	0.0010	28
Oakland	C013	63,277	0	0	0.00	0.00	0.0	0.0000	0.000	0.000	0	0.0000	0.0000	0
Oakland	C018	110,633	4,810	0	0.02	0.11	0.1	0.0002	0.001	0.001	20	0.0008	0.0002	20
Oakland	C024	54,474	2,368	5	0.02	0.08	0.1	0.0005	0.005	0.003	44	0.0006	0.0014	45
Oakland	C008	59,798	2,600	28	0.05	0.22	0.4	0.0028	0.027	0.016	235	0.0019	0.0087	238
Oakland	C011	100,049	4,350	6	0.03	0.16	0.2	0.0011	0.010	0.006	95	0.0013	0.0031	96
Oakland	C012	110,359	4,798	2	0.02	0.13	0.1	0.0005	0.003	0.002	39	0.0010	0.0009	39
Oakland	C009	153,628	6,679	26	0.11	0.53	1.0	0.0065	0.064	0.039	559	0.0047	0.0207	566
Oakland	C010	40,869	1,777	17	0.02	0.10	0.2	0.0011	0.011	0.007	97	0.0009	0.0035	98
Oakland	C017	21,648	941	8	0.01	0.04	0.1	0.0003	0.003	0.002	26	0.0003	0.0009	26
SF Pier 92	C007	582,300	19,410	0	0.08	0.46	0.4	0.0009	0.003	0.002	80	0.0034	0.0007	80
SF Pier 92	C026	9,817	427	5	0.00	0.01	0.0	0.0001	0.001	0.000	8	0.0001	0.0003	8
SF Pier 92	C006	81,942	3,563	10	0.03	0.16	0.2	0.0014	0.013	0.008	119	0.0013	0.0041	120
SF Pier 92	C004	294,372	9,812	0	0.04	0.23	0.2	0.0005	0.002	0.001	40	0.0017	0.0004	40
SF Pier 92	C005	29,895	1,300	10	0.01	0.06	0.1	0.0005	0.005	0.003	43	0.0005	0.0015	44
SF Pier 92	C022	21,114	918	5	0.01	0.03	0.0	0.0002	0.002	0.001	17	0.0003	0.0005	17
SF Pier 92	C020	44,238	1,923	5	0.01	0.06	0.1	0.0004	0.004	0.002	36	0.0005	0.0011	36
SF Pier 92	C021	44,238	1,923	10	0.02	0.09	0.1	0.0008	0.007	0.004	66	0.0007	0.0023	67
SF Pier 92	C023	43,746	1,902	5	0.01	0.06	0.1	0.0004	0.004	0.002	36	0.0005	0.0011	36
SF Pier 92	C025	43,746	1,902	10	0.02	0.08	0.1	0.0008	0.007	0.004	65	0.0007	0.0023	66
SF Pier 92	C015	19,087	830	5	0.01	0.03	0.0	0.0002	0.002	0.001	16	0.0002	0.0005	16
SF Pier 92	C016	18,035	784	5	0.01	0.03	0.0	0.0002	0.001	0.001	15	0.0002	0.0005	15
Total		2,520,528	97,941		0.83	4.2	6.3	0.036	0.34	0.20	3,109	0.035	0.108	3,143

Table P.18
Project Haul Truck Trips and Emissions: 2024
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Abbreviations:

µm - micrometer
CARB - California Air Resources Board
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
EMFAC - EMission FACtors Model
NOx - nitrogen oxides
N_2O - nitrous oxide
PM_{10} - particulate matter having a diameter ≤ 10 µm
$PM_{2.5}$ - particulate matter having a diameter ≤ 2.5 µm
ROG - reactive organic gases
SO_x - sulfur oxides
yr - year

Notes:

1. Sand delivered to each customer are approximations provided by Hanson. Mass do not include material offloaded from barge directly at customer site.
2. Round trips calculated by dividing the annual sand delivery to each customer by the average truck capacity of 23 tons.
3. One way trip length was the Google Maps recommended route from the alternative provider to the customer.
4. Annual emissions were calculated based on the methodology described in previous tables.
5. CO_2 emissions were calculated using the CO_2-Pavley emission factor presented in EMFAC 2011. This emission factor accounts for reductions in greenhouse gas (GHG) emissions expected as a result of California Assembly Bill 1493 ("Pavley"), which requires GHG reductions in new passenger vehicles from 2009 through 2016.
6. CO_2e emissions include the sum of CO_2, CH_4, and N_2O multiplied by their respective global warming potentials, as follows: $CO_2e = (CO_2 \times 1) + (CH_4 \times 21) + (N_2O \times 310)$. Global warming potentials are from Appendix E of California Air Resources Board's (CARB's) Local Government Operations Protocol (LGOP). As specified in the Protocol, the Intergovernmental Panel on Climate Change (IPCC)'s Second Assessment Report (SAR) global warming potentials are still used by international convention and in the United States, and are therefore used here.

Sources:

CARB LGOP, Version 1.1. Appendix G. Accessed October 2013. Available at: http://www.arb.ca.gov/cc/protocols/localgov/pubs/lgo_protocol_v1_1_2010-05-03.pdf

Table P.19
Project Haul Truck Trip Emissions Summary
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Year	VMT	Emissions (tons/yr)						Emissions (tonnes/yr)			
	miles/yr	ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
2014	879,836	0.48	2.3	10	0.02	0.26	0.19	1,681	0.02	0.05	1,698
2015	1,800,071	0.92	4.5	18.2	0.04	0.44	0.30	3,416	0.04	0.11	3,450
2024	1,800,071	0.83	4.2	6.3	0.04	0.34	0.20	3,109	0.04	0.11	3,143

Abbreviations:

µm - micrometer
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
NOx - nitrogen oxides
N_2O - nitrous oxide
PM_{10} - particulate matter having a diameter ≤ 10 µm
$PM_{2.5}$ - particulate matter having a diameter ≤ 2.5 µm
ROG - reactive organic gases
SOx - sulfur oxides
VMT - vehicle miles traveled
yr - year

Table NP.1
No Project: Overview of Emissions Calculation Methodology
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Activity[1]		Equipment	Activity Data[3]	Emission Factor[3]
Sand Mining and Production	Marine Sand Mining (Dredging, Cruising, Offloading)[2]	barges, tugs, loaders	N/A	
	Land-Based Sand Production	off-road equipment, electric equipment	Sunol EIR, scaled based on tons of sand (1.2 MM TPY Sunol EIR, 2.856 TPY No Project)	CalEEMod and CARB OFFROAD 2011, PG&E electricity emission factor, adjusted for RPS
Material Movement at Offloading Sites	Material Movement at Offloading Sites	loader, electric equipment	N/A	
Transport of Sand to Customers	via Haul Truck (in SF Bay Area)	haul trucks	Hanson and Jerico	CARB EMFAC 2011
	via Barge and Tug - from DI Aggregates (Decker Island) to Shamrock (Petaluma) - from SF Bay Anchorages 8/9 to Shamrock (Petaluma)	barges, tugs, loaders	Hanson and Jerico	CARB Emissions Databases: Harbor Craft Emissions Inventory, OFFROAD 2007 and 2011
	via Ocean-Going Vessel (British Columbia to SF Bay Area)	ocean-going vessels	CSL Trillium Class specifications, assumptions based on publically-available data	CARB Marine Emissions Model

Abbreviations:
CalEEMod - California Emissions Estimator Model
CARB - California Air Resources Board
CSL - Canada Steamship Lines
EMFAC - EMission FACtors Model
MM - million
N/A - not applicable
PG&E - Pacific Gas and Electric
RPS - Renewables Portfolio Standard
Sunol EIR - Lamphier-Gregory 2012 Draft Environmental Impact Report: SMP-30 Revised Use Permit Sunol Valley Aggregate Quarry Project. (Consistent with the Final EIR, published June 2012.)
TPY - tons per year

Notes:
1. Emissions-generating activities associated with the mining and delivery of sand for all scenarios, as discussed with Hanson Marine Operations and Jerico Products, Inc.
2. This includes cruising and offloading emissions associated with Jerico delivering sand to three customers directly via barge and tug (Shamrock in Petaluma, Syar Industries in Napa, and the Collinsville Plant).
3. Emissions are calculated as: Emissions = Activity Data x Emission Factor.

Sources:

California Air Resources Board (CARB). Harbor Craft Emissions Inventory Database; available at http://www.arb.ca.gov/msei/categories.htm#chc_category
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Pacific Gas and Electric (PG&E). 2008 Power/Utility Protocol (PUP) Report. http://www.climateregistry.org/tools/carrot/carrot-public-reports.html.

Table NP.2
No Project Land-Based Sand Production Facility Off-Road Equipment Emission Factors
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Project Year	Equipment[1]	OFFROAD2011 Equipment Name[1]	Horsepower[1]	Emission Factors (g/bhp-hr)[2]							
				ROG	CO	NOx	SO_2	PM_{10}	$PM_{2.5}$	CO_2	CH_4
2014	Blade 14H	Graders	215	0.39	1.5	5.7	4.9E-03	0.19	0.17	522	0.15
	Bobcat	Rubber Tired Loaders	61	0.87	4.3	7.1	4.8E-03	0.62	0.57	510	0.15
	Crane 50 Ton	Cranes	215	0.66	2.7	7.9	4.9E-03	0.36	0.33	518	0.15
	Dozer D 10	Crawler Tractors	570	0.35	1.7	4.9	4.9E-03	0.18	0.16	518	0.15
	Loader 988 H	Rubber Tired Loaders	430	0.42	2.4	5.2	4.8E-03	0.20	0.18	513	0.15
	Scraper 657	Scrapers	1,045	0.37	2.8	5.0	4.9E-03	0.19	0.17	517	0.15
	Water Truck	Off-Highway Trucks	479	0.39	2.1	4.7	4.9E-03	0.18	0.17	521	0.15
2015	Blade 14H	Graders	215	0.40	1.5	5.7	4.9E-03	0.19	0.17	517	0.15
	Bobcat	Rubber Tired Loaders	61	0.86	4.3	7.0	4.8E-03	0.61	0.56	505	0.15
	Crane 50 Ton	Cranes	215	0.64	2.7	7.6	4.9E-03	0.35	0.32	512	0.15
	Dozer D 10	Crawler Tractors	570	0.35	1.7	4.9	4.9E-03	0.18	0.16	513	0.15
	Loader 988 H	Rubber Tired Loaders	430	0.42	2.3	5.0	4.8E-03	0.19	0.17	506	0.15
	Scraper 657	Scrapers	1,045	0.36	2.7	4.8	4.9E-03	0.18	0.17	512	0.15
	Water Truck	Off-Highway Trucks	479	0.38	2.0	4.5	4.9E-03	0.17	0.16	516	0.15
2024	Blade 14H	Graders	215	0.26	1.2	3.1	4.9E-03	0.10	0.09	474	0.15
	Bobcat	Rubber Tired Loaders	61	0.40	3.8	3.3	4.8E-03	0.22	0.20	467	0.15
	Crane 50 Ton	Cranes	215	0.28	1.5	3.0	4.9E-03	0.12	0.11	473	0.15
	Dozer D 10	Crawler Tractors	570	0.18	1.2	1.8	4.9E-03	0.07	0.06	472	0.15
	Loader 988 H	Rubber Tired Loaders	430	0.21	1.4	1.7	4.8E-03	0.06	0.06	469	0.15
	Scraper 657	Scrapers	1,045	0.21	1.5	2.2	4.9E-03	0.08	0.07	471	0.15
	Water Truck	Off-Highway Trucks	479	0.18	1.2	1.2	4.9E-03	0.04	0.04	475	0.15

Abbreviations:

µm = micrometer
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
g/bhp-hr - grams per brake horsepower hour
MM - million
NOx - nitrogen oxides
PM_{10} - particulate matter having a diameter $\leq$ 10 µm
$PM_{2.5}$ - particulate matter having a diameter $\leq$ 2.5 µm
ROG - reactive organic gases
SO_2 - sulfur dioxide

Notes:

1. Equipment details were presented in the Draft Environmental Impact Report (EIR) for the Sunol Valley Aggregate Quarry Project. Appendix C Air Quality Table A.12 details the equipment necessary for production of 1.2 MM tons per year aggregate (baseline scenario).
2. Emission factors were obtained from Table 3.4 of supporting Appendix D for the California Emission Estimator Model (CalEEMod).

Sources:

Lamphier - Gregory. 2012. SMP-30 Revised Use Permit Sunol Valley Aggregate Quarry Project: Draft Environmental Impact Report. April. (Final EIR published June 2012.)

CalEEMod. 2013. California Emission Estimator Model (CalEEMod): Appendix D - Default Data Tables. September. Available online at: http://www.caleemod.com/

Table NP.3
No Project Land-Based Sand Production Facility Off-Road Equipment Emissions
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Project Year[1]	Equipment[2]	Horsepower[2]	Load Factor[2]	Quantity[2]	Hours of Operation (per Equipment)[2]	Emissions (tons/yr)[3]						Emissions (tonnes/yr)[3,4]		
						ROG	CO	NOx	SO_2	PM_{10}	$PM_{2.5}$	CO_2	CH_4	CO_2e
2014	Blade 14H	215	0.4087	1	1,500	0.06	0.21	0.83	7.1E-04	0.027	0.025	76	0.02	76
	Bobcat	61	0.3618	3	2,000	0.13	0.62	1.04	7.0E-04	0.090	0.083	74	0.02	75
	Crane 50 Ton	215	0.2881	1	200	0.01	0.04	0.11	6.7E-05	0.005	0.005	7	0.00	7
	Dozer D 10	570	0.4288	1	500	0.05	0.23	0.66	6.6E-04	0.024	0.022	70	0.02	70
	Loader 988 H	430	0.3618	3	2,000	0.43	2.48	5.34	4.9E-03	0.201	0.185	527	0.16	531
	Scraper 657	1045	0.4824	2	2,000	0.82	6.33	11.14	1.1E-02	0.421	0.388	1,150	0.34	1,157
	Water Truck	479	0.3819	1	2,000	0.16	0.84	1.89	2.0E-03	0.072	0.067	210	0.06	211
	Total					1.7	11	21	0.02	0.84	0.77	2,115	0.62	2,128
2015	Blade 14H	215	0.4087	1	1,500	0.06	0.21	0.83	7.1E-04	0.027	0.025	68	0.02	69
	Bobcat	61	0.3618	3	2,000	0.12	0.62	1.02	7.0E-04	0.088	0.081	67	0.02	67
	Crane 50 Ton	215	0.2881	1	200	0.01	0.04	0.10	6.7E-05	0.005	0.004	6	0.00	6
	Dozer D 10	570	0.4288	1	500	0.05	0.22	0.66	6.6E-04	0.024	0.022	63	0.02	63
	Loader 988 H	430	0.3618	3	2,000	0.43	2.40	5.16	4.9E-03	0.195	0.179	473	0.14	476
	Scraper 657	1045	0.4824	2	2,000	0.80	5.97	10.75	1.1E-02	0.404	0.372	1,033	0.31	1,039
	Water Truck	479	0.3819	1	2,000	0.16	0.82	1.83	2.0E-03	0.070	0.064	189	0.06	190
	Total					1.6	10	20	0.02	0.81	0.75	1,898	0.57	1,910
2024	Blade 14H	215	0.4087	1	1,500	0.04	0.18	0.45	7.1E-04	0.014	0.013	62	0.02	63
	Bobcat	61	0.3618	3	2,000	0.06	0.56	0.49	7.0E-04	0.032	0.030	62	0.02	62
	Crane 50 Ton	215	0.2881	1	200	0.00	0.02	0.04	6.7E-05	0.002	0.002	6	0.00	6
	Dozer D 10	570	0.4288	1	500	0.02	0.16	0.24	6.6E-04	0.009	0.008	58	0.02	58
	Loader 988 H	430	0.3618	3	2,000	0.22	1.39	1.75	4.9E-03	0.065	0.060	437	0.14	440
	Scraper 657	1045	0.4824	2	2,000	0.47	3.25	4.86	1.1E-02	0.179	0.165	951	0.31	957
	Water Truck	479	0.3819	1	2,000	0.07	0.49	0.50	2.0E-03	0.018	0.016	174	0.06	175
	Total					0.89	6.0	8.3	0.02	0.32	0.29	1,750	0.57	1,762

Abbreviations:

µm - micrometer
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
g/hp-hr - grams per horsepower hour
MM - million
NOx - nitrogen oxides
PM_{10} - particulate matter having a diameter ≤ 10 µm
$PM_{2.5}$ - particulate matter having a diameter ≤ 2.5 µm
ROG - reactive organic gases
SO_2 - sulfur dioxide
yr - year

Notes:

1. This analysis is for the proposed period of sand mining from 2014 to 2024.
2. Equipment details were presented in the Draft Environmental Impact Report (EIR) for the Sunol Valley Aggregate Quarry Project. Appendix C Air Quality Table A.12 details the equipment necessary for production of 1.2 MM tons per year aggregate (baseline scenario).
3. Emissions were estimated as follows: E = EF * HP * LF * Hr * Q * C

    where,

    EF = emission factor [g/hp-hr] as shown in the previous table

    HP = equipment horsepower as provided in Sunol Valley Aggregate Quarry Project Draft EIR

    LF = equipment load factor provided in Sunol Valley Aggregate Quarry Project Draft EIR

    Hr = equipment hours provided in Sunol Valley Aggregate Quarry Project Draft EIR

    Q = equipment quantity

    C = conversion constants
4. CO_2e emissions include the sum of CO_2 and CH_4 emissions multiplied by their respective global warming potentials, as follows: $CO_2e = (CO_2 \times 1) + (CH_4 \times 21)$. Global warming potentials are fromAppendix E of California Air Resources Board's (CARB's) Local Government Operations Protocol. As specified in the Protocol, the Intergovernmental Panel on Climate Change (IPCC)'s Second Assessment Report (SAR) global warming potentials are still used by international convention and in the United States, and are therefore used here.

Sources:

Lamphier - Gregory. 2012. SMP-30 Revised Use Permit Sunol Valley Aggregate Quarry Project: Draft Environmental Impact Report. April. (Final EIR published June 2012.)

Table NP.4
No Project Land-Based Sand Production Facility Electrical Equipment Emissions
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Year	Source[1]	Electricity Usage	Emission Factors (tones/kWh)[2]			Emissions (tonnes/yr)[3]			
		kWh	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O	CO_2e
2014	Aggregate Plant	9,025,898	2.6E-04	1.4E-08	4.3E-09	2,386	0.1	0.0389	2,401
2015	Aggregate Plant	9,025,898	2.6E-04	1.4E-08	4.3E-09	2,386	0.1	0.0389	2,401
2024	Aggregate Plant	9,025,898	2.2E-04	1.4E-08	4.3E-09	1,998	0.1	0.0389	2,013

Abbreviations:

CARB - California Air Resources Board
CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
kWh - kilowatt-hour
N_2O - nitrous oxide
PG&E - Pacific Gas and Electric Company
yr - year

Notes:

1. The electricity usage provided is as calculated for the aggregate plant presented in the Sunol de Silva draft Environmental Impact Report (EIR) (final published June 2012).

2. CH_4 and N_2O emission factors are the average of 2006 and 2007 emission factors from the California Air Resources Board (CARB) Local Goverrnment Operations Protocol (LGOP), Table G.7. The emission factor for CO_2 is as presented in a previous table.

3. CO_2e emissions include the sum of CO_2, CH_4, and N_2O multiplied by their respective global warming potentials, as follows: $CO_2e = (CO_2 \text{ x } 1) + (CH_4 \text{ x } 21) + (N_2O \text{ x } 310)$. Global warming potentials are from Appendix E of California Air Resources Board's (CARB's) Local Government Operations Protocol (LGOP). As specified in the Protocol, the Intergovernmental Panel on Climate Change (IPCC)'s Second Assessment Report (SAR) global warming potentials are still used by international convention and in the United States, and are therefore used here.

Sources:

CARB LGOP, Version 1.1. Appendix G. Accessed October 2013. Available at: http://www.arb.ca.gov/cc/protocols/localgov/pubs/lgo_protocol_v1_1_2010-05-03.pdf

Lamphier - Gregory. 2012. SMP-30 Revised Use Permit Sunol Valley Aggregate Quarry Project: Draft Environmental Impact Report. April. (Final EIR published June 2012.)

PG&E. 2008. Power/Utility Protocol (PUP) Report. Available online at: https://www.climateregistry.org/CARROT/public/reports.aspx

Table NP.5
No Project Land-Based Sand Production Facility Emissions Summary
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Project Year[1]	Aggregate Production (MM tons/yr)[2]	Emission Source	Emissions (tons/yr)[3,4]						Emissions (tonnes/yr)[4,5]			
			ROG	CO	NOx	SO_2	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
2014	1.2	Aggregate Plant	N/A	N/A	N/A	N/A	2.4	0.26	2,386	0.12	0.039	2,401
		Off Road Equipment	1.7	11	21	0.020	0.84	0.77	2,115	0.62	0	2,128
		Total	1.7	11	21	0.020	3.2	1.0	4,501	0.75	0.039	4,528
	1.4	Total	1.9	12	24	0.023	3.8	1.2	5,227	0.9	0.045	5,259
2015	1.2	Aggregate Plant	N/A	N/A	N/A	N/A	2.4	0.26	2,386	0.12	0.039	2,401
		Off Road Equipment	1.6	10	20	0.020	0.81	0.75	1,898	0.57	0	1,910
		Total	1.6	10	20	0.020	3.2	1.0	4,284	0.69	0.039	4,310
	2.9	Total	3.9	24	48	0.047	7.6	2.4	10,196	1.6	0.093	10,259
2024	1.2	Aggregate Plant	N/A	N/A	N/A	N/A	2.4	0.26	1,998	0.12	0.039	2,013
		Off Road Equipment	0.89	6.0	8.3	0.020	0.32	0.29	1,750	0.57	0	1,762
		Total	0.89	6.0	8.3	0.020	2.7	0.55	3,748	0.69	0.039	3,774
	2.9	Total	2.1	14	20	0.047	6.5	1.3	8,920	1.6	0.093	8,983

Abbreviations:

µm = micrometer
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
MM - million
N/A - not applicable
N_2O - nitrous oxide
NOx - nitrogen oxides
PM_{10} - particulate matter having a diameter $\leq$ 10 µm
$PM_{2.5}$ - particulate matter having a diameter $\leq$ 2.5 µm
ROG - reactive organic gases
SO_2 - sulfur dioxide
yr - year

Notes:

1. This analysis is for the proposed period of sand mining from 2014 to 2024.
2. Aggregate production for the Sunol Valley Aggregate Quarry baseline scenario is listed at 1.2 million tons/year. The alternative providers are expected to replace the sand mining production rate of 2.856 million tons/year.
3. Criteria emissions associated with the aggregate plant including crushing and screening operations were presented in Appendix C Table A.1 of the Draft Environmental Impact Report (EIR) for the Sunol Valley Aggregate Quarry Project.
4. Pollutant emissions from off road equipment are presented in previous tables.
5. Greenhouse Gas (GHG) emissions associated with the aggregate plant are as presented for the baseline scenario in Appendix D Table A.2. Emission factors for all GHG pollutants are as presented in Table A.1. Emissions for 2024 from electricity usage emissions in the aggregate plant were calculated from 2015 electricity usage emissions by assuming a CO_2e reduction of 33%, consistent with the California's renewable energy standard for years beyond 2020.

Sources:

Lamphier - Gregory. 2012. SMP-30 Revised Use Permit Sunol Valley Aggregate Quarry Project: Draft Environmental Impact Report. April. (Final EIR published June 2012.)
Senate Bill No. 107. Approved by Governor September 26, 2006

Table NP.6
No Project Haul Truck Trips and Emissions: 2014
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Alternative Provider	Customer ID	Scenario	Sand Delivered (tons/yr)[1]	Number of Round Trips (trips/yr)[2]	One Way Trip Length (miles)[3]	Emissions (tons/yr)[4]						Emissions (tonnes/yr)[4,5,6]			
						ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
British Columbia	C007	2014 Alternative	182,839	7,950	0	0.03	0.15	0.4	0.0004	0.003	0.003	36	0.0012	0.0003	36
British Columbia	C006	2014 Alternative	25,729	1,119	10	0.01	0.06	0.3	0.0004	0.006	0.005	42	0.0005	0.0013	42
British Columbia	C004	2014 Alternative	92,431	4,019	0	0.01	0.08	0.2	0.0002	0.002	0.001	18	0.0006	0.0001	18
British Columbia	C005	2014 Alternative	9,387	408	10	0.00	0.02	0.1	0.0002	0.002	0.002	15	0.0002	0.0005	15
British Columbia	C027	2014 Alternative	22,332	0	0	0.00	0.00	0.0	0.0000	0.000	0.000	0	0.0000	0.0000	0
Brownsand	C003	2014 Alternative	3,048	133	32	0.00	0.02	0.1	0.0002	0.002	0.002	15	0.0002	0.0005	15
Brownsand	C009	2014 Alternative	68,912	2,996	34	0.08	0.39	2.0	0.0038	0.057	0.041	358	0.0036	0.0121	362
Cemex - Pleasanton	C007	2014 Alternative	10,448	454	58	0.02	0.10	0.5	0.0010	0.015	0.011	92	0.0009	0.0031	93
Cemex - Pleasanton	C014	2014 Alternative	2,529	110	34	0.00	0.01	0.1	0.0001	0.002	0.002	13	0.0001	0.0004	13
Cemex - Pleasanton	C026	2014 Alternative	587	26	59	0.00	0.01	0.0	0.0001	0.001	0.001	5	0.0001	0.0002	5
Cemex - Pleasanton	C006	2014 Alternative	1,470	64	50	0.00	0.01	0.1	0.0001	0.002	0.001	11	0.0001	0.0004	11
Cemex - Pleasanton	C002	2014 Alternative	17,998	783	37	0.02	0.11	0.6	0.0011	0.017	0.012	103	0.0010	0.0035	104
Cemex - Pleasanton	C004	2014 Alternative	5,282	230	58	0.01	0.05	0.3	0.0005	0.008	0.005	47	0.0004	0.0016	47
Cemex - Pleasanton	C005	2014 Alternative	536	23	50	0.00	0.00	0.0	0.0000	0.001	0.000	4	0.0000	0.0001	4
Cemex - Pleasanton	C013	2014 Alternative	3,784	165	30	0.00	0.02	0.1	0.0002	0.003	0.002	18	0.0002	0.0006	18
Cemex - Pleasanton	C020	2014 Alternative	2,646	115	59	0.01	0.03	0.1	0.0003	0.004	0.003	24	0.0002	0.0008	24
Cemex - Pleasanton	C021	2014 Alternative	2,646	115	50	0.00	0.02	0.1	0.0002	0.003	0.002	20	0.0002	0.0007	21
Cemex - Pleasanton	C018	2014 Alternative	6,617	288	30	0.01	0.03	0.2	0.0003	0.005	0.004	31	0.0003	0.0010	31
Cemex - Pleasanton	C024	2014 Alternative	3,258	142	25	0.00	0.01	0.1	0.0001	0.002	0.001	13	0.0001	0.0004	13
Cemex - Pleasanton	C011	2014 Alternative	5,984	260	25	0.01	0.03	0.1	0.0003	0.004	0.003	23	0.0002	0.0008	24
Cemex - Pleasanton	C012	2014 Alternative	6,600	287	32	0.01	0.04	0.2	0.0003	0.005	0.004	33	0.0003	0.0011	33
Cemex - Pleasanton	C010	2014 Alternative	2,444	106	32	0.00	0.01	0.1	0.0001	0.002	0.001	12	0.0001	0.0004	12
Cemex - Pleasanton	C017	2014 Alternative	1,295	56	37	0.00	0.01	0.0	0.0001	0.001	0.001	7	0.0001	0.0003	7
DI Aggregates - Antioch	C027	2014 Alternative	45,422	0	0	0.00	0.00	0.0	0.0000	0.000	0.000	0	0.0000	0.0000	0
DI Aggregates - Mare Island	C027	2014 Alternative	45,422	0	0	0.00	0.00	0.0	0.0000	0.000	0.000	0	0.0000	0.0000	0
Hanson Aggregates - Sunol	C007	2014 Alternative	10,448	454	51	0.019	0.09	0.46	8.8E-04	0.013	0.009	82	7.9E-04	2.8E-03	83
Hanson Aggregates - Sunol	C014	2014 Alternative	2,529	110	34	0.003	0.01	0.08	1.4E-04	0.002	0.002	13	1.3E-04	4.5E-04	13
Hanson Aggregates - Sunol	C026	2014 Alternative	587	26	53	0.001	0.01	0.03	5.2E-05	0.001	0.001	5	4.7E-05	1.7E-04	5
Hanson Aggregates - Sunol	C006	2014 Alternative	1,470	64	44	0.002	0.01	0.06	1.1E-04	0.002	0.001	10	9.7E-05	3.4E-04	10
Hanson Aggregates - Sunol	C001	2014 Alternative	62,225	2,705	38	0.086	0.40	2.08	3.9E-03	0.059	0.042	369	3.6E-03	1.2E-02	373
Hanson Aggregates - Sunol	C002	2014 Alternative	17,998	783	37	0.024	0.11	0.58	1.1E-03	0.016	0.012	103	1.0E-03	3.5E-03	104
Hanson Aggregates - Sunol	C004	2014 Alternative	5,282	230	51	0.010	0.04	0.23	4.5E-04	0.007	0.005	42	4.0E-04	1.4E-03	42
Hanson Aggregates - Sunol	C005	2014 Alternative	536	23	44	0.001	0.00	0.02	3.8E-05	0.001	0.000	4	3.5E-05	1.2E-04	4
Hanson Aggregates - Sunol	C013	2014 Alternative	3,784	165	30	0.004	0.02	0.10	1.9E-04	0.003	0.002	18	1.8E-04	6.0E-04	18
Hanson Aggregates - Sunol	C020	2014 Alternative	2,646	115	53	0.005	0.02	0.12	2.3E-04	0.003	0.002	22	2.1E-04	7.3E-04	22
Hanson Aggregates - Sunol	C021	2014 Alternative	2,646	115	44	0.004	0.02	0.10	1.9E-04	0.003	0.002	18	1.8E-04	6.1E-04	18
Hanson Aggregates - Sunol	C018	2014 Alternative	6,617	288	30	0.007	0.03	0.18	3.3E-04	0.005	0.004	31	3.1E-04	1.0E-03	31
Hanson Aggregates - Sunol	C024	2014 Alternative	3,258	142	25	0.003	0.01	0.07	1.4E-04	0.002	0.001	13	1.3E-04	4.3E-04	13

Table NP.6
No Project Haul Truck Trips and Emissions: 2014
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Alternative Provider	Customer ID	Scenario	Sand Delivered (tons/yr)[1]	Number of Round Trips (trips/yr)[2]	One Way Trip Length (miles)[3]	Emissions (tons/yr)[4]						Emissions (tonnes/yr)[4,5,6]			
						ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
Hanson Aggregates - Sunol	C008	2014 Alternative	26,823	1,166	35	0.034	0.16	0.82	1.6E-03	0.023	0.017	145	1.4E-03	4.9E-03	147
Hanson Aggregates - Sunol	C011	2014 Alternative	5,984	260	25	0.006	0.03	0.13	2.5E-04	0.004	0.003	23	2.4E-04	7.8E-04	24
Hanson Aggregates - Sunol	C012	2014 Alternative	6,600	287	32	0.008	0.04	0.18	3.5E-04	0.005	0.004	32	3.2E-04	1.1E-03	33
Hanson Aggregates - Sunol	C010	2014 Alternative	2,444	106	21	0.002	0.01	0.05	8.7E-05	0.001	0.001	8	8.6E-05	2.7E-04	8
Hanson Aggregates - Sunol	C017	2014 Alternative	1,295	56	37	0.002	0.01	0.04	7.9E-05	0.001	0.001	7	7.3E-05	2.5E-04	7
Sunol Aggregates	C007	2014 Alternative	10,448	454	54	0.020	0.09	0.48	9.2E-04	0.014	0.010	86	8.3E-04	2.9E-03	87
Sunol Aggregates	C014	2014 Alternative	2,529	110	34	0.003	0.01	0.08	1.4E-04	0.002	0.002	13	1.3E-04	4.5E-04	13
Sunol Aggregates	C026	2014 Alternative	587	26	56	0.001	0.01	0.03	5.5E-05	0.001	0.001	5	4.9E-05	1.8E-04	5
Sunol Aggregates	C006	2014 Alternative	1,470	64	46	0.002	0.01	0.06	1.1E-04	0.002	0.001	10	1.0E-04	3.5E-04	11
Sunol Aggregates	C002	2014 Alternative	17,998	783	37	0.024	0.11	0.58	1.1E-03	0.016	0.012	102	1.0E-03	3.4E-03	103
Sunol Aggregates	C004	2014 Alternative	5,282	230	54	0.010	0.05	0.24	4.7E-04	0.007	0.005	44	4.2E-04	1.5E-03	44
Sunol Aggregates	C005	2014 Alternative	536	23	46	0.001	0.00	0.02	4.0E-05	0.001	0.000	4	3.7E-05	1.3E-04	4
Sunol Aggregates	C013	2014 Alternative	3,784	165	30	0.004	0.02	0.10	1.9E-04	0.003	0.002	18	1.8E-04	5.9E-04	18
Sunol Aggregates	C020	2014 Alternative	2,646	115	56	0.005	0.02	0.13	2.4E-04	0.004	0.003	23	2.2E-04	7.7E-04	23
Sunol Aggregates	C021	2014 Alternative	2,646	115	46	0.004	0.02	0.11	2.0E-04	0.003	0.002	19	1.8E-04	6.4E-04	19
Sunol Aggregates	C018	2014 Alternative	6,617	288	30	0.007	0.03	0.18	3.3E-04	0.005	0.004	31	3.1E-04	1.0E-03	31
Sunol Aggregates	C024	2014 Alternative	3,258	142	25	0.003	0.01	0.07	1.4E-04	0.002	0.001	13	1.3E-04	4.3E-04	13
Sunol Aggregates	C011	2014 Alternative	5,984	260	25	0.006	0.03	0.13	2.5E-04	0.004	0.003	23	2.4E-04	7.8E-04	24
Sunol Aggregates	C012	2014 Alternative	6,600	287	31	0.008	0.04	0.18	3.4E-04	0.005	0.004	32	3.2E-04	1.1E-03	33
Sunol Aggregates	C010	2014 Alternative	2,444	106	23	0.002	0.01	0.05	9.6E-05	0.001	0.001	9	9.3E-05	3.0E-04	9
Sunol Aggregates	C017	2014 Alternative	1,295	56	37	0.002	0.01	0.04	7.9E-05	0.001	0.001	7	7.3E-05	2.5E-04	7
Syar - Cache Creek	C028	2014 Alternative	187,824	8,166	49	0.324	1.50	7.90	1.5E-02	0.227	0.162	1,411	1.4E-02	4.8E-02	1,426
Vulcan Materials	C007	2014 Alternative	47,016	2,044	53	0.087	0.40	2.12	4.0E-03	0.061	0.044	379	3.7E-03	1.3E-02	383
Vulcan Materials	C014	2014 Alternative	11,381	495	29	0.012	0.06	0.29	5.5E-04	0.008	0.006	52	5.2E-04	1.7E-03	52
Vulcan Materials	C026	2014 Alternative	2,642	115	54	0.005	0.02	0.12	2.3E-04	0.004	0.003	22	2.1E-04	7.5E-04	22
Vulcan Materials	C006	2014 Alternative	6,616	288	45	0.011	0.05	0.26	4.9E-04	0.007	0.005	46	4.5E-04	1.6E-03	46
Vulcan Materials	C002	2014 Alternative	80,992	3,521	32	0.096	0.45	2.28	4.3E-03	0.064	0.046	402	4.0E-03	1.4E-02	406
Vulcan Materials	C004	2014 Alternative	23,768	1,033	53	0.044	0.20	1.07	2.0E-03	0.031	0.022	192	1.8E-03	6.5E-03	194
Vulcan Materials	C005	2014 Alternative	2,414	105	45	0.004	0.02	0.09	1.8E-04	0.003	0.002	17	1.6E-04	5.7E-04	17
Vulcan Materials	C013	2014 Alternative	17,030	740	25	0.016	0.08	0.38	7.2E-04	0.011	0.008	67	6.9E-04	2.2E-03	68
Vulcan Materials	C020	2014 Alternative	11,906	518	54	0.023	0.10	0.55	1.1E-03	0.016	0.011	99	9.5E-04	3.4E-03	100
Vulcan Materials	C021	2014 Alternative	11,906	518	45	0.019	0.09	0.46	8.8E-04	0.013	0.009	83	8.0E-04	2.8E-03	84
Vulcan Materials	C018	2014 Alternative	29,776	1,295	25	0.029	0.13	0.67	1.3E-03	0.019	0.013	117	1.2E-03	3.9E-03	118
Vulcan Materials	C024	2014 Alternative	14,661	637	20	0.012	0.05	0.27	5.0E-04	0.007	0.005	46	4.9E-04	1.5E-03	47
Vulcan Materials	C011	2014 Alternative	26,927	1,171	20	0.021	0.10	0.49	9.1E-04	0.013	0.010	85	9.0E-04	2.8E-03	86
Vulcan Materials	C012	2014 Alternative	29,702	1,291	27	0.030	0.14	0.71	1.3E-03	0.020	0.014	124	1.3E-03	4.1E-03	125
Vulcan Materials	C010	2014 Alternative	10,999	478	27	0.011	0.05	0.26	4.9E-04	0.007	0.005	46	4.7E-04	1.5E-03	46
Vulcan Materials	C017	2014 Alternative	5,826	253	32	0.007	0.03	0.16	3.1E-04	0.005	0.003	29	2.9E-04	9.8E-04	29

Table NP.6
No Project Haul Truck Trips and Emissions: 2014
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Alternative Provider	Customer ID	Scenario	Sand Delivered (tons/yr)[1]	Number of Round Trips (trips/yr)[2]	One Way Trip Length (miles)[3]	Emissions (tons/yr)[4]						Emissions (tonnes/yr)[4,5,6]			
						ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
West Coast Aggregates	C022	2014 Alternative	9,471	412	27	0.010	0.05	0.23	4.3E-04	0.006	0.005	40	4.1E-04	1.3E-03	40
West Coast Aggregates	C023	2014 Alternative	19,623	853	27	0.020	0.09	0.47	8.8E-04	0.013	0.009	83	8.5E-04	2.8E-03	84
West Coast Aggregates	C025	2014 Alternative	19,623	853	17	0.014	0.06	0.31	5.7E-04	0.008	0.006	53	5.8E-04	1.7E-03	54
West Coast Aggregates	C015	2014 Alternative	8,562	372	27	0.009	0.04	0.21	3.9E-04	0.006	0.004	36	3.7E-04	1.2E-03	37
West Coast Aggregates	C016	2014 Alternative	8,090	352	27	0.008	0.04	0.19	3.6E-04	0.005	0.004	34	3.5E-04	1.1E-03	35
Total		2014 Alternative	1,393,697	55,678		1.4	6	33	0.06	0.9	0.7	5,787	0.06	0.19	5,849

Abbreviations:

µm - micrometer
CARB - California Air Resources Board
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
EMFAC - EMission FACtors Model
N_2O - nitrous oxide
NOx - nitrogen oxides
PM_{10} - particulate matter having a diameter ≤ 10 µm
$PM_{2.5}$ - particulate matter having a diameter ≤ 2.5 µm
ROG - reactive organic gases
SOx - sulfur oxides
yr - year

Notes:

1. Sand volumes delivered to each customer are approximations provided by Hanson.
2. Round trips calculated by dividing the annual sand delivery to each customer by the average truck capacity of 23 tons.
3. One way trip length was the Google Maps recommended route from the alternative provider to the customer.
4. Annual emissions were calculated based on the methodology described in previous tables.
5. CO_2 emissions were calculated using the CO_2-Pavley emission factor presented in EMFAC 2011. This emission factor accounts for reductions in greenhouse gas (GHG) emissions expected as a result of California Assembly Bill 1493 ("Pavley"), which requires GHG reductions in new passenger vehicles from 2009 through 2016.
6. CO_2e emissions include the sum of CO_2, CH_4, and N_2O multiplied by their respective global warming potentials, as follows: $CO_2e = (CO_2 \times 1) + (CH_4 \times 21) + (N_2O \times 310)$. Global warming potentials are from Appendix E of California Air Resources Board's (CARB's) Local Government Operations Protocol (LGOP). As specified in the Protocol, the Intergovernmental Panel on Climate Change (IPCC)'s Second Assessment Report (SAR) global warming potentials are still used by international convention and in the United States, and are therefore used here.

Sources:

CARB LGOP, Version 1.1. Appendix G. Accessed October 2013. Available at: http://www.arb.ca.gov/cc/protocols/localgov/pubs/lgo_protocol_v1_1_2010-05-03.pdf

Table NP.7
No Project Haul Truck Trips and Emissions: 2015
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Alternative Provider	Customer ID	Scenario	Sand Delivered (tons/yr)[1]	Number of Round Trips (trips/yr)[2]	One Way Trip Length (miles)[3]	Emissions (tons/yr)[4]						Emissions (tonnes/yr)[4,5,6]			
						ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
British Columbia	C007	Project Alternative	407,610	17,722	0	0.066	0.35	0.73	8.5E-04	0.005	0.004	79	2.8E-03	6.4E-04	79
British Columbia	C006	Project Alternative	57,359	2,494	10	0.024	0.12	0.48	9.9E-04	0.012	0.008	91	1.0E-03	2.9E-03	92
British Columbia	C004	Project Alternative	206,060	8,959	0	0.033	0.18	0.37	4.3E-04	0.003	0.002	40	1.4E-03	3.2E-04	40
British Columbia	C005	Project Alternative	20,926	910	10	0.009	0.04	0.18	3.6E-04	0.004	0.003	33	3.7E-04	1.1E-03	34
British Columbia	C027	Project Alternative	31,161	0	0	0.000	0.00	0.00	0.0E+00	0.000	0.000	0	0.0E+00	0.0E+00	0
Brownsand	C003	Project Alternative	6,796	295	32	0.007	0.03	0.16	3.6E-04	0.004	0.003	34	3.0E-04	1.1E-03	34
Brownsand	C009	Project Alternative	153,628	6,679	34	0.167	0.77	3.87	8.5E-03	0.106	0.071	789	7.0E-03	2.7E-02	797
Cemex - Pleasanton	C007	Project Alternative	23,292	1,013	58	0.041	0.19	0.98	2.2E-03	0.027	0.018	203	1.7E-03	7.0E-03	205
Cemex - Pleasanton	C014	Project Alternative	5,638	245	34	0.006	0.03	0.14	3.2E-04	0.004	0.003	29	2.6E-04	1.0E-03	30
Cemex - Pleasanton	C026	Project Alternative	1,309	57	59	0.002	0.01	0.06	1.3E-04	0.002	0.001	12	9.9E-05	4.0E-04	12
Cemex - Pleasanton	C006	Project Alternative	3,278	143	50	0.005	0.02	0.12	2.7E-04	0.003	0.002	25	2.1E-04	8.6E-04	25
Cemex - Pleasanton	C002	Project Alternative	40,124	1,745	37	0.047	0.22	1.11	2.4E-03	0.030	0.020	226	2.0E-03	7.7E-03	229
Cemex - Pleasanton	C004	Project Alternative	11,775	512	58	0.021	0.09	0.50	1.1E-03	0.014	0.009	102	8.7E-04	3.5E-03	104
Cemex - Pleasanton	C005	Project Alternative	1,196	52	50	0.002	0.01	0.04	9.8E-05	0.001	0.001	9	7.8E-05	3.1E-04	9
Cemex - Pleasanton	C013	Project Alternative	8,437	367	30	0.008	0.04	0.19	4.2E-04	0.005	0.004	39	3.5E-04	1.3E-03	39
Cemex - Pleasanton	C020	Project Alternative	5,898	256	59	0.011	0.05	0.25	5.7E-04	0.007	0.005	53	4.5E-04	1.8E-03	53
Cemex - Pleasanton	C021	Project Alternative	5,898	256	50	0.009	0.04	0.22	4.8E-04	0.006	0.004	45	3.8E-04	1.5E-03	45
Cemex - Pleasanton	C018	Project Alternative	14,751	641	30	0.015	0.07	0.34	7.4E-04	0.009	0.006	68	6.2E-04	2.3E-03	69
Cemex - Pleasanton	C024	Project Alternative	7,263	316	25	0.006	0.03	0.14	3.0E-04	0.004	0.003	28	2.6E-04	9.5E-04	28
Cemex - Pleasanton	C011	Project Alternative	13,340	580	25	0.011	0.05	0.26	5.6E-04	0.007	0.005	52	4.8E-04	1.7E-03	52
Cemex - Pleasanton	C012	Project Alternative	14,714	640	32	0.015	0.07	0.35	7.7E-04	0.010	0.006	72	6.4E-04	2.4E-03	72
Cemex - Pleasanton	C010	Project Alternative	5,449	237	32	0.006	0.03	0.13	2.8E-04	0.004	0.002	26	2.4E-04	9.0E-04	27
Cemex - Pleasanton	C017	Project Alternative	2,886	125	37	0.00	0.02	0.1	0.0002	0.002	0.001	16	0.0001	0.0006	17
DI Aggregates - Antioch	C027	Project Alternative	63,379	0	0	0.00	0.00	0.0	0.0000	0.000	0.000	0	0.0000	0.0000	0
DI Aggregates - Mare Island	C027	Project Alternative	63,379	0	0	0.00	0.00	0.0	0.0000	0.000	0.000	0	0.0000	0.0000	0
Hanson Aggregates - Sunol	C007	Project Alternative	23,292	1,013	51	0.04	0.17	0.9	0.0020	0.024	0.016	181	0.0016	0.0062	183
Hanson Aggregates - Sunol	C014	Project Alternative	5,638	245	34	0.01	0.03	0.1	0.0003	0.004	0.003	29	0.0003	0.0010	30
Hanson Aggregates - Sunol	C026	Project Alternative	1,309	57	53	0.00	0.01	0.1	0.0001	0.001	0.001	11	0.0001	0.0004	11
Hanson Aggregates - Sunol	C006	Project Alternative	3,278	143	44	0.00	0.02	0.1	0.0002	0.003	0.002	22	0.0002	0.0008	22
Hanson Aggregates - Sunol	C001	Project Alternative	138,721	6,031	38	0.17	0.78	4.0	0.0087	0.109	0.073	811	0.0071	0.0278	820
Hanson Aggregates - Sunol	C002	Project Alternative	40,124	1,745	37	0.05	0.22	1.1	0.0024	0.030	0.020	226	0.0020	0.0077	228
Hanson Aggregates - Sunol	C004	Project Alternative	11,775	512	51	0.02	0.09	0.4	0.0010	0.012	0.008	92	0.0008	0.0032	93
Hanson Aggregates - Sunol	C005	Project Alternative	1,196	52	44	0.00	0.01	0.0	0.0001	0.001	0.001	8	0.0001	0.0003	8
Hanson Aggregates - Sunol	C013	Project Alternative	8,437	367	30	0.01	0.04	0.2	0.0004	0.005	0.004	39	0.0004	0.0013	39
Hanson Aggregates - Sunol	C020	Project Alternative	5,898	256	53	0.01	0.04	0.2	0.0005	0.006	0.004	47	0.0004	0.0016	48
Hanson Aggregates - Sunol	C021	Project Alternative	5,898	256	44	0.01	0.04	0.2	0.0004	0.005	0.004	39	0.0003	0.0014	40
Hanson Aggregates - Sunol	C018	Project Alternative	14,751	641	30	0.01	0.07	0.3	0.0007	0.009	0.006	68	0.0006	0.0023	69
Hanson Aggregates - Sunol	C024	Project Alternative	7,263	316	25	0.01	0.03	0.1	0.0003	0.004	0.003	28	0.0003	0.0009	28

Table NP.7
No Project Haul Truck Trips and Emissions: 2015
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Alternative Provider	Customer ID	Scenario	Sand Delivered (tons/yr)[1]	Number of Round Trips (trips/yr)[2]	One Way Trip Length (miles)[3]	Emissions (tons/yr)[4]						Emissions (tonnes/yr)[4,5,6]			
						ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
Hanson Aggregates - Sunol	C008	Project Alternative	59,798	2,600	35	0.07	0.31	1.6	0.0034	0.043	0.029	319	0.0028	0.0109	323
Hanson Aggregates - Sunol	C011	Project Alternative	13,340	580	25	0.01	0.05	0.3	0.0006	0.007	0.005	52	0.0005	0.0017	52
Hanson Aggregates - Sunol	C012	Project Alternative	14,714	640	32	0.02	0.07	0.4	0.0008	0.010	0.006	71	0.0006	0.0024	72
Hanson Aggregates - Sunol	C010	Project Alternative	5,449	237	21	0.00	0.02	0.1	0.0002	0.002	0.002	18	0.0002	0.0006	18
Hanson Aggregates - Sunol	C017	Project Alternative	2,886	125	37	0.00	0.02	0.1	0.0002	0.002	0.001	16	0.0001	0.0006	16
Sunol Aggregates	C007	Project Alternative	23,292	1,013	54	0.04	0.18	0.9	0.0020	0.026	0.017	189	0.0016	0.0065	191
Sunol Aggregates	C014	Project Alternative	5,638	245	34	0.01	0.03	0.1	0.0003	0.004	0.003	29	0.0003	0.0010	30
Sunol Aggregates	C026	Project Alternative	1,309	57	56	0.00	0.01	0.1	0.0001	0.002	0.001	11	0.0001	0.0004	11
Sunol Aggregates	C006	Project Alternative	3,278	143	46	0.00	0.02	0.1	0.0002	0.003	0.002	23	0.0002	0.0008	23
Sunol Aggregates	C002	Project Alternative	40,124	1,745	37	0.05	0.22	1.1	0.0024	0.030	0.020	225	0.0020	0.0077	227
Sunol Aggregates	C004	Project Alternative	11,775	512	54	0.02	0.09	0.5	0.0010	0.013	0.009	96	0.0008	0.0033	97
Sunol Aggregates	C005	Project Alternative	1,196	52	46	0.00	0.01	0.0	0.0001	0.001	0.001	8	0.0001	0.0003	8
Sunol Aggregates	C013	Project Alternative	8,437	367	30	0.01	0.04	0.2	0.0004	0.005	0.003	39	0.0003	0.0013	39
Sunol Aggregates	C020	Project Alternative	5,898	256	56	0.01	0.05	0.2	0.0005	0.007	0.005	50	0.0004	0.0017	50
Sunol Aggregates	C021	Project Alternative	5,898	256	46	0.01	0.04	0.2	0.0004	0.006	0.004	41	0.0004	0.0014	42
Sunol Aggregates	C018	Project Alternative	14,751	641	30	0.01	0.07	0.3	0.0007	0.009	0.006	68	0.0006	0.0023	69
Sunol Aggregates	C024	Project Alternative	7,263	316	25	0.01	0.03	0.1	0.0003	0.004	0.003	28	0.0003	0.0009	28
Sunol Aggregates	C011	Project Alternative	13,340	580	25	0.01	0.05	0.3	0.0006	0.007	0.005	52	0.0005	0.0017	52
Sunol Aggregates	C012	Project Alternative	14,714	640	31	0.02	0.07	0.3	0.0008	0.010	0.006	71	0.0006	0.0024	72
Sunol Aggregates	C010	Project Alternative	5,449	237	23	0.00	0.02	0.1	0.0002	0.003	0.002	20	0.0002	0.0007	20
Sunol Aggregates	C017	Project Alternative	2,886	125	37	0.00	0.02	0.1	0.0002	0.002	0.001	16	0.0001	0.0006	16
Syar - Cache Creek	C028	Project Alternative	262,081	11,395	49	0.40	1.82	9.4	0.0209	0.262	0.176	1,942	0.0167	0.0668	1,963
Vulcan Materials	C007	Project Alternative	104,814	4,557	53	0.17	0.78	4.0	0.0090	0.113	0.076	834	0.0071	0.0288	843
Vulcan Materials	C014	Project Alternative	25,371	1,103	29	0.02	0.11	0.6	0.0012	0.015	0.010	113	0.0010	0.0038	114
Vulcan Materials	C026	Project Alternative	5,890	256	54	0.01	0.04	0.2	0.0005	0.007	0.004	48	0.0004	0.0017	49
Vulcan Materials	C006	Project Alternative	14,750	641	45	0.02	0.10	0.5	0.0011	0.014	0.009	101	0.0009	0.0035	102
Vulcan Materials	C002	Project Alternative	180,559	7,850	32	0.19	0.87	4.3	0.0095	0.119	0.080	884	0.0079	0.0301	893
Vulcan Materials	C004	Project Alternative	52,987	2,304	53	0.09	0.39	2.0	0.0045	0.057	0.038	422	0.0036	0.0145	426
Vulcan Materials	C005	Project Alternative	5,381	234	45	0.01	0.03	0.2	0.0004	0.005	0.003	37	0.0003	0.0013	37
Vulcan Materials	C013	Project Alternative	37,966	1,651	25	0.03	0.15	0.7	0.0016	0.020	0.013	147	0.0014	0.0050	149
Vulcan Materials	C020	Project Alternative	26,543	1,154	54	0.04	0.20	1.1	0.0023	0.029	0.020	217	0.0019	0.0075	220
Vulcan Materials	C021	Project Alternative	26,543	1,154	45	0.04	0.17	0.9	0.0020	0.025	0.016	182	0.0016	0.0062	184
Vulcan Materials	C018	Project Alternative	66,380	2,886	25	0.06	0.26	1.3	0.0028	0.034	0.023	258	0.0024	0.0087	261
Vulcan Materials	C024	Project Alternative	32,685	1,421	20	0.02	0.11	0.5	0.0011	0.014	0.009	102	0.0010	0.0034	103
Vulcan Materials	C011	Project Alternative	60,030	2,610	20	0.04	0.20	0.9	0.0020	0.025	0.017	188	0.0018	0.0063	190
Vulcan Materials	C012	Project Alternative	66,215	2,879	27	0.06	0.28	1.4	0.0029	0.036	0.025	273	0.0025	0.0092	276
Vulcan Materials	C010	Project Alternative	24,521	1,066	27	0.02	0.10	0.5	0.0011	0.013	0.009	100	0.0009	0.0034	101
Vulcan Materials	C017	Project Alternative	12,989	565	32	0.01	0.06	0.3	0.0007	0.009	0.006	64	0.0006	0.0022	65

Table NP.7
No Project Haul Truck Trips and Emissions: 2015
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Alternative Provider	Customer ID	Scenario	Sand Delivered (tons/yr)[1]	Number of Round Trips (trips/yr)[2]	One Way Trip Length (miles)[3]	Emissions (tons/yr)[4]						Emissions (tonnes/yr)[4,5,6]			
						ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
West Coast Aggregates	C022	Project Alternative	21,114	918	27	0.02	0.09	0.4	0.0009	0.012	0.008	88	0.0008	0.0030	89
West Coast Aggregates	C023	Project Alternative	43,746	1,902	27	0.04	0.18	0.9	0.0020	0.024	0.016	182	0.0017	0.0062	184
West Coast Aggregates	C025	Project Alternative	43,746	1,902	17	0.03	0.13	0.6	0.0013	0.015	0.010	117	0.0012	0.0039	118
West Coast Aggregates	C015	Project Alternative	19,087	830	27	0.02	0.08	0.4	0.0009	0.011	0.007	80	0.0007	0.0027	80
West Coast Aggregates	C016	Project Alternative	18,035	784	27	0.02	0.08	0.4	0.0008	0.010	0.007	75	0.0007	0.0025	76
Total		Project Alternative	2,855,994	117,307		2.5	12	57	0.12	1.5	1.0	11,568	0.11	0.39	11,692

Abbreviations:

µm - micrometer
CARB - California Air Resources Board
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
EMFAC - EMission FACtors Model
N_2O - nitrous oxide
NOx - nitrogen oxides
PM_{10} - particulate matter having a diameter $\leq$ 10 µm
$PM_{2.5}$ - particulate matter having a diameter $\leq$ 2.5 µm
ROG - reactive organic gases
SOx - sulfur oxides
yr - year

Notes:

1. Sand volumes delivered to each customer are approximations provided by Hanson.
2. Round trips calculated by dividing the annual sand delivery to each customer by the average truck capacity of 23 tons.
3. One way trip length was the Google Maps recommended route from the alternative provider to the customer.
4. Annual emissions were calculated based on the methodology described in previous tables.
5. CO_2 emissions were calculated using the CO_2-Pavley emission factor presented in EMFAC 2011. This emission factor accounts for reductions in greenhouse gas (GHG) emissions expected as a result of California Assembly Bill 1493 ("Pavley"), which requires GHG reductions in new passenger vehicles from 2009 through 2016.
6. CO_2e emissions include the sum of CO_2, CH_4, and N_2O multiplied by their respective global warming potentials, as follows: $CO_2e = (CO_2 \times 1) + (CH_4 \times 21) + (N_2O \times 310)$. Global warming potentials are from Appendix E of California Air Resources Board's (CARB's) Local Government Operations Protocol (LGOP). As specified in the Protocol, the Intergovernmental Panel on Climate Change (IPCC)'s Second Assessment Report (SAR) global warming potentials are still used by international convention and in the United States, and are therefore used here.

Sources:

CARB LGOP, Version 1.1. Appendix G. Accessed October 2013. Available at: http://www.arb.ca.gov/cc/protocols/localgov/pubs/lgo_protocol_v1_1_2010-05-03.pdf

Table NP.8
No Project Haul Truck Trips and Emissions: 2024
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Alternative Provider	Customer ID	Scenario	Sand Delivered (tons/yr)[1]	Number of Round Trips (trips/yr)[2]	One Way Trip Length (miles)[3]	Emissions (tons/yr)[4]						Emissions (tonnes/yr)[4,5,6]			
						ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
British Columbia	C007	Project Alterna	407,610	17,722	0	0.074	0.42	0.41	8.5E-04	0.003	0.002	73	3.1E-03	6.4E-04	73
British Columbia	C006	Project Alterna	57,359	2,494	10	0.022	0.11	0.17	9.7E-04	0.009	0.006	83	9.2E-04	2.9E-03	84
British Columbia	C004	Project Alterna	206,060	8,959	0	0.038	0.21	0.21	4.3E-04	0.002	0.001	37	1.6E-03	3.2E-04	37
British Columbia	C005	Project Alterna	20,926	910	10	0.008	0.04	0.06	3.5E-04	0.003	0.002	30	3.4E-04	1.1E-03	31
British Columbia	C027	Project Alterna	31,161	0	0	0.000	0.00	0.00	0.0E+00	0.000	0.000	0	0.0E+00	0.0E+00	0
Brownsand	C003	Project Alterna	6,796	295	32	0.006	0.03	0.05	3.6E-04	0.004	0.002	30	2.4E-04	1.1E-03	31
Brownsand	C009	Project Alterna	153,628	6,679	34	0.135	0.64	1.19	8.4E-03	0.083	0.050	717	5.7E-03	2.7E-02	725
Cemex - Pleasanton	C007	Project Alterna	23,292	1,013	58	0.032	0.15	0.29	2.2E-03	0.022	0.013	184	1.4E-03	7.0E-03	187
Cemex - Pleasanton	C014	Project Alterna	5,638	245	34	0.005	0.02	0.04	3.1E-04	0.003	0.002	27	2.1E-04	1.0E-03	27
Cemex - Pleasanton	C026	Project Alterna	1,309	57	59	0.002	0.01	0.02	1.2E-04	0.001	0.001	11	7.8E-05	4.0E-04	11
Cemex - Pleasanton	C006	Project Alterna	3,278	143	50	0.004	0.02	0.04	2.7E-04	0.003	0.002	23	1.7E-04	8.5E-04	23
Cemex - Pleasanton	C002	Project Alterna	40,124	1,745	37	0.038	0.18	0.34	2.4E-03	0.024	0.014	206	1.6E-03	7.7E-03	208
Cemex - Pleasanton	C004	Project Alterna	11,775	512	58	0.016	0.08	0.15	1.1E-03	0.011	0.007	93	6.9E-04	3.5E-03	94
Cemex - Pleasanton	C005	Project Alterna	1,196	52	50	0.001	0.01	0.01	9.6E-05	0.001	0.001	8	6.2E-05	3.1E-04	8
Cemex - Pleasanton	C013	Project Alterna	8,437	367	30	0.007	0.03	0.06	4.2E-04	0.004	0.002	36	2.9E-04	1.3E-03	36
Cemex - Pleasanton	C020	Project Alterna	5,898	256	59	0.008	0.04	0.08	5.6E-04	0.006	0.003	48	3.5E-04	1.8E-03	48
Cemex - Pleasanton	C021	Project Alterna	5,898	256	50	0.007	0.03	0.07	4.7E-04	0.005	0.003	41	3.1E-04	1.5E-03	41
Cemex - Pleasanton	C018	Project Alterna	14,751	641	30	0.012	0.06	0.10	7.2E-04	0.007	0.004	62	5.0E-04	2.3E-03	63
Cemex - Pleasanton	C024	Project Alterna	7,263	316	25	0.005	0.02	0.04	3.0E-04	0.003	0.002	26	2.2E-04	9.4E-04	26
Cemex - Pleasanton	C011	Project Alterna	13,340	580	25	0.009	0.04	0.08	5.5E-04	0.005	0.003	47	4.0E-04	1.7E-03	47
Cemex - Pleasanton	C012	Project Alterna	14,714	640	32	0.012	0.06	0.11	7.6E-04	0.008	0.005	65	5.2E-04	2.4E-03	66
Cemex - Pleasanton	C010	Project Alterna	5,449	237	32	0.005	0.02	0.04	2.8E-04	0.003	0.002	24	1.9E-04	8.9E-04	24
Cemex - Pleasanton	C017	Project Alterna	2,886	125	37	0.003	0.01	0.02	1.7E-04	0.002	0.001	15	1.2E-04	5.6E-04	15
DI Aggregates - Antioch	C027	Project Alterna	63,379	0	0	0.000	0.00	0.00	0.0E+00	0.000	0.000	0	0.0E+00	0.0E+00	0
DI Aggregates - Mare Island	C027	Project Alterna	63,379	0	0	0.000	0.00	0.00	0.0E+00	0.000	0.000	0	0.0E+00	0.0E+00	0
Hanson Aggregates - Sunol	C007	Project Alterna	23,292	1,013	51	0.029	0.14	0.26	1.9E-03	0.019	0.012	165	1.2E-03	6.2E-03	167
Hanson Aggregates - Sunol	C014	Project Alterna	5,638	245	34	0.005	0.02	0.04	3.1E-04	0.003	0.002	27	2.1E-04	1.0E-03	27
Hanson Aggregates - Sunol	C026	Project Alterna	1,309	57	53	0.002	0.01	0.02	1.1E-04	0.001	0.001	10	7.1E-05	3.6E-04	10
Hanson Aggregates - Sunol	C006	Project Alterna	3,278	143	44	0.004	0.02	0.03	2.3E-04	0.002	0.001	20	1.5E-04	7.5E-04	20
Hanson Aggregates - Sunol	C001	Project Alterna	138,721	6,031	38	0.136	0.64	1.21	8.6E-03	0.085	0.052	738	5.7E-03	2.8E-02	746
Hanson Aggregates - Sunol	C002	Project Alterna	40,124	1,745	37	0.038	0.18	0.34	2.4E-03	0.024	0.014	205	1.6E-03	7.7E-03	208
Hanson Aggregates - Sunol	C004	Project Alterna	11,775	512	51	0.015	0.07	0.13	9.7E-04	0.010	0.006	83	6.2E-04	3.1E-03	84
Hanson Aggregates - Sunol	C005	Project Alterna	1,196	52	44	0.001	0.01	0.01	8.5E-05	0.001	0.001	7	5.5E-05	2.7E-04	7
Hanson Aggregates - Sunol	C013	Project Alterna	8,437	367	30	0.007	0.03	0.06	4.1E-04	0.004	0.002	35	2.9E-04	1.3E-03	36
Hanson Aggregates - Sunol	C020	Project Alterna	5,898	256	53	0.008	0.04	0.07	5.0E-04	0.005	0.003	43	3.2E-04	1.6E-03	44
Hanson Aggregates - Sunol	C021	Project Alterna	5,898	256	44	0.006	0.03	0.06	4.2E-04	0.004	0.003	36	2.7E-04	1.3E-03	36
Hanson Aggregates - Sunol	C018	Project Alterna	14,751	641	30	0.012	0.06	0.10	7.2E-04	0.007	0.004	62	5.0E-04	2.3E-03	63
Hanson Aggregates - Sunol	C024	Project Alterna	7,263	316	25	0.005	0.02	0.04	3.0E-04	0.003	0.002	26	2.2E-04	9.4E-04	26

Table NP.8
No Project Haul Truck Trips and Emissions: 2024
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Alternative Provider	Customer ID	Scenario	Sand Delivered (tons/yr)[1]	Number of Round Trips (trips/yr)[2]	One Way Trip Length (miles)[3]	Emissions (tons/yr)[4]						Emissions (tonnes/yr)[4,5,6]			
						ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
Hanson Aggregates - Sunol	C008	Project Alterna	59,798	2,600	35	0.055	0.26	0.48	3.4E-03	0.034	0.020	290	2.3E-03	1.1E-02	294
Hanson Aggregates - Sunol	C011	Project Alterna	13,340	580	25	0.009	0.04	0.08	5.5E-04	0.005	0.003	47	4.0E-04	1.7E-03	47
Hanson Aggregates - Sunol	C012	Project Alterna	14,714	640	32	0.012	0.06	0.11	7.6E-04	0.007	0.005	65	5.2E-04	2.4E-03	65
Hanson Aggregates - Sunol	C010	Project Alterna	5,449	237	21	0.003	0.02	0.03	1.9E-04	0.002	0.001	16	1.4E-04	6.0E-04	16
Hanson Aggregates - Sunol	C017	Project Alterna	2,886	125	37	0.003	0.01	0.02	1.7E-04	0.002	0.001	15	1.2E-04	5.5E-04	15
Sunol Aggregates	C007	Project Alterna	23,292	1,013	54	0.030	0.14	0.28	2.0E-03	0.020	0.012	172	1.3E-03	6.5E-03	174
Sunol Aggregates	C014	Project Alterna	5,638	245	34	0.005	0.02	0.04	3.1E-04	0.003	0.002	27	2.1E-04	1.0E-03	27
Sunol Aggregates	C026	Project Alterna	1,309	57	56	0.002	0.01	0.02	1.2E-04	0.001	0.001	10	7.5E-05	3.8E-04	10
Sunol Aggregates	C006	Project Alterna	3,278	143	46	0.004	0.02	0.03	2.4E-04	0.002	0.001	21	1.6E-04	7.9E-04	21
Sunol Aggregates	C002	Project Alterna	40,124	1,745	37	0.038	0.18	0.34	2.4E-03	0.024	0.014	204	1.6E-03	7.6E-03	207
Sunol Aggregates	C004	Project Alterna	11,775	512	54	0.015	0.07	0.14	1.0E-03	0.010	0.006	87	6.5E-04	3.3E-03	88
Sunol Aggregates	C005	Project Alterna	1,196	52	46	0.001	0.01	0.01	8.9E-05	0.001	0.001	8	5.8E-05	2.9E-04	8
Sunol Aggregates	C013	Project Alterna	8,437	367	30	0.007	0.03	0.06	4.1E-04	0.004	0.002	35	2.9E-04	1.3E-03	36
Sunol Aggregates	C020	Project Alterna	5,898	256	56	0.008	0.04	0.07	5.3E-04	0.005	0.003	45	3.4E-04	1.7E-03	46
Sunol Aggregates	C021	Project Alterna	5,898	256	46	0.007	0.03	0.06	4.4E-04	0.004	0.003	37	2.8E-04	1.4E-03	38
Sunol Aggregates	C018	Project Alterna	14,751	641	30	0.012	0.06	0.10	7.2E-04	0.007	0.004	62	5.0E-04	2.3E-03	62
Sunol Aggregates	C024	Project Alterna	7,263	316	25	0.005	0.02	0.04	3.0E-04	0.003	0.002	26	2.2E-04	9.4E-04	26
Sunol Aggregates	C011	Project Alterna	13,340	580	25	0.009	0.04	0.08	5.5E-04	0.005	0.003	47	4.0E-04	1.7E-03	47
Sunol Aggregates	C012	Project Alterna	14,714	640	31	0.012	0.06	0.11	7.5E-04	0.007	0.004	65	5.2E-04	2.4E-03	65
Sunol Aggregates	C010	Project Alterna	5,449	237	23	0.004	0.02	0.03	2.1E-04	0.002	0.001	18	1.5E-04	6.6E-04	18
Sunol Aggregates	C017	Project Alterna	2,886	125	37	0.003	0.01	0.02	1.7E-04	0.002	0.001	15	1.2E-04	5.5E-04	15
Syar - Cache Creek	C028	Project Alterna	262,081	11,395	49	0.316	1.48	2.85	2.1E-02	0.206	0.124	1,766	1.3E-02	6.6E-02	1,786
Vulcan Materials	C007	Project Alterna	104,814	4,557	53	0.134	0.63	1.22	8.9E-03	0.088	0.053	759	5.7E-03	2.9E-02	768
Vulcan Materials	C014	Project Alterna	25,371	1,103	29	0.020	0.10	0.17	1.2E-03	0.012	0.007	103	8.4E-04	3.8E-03	104
Vulcan Materials	C026	Project Alterna	5,890	256	54	0.008	0.04	0.07	5.1E-04	0.005	0.003	44	3.3E-04	1.7E-03	44
Vulcan Materials	C006	Project Alterna	14,750	641	45	0.017	0.08	0.15	1.1E-03	0.011	0.006	92	7.0E-04	3.4E-03	93
Vulcan Materials	C002	Project Alterna	180,559	7,850	32	0.153	0.73	1.34	9.4E-03	0.093	0.056	804	6.5E-03	3.0E-02	813
Vulcan Materials	C004	Project Alterna	52,987	2,304	53	0.068	0.32	0.62	4.5E-03	0.045	0.027	384	2.9E-03	1.4E-02	388
Vulcan Materials	C005	Project Alterna	5,381	234	45	0.006	0.03	0.05	3.9E-04	0.004	0.002	33	2.5E-04	1.3E-03	34
Vulcan Materials	C013	Project Alterna	37,966	1,651	25	0.027	0.13	0.23	1.6E-03	0.015	0.009	134	1.1E-03	5.0E-03	136
Vulcan Materials	C020	Project Alterna	26,543	1,154	54	0.035	0.16	0.32	2.3E-03	0.023	0.014	197	1.5E-03	7.4E-03	200
Vulcan Materials	C021	Project Alterna	26,543	1,154	45	0.030	0.14	0.27	1.9E-03	0.019	0.012	165	1.3E-03	6.2E-03	167
Vulcan Materials	C018	Project Alterna	66,380	2,886	25	0.047	0.22	0.40	2.7E-03	0.027	0.016	234	2.0E-03	8.7E-03	237
Vulcan Materials	C024	Project Alterna	32,685	1,421	20	0.020	0.09	0.16	1.1E-03	0.011	0.006	93	8.2E-04	3.4E-03	94
Vulcan Materials	C011	Project Alterna	60,030	2,610	20	0.036	0.17	0.30	2.0E-03	0.019	0.012	171	1.5E-03	6.2E-03	173
Vulcan Materials	C012	Project Alterna	66,215	2,879	27	0.049	0.23	0.42	2.9E-03	0.028	0.017	248	2.1E-03	9.2E-03	251
Vulcan Materials	C010	Project Alterna	24,521	1,066	27	0.018	0.09	0.16	1.1E-03	0.010	0.006	91	7.6E-04	3.4E-03	92
Vulcan Materials	C017	Project Alterna	12,989	565	32	0.011	0.05	0.10	6.8E-04	0.007	0.004	58	4.7E-04	2.2E-03	59

Table NP.8
No Project Haul Truck Trips and Emissions: 2024
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Alternative Provider	Customer ID	Scenario	Sand Delivered (tons/yr)[1]	Number of Round Trips (trips/yr)[2]	One Way Trip Length (miles)[3]	Emissions (tons/yr)[4]						Emissions (tonnes/yr)[4,5,6]			
						ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
West Coast Aggregates	C022	Project Alterna	21,114	918	27	0.016	0.08	0.14	9.3E-04	0.009	0.006	80	6.6E-04	3.0E-03	81
West Coast Aggregates	C023	Project Alterna	43,746	1,902	27	0.033	0.16	0.28	1.9E-03	0.019	0.011	166	1.4E-03	6.1E-03	168
West Coast Aggregates	C025	Project Alterna	43,746	1,902	17	0.023	0.11	0.19	1.2E-03	0.012	0.007	107	9.8E-04	3.9E-03	108
West Coast Aggregates	C015	Project Alterna	19,087	830	27	0.014	0.07	0.12	8.5E-04	0.008	0.005	72	6.0E-04	2.7E-03	73
West Coast Aggregates	C016	Project Alterna	18,035	784	27	0.013	0.06	0.12	8.0E-04	0.008	0.005	68	5.7E-04	2.5E-03	69
Total		Project Alterna	2,855,994	117,307		2.1	10	18	0.12	1.2	0.7	10,521	0.09	0.39	10,643

Abbreviations:

µm - micrometer
CARB - California Air Resources Board
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
EMFAC - EMission FACtors Model
N_2O - nitrous oxide
NOx - nitrogen oxides
PM_{10} - particulate matter having a diameter $\leq$ 10 µm
$PM_{2.5}$ - particulate matter having a diameter $\leq$ 2.5 µm
ROG - reactive organic gases
SOx - sulfur oxides
yr - year

Notes:

1. Sand volumes delivered to each customer are approximations provided by Hanson.
2. Round trips calculated by dividing the annual sand delivery to each customer by the average truck capacity of 23 tons.
3. One way trip length was the Google Maps recommended route from the alternative provider to the customer.
4. Annual emissions were calculated based on the methodology described in previous tables.
5. CO_2 emissions were calculated using the CO_2-Pavley emission factor presented in EMFAC 2011. This emission factor accounts for reductions in greenhouse gas (GHG) emissions expected as a result of California Assembly Bill 1493 ("Pavley"), which requires GHG reductions in new passenger vehicles from 2009 through 2016.
6. CO_2e emissions include the sum of CO_2, CH_4, and N_2O multiplied by their respective global warming potentials, as follows: $CO_2e = (CO_2 \times 1) + (CH_4 \times 21) + (N_2O \times 310)$. Global warming potentials are from Appendix E of California Air Resources Board's (CARB's) Local Government Operations Protocol (LGOP). As specified in the Protocol, the Intergovernmental Panel on Climate Change (IPCC)'s Second Assessment Report (SAR) global warming potentials are still used by international convention and in the United States, and are therefore used here.

Sources:

CARB LGOP, Version 1.1. Appendix G. Accessed October 2013. Available at: http://www.arb.ca.gov/cc/protocols/localgov/pubs/lgo_protocol_v1_1_2010-05-03.pdf

Table NP.9
No Project Haul Truck Trip Emissions Summary
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Year	Operator	VMT	Emissions (tons/yr)						Emissions (tonnes/yr)			
		miles/yr	ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
2014	Total	3,225,860	1.4	6	33	0.06	0.9	0.7	5,787	0.06	0.19	5,849
2015	Total	6,526,301	2.5	12	57	0.12	1.5	1.0	11,568	0.11	0.39	11,692
2024	Total	6,526,301	2.1	10	18	0.12	1.2	0.7	10,521	0.09	0.39	10,643

Abbreviations:

µm - micrometer
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
N_2O - nitrous oxide
NOx - nitrogen oxides
PM_{10} - particulate matter having a diameter ≤ 10 µm
$PM_{2.5}$ - particulate matter having a diameter ≤ 2.5 µm
ROG - reactive organic gases
SOx - sulfur oxides
VMT - vehicle miles traveled
yr - year

Table NP.10
No Project Tug Emission Factors
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Project Year[1]	Equipment[2]	Engine Type	Model Year[2]	Horsepower[2]	Emission Factors (g/bhp-hr)[3]								
					TOG	ROG	CO	NOx	SO_2	PM_{10}	$PM_{2.5}$	CO_2	CH_4
2014	Tug	Main	2001	1,060	0.8095	0.68	1.97	7.31	N/A	0.36	0.35	587	0.18
	Tug	Aux	2000	64	1.4025	1.18	3.59	7.31	N/A	0.58	0.56	587	0.32
	Tug	Main	2013	1,320	0.8095	0.68	3.73	3.99	N/A	0.08	0.08	587	0.34
	Tug	Aux	2000	64	1.4025	1.18	3.59	7.31	N/A	0.58	0.56	587	0.32
2015	Tug	Main	2001	1,060	0.8095	0.68	1.97	7.31	N/A	0.36	0.35	587	0.06
	Tug	Aux	2000	64	1.4025	1.18	3.59	7.31	N/A	0.58	0.56	587	0.11
	Tug	Main	2013	1,320	0.8095	0.68	3.73	3.99	N/A	0.08	0.08	587	0.06
	Tug	Aux	2000	64	1.4025	1.18	3.59	7.31	N/A	0.58	0.56	587	0.11
2024	Tug	Main	2017	1,060	0.8095	0.68	3.73	3.99	N/A	0.08	0.08	587	0.06
	Tug	Aux	2015	64	1.4025	1.18	3.73	5.32	N/A	0.22	0.21	587	0.11
	Tug	Main	2013	1,320	0.8095	0.68	3.73	3.99	N/A	0.08	0.08	587	0.06
	Tug	Aux	2015	64	1.4025	1.18	3.73	5.32	N/A	0.22	0.21	587	0.11

Abbreviations:

µm - micrometer
BSFC - Brake Specific Fuel Consumption
CARB - California Air Resources Board
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
g/bhp-hr - grams per brake horsepower hour
g/hp-hr - grams per horsepower hour
N/A - not applicable
NOx - nitrogen oxides
PM_{10} - particulate matter having a diameter $\leq$ 10 µm
$PM_{2.5}$ - particulate matter having a diameter $\leq$ 2.5 µm
ppm - parts per million
ROG - reactive organic gases
SO_2 - sulfur dioxide

Notes:

1. This analysis is for the proposed period of sand mining from 2014 to 2024.
2. Tug boat model years and horsepower info are provided by Hanson and Jerico.
3. Emission factors were obtained from ARB's Harbor Craft Emissions Inventory Database
   SO_2 emissions factors are derived from fuel consumption, assuming BSFC of 184 g/hp-hr and the use of 15 ppm sulfur fuel

Sources:

California Air Resources Board (CARB). Harbor Craft Emissions Inventory Database; available at http://www.arb.ca.gov/msei/categories.htm#chc_category

Table NP.11
No Project Tug Emissions
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Project Year[1]	Equipment	Origin of Material	Annual Hours by Operator[2]	Emissions (tons/yr)[3]						Emissions (tonnes/yr)[3,4]			
				ROG	CO	NOx	SO_2	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
2014	Tug	Decker Island	780	0.57	2.00	4.4	3.8E-03	0.20	0.19	370	0.046	1.3E-02	375
	Tug	SF Bay Anchorages 8/9	140	0.10	0.36	0.8	6.9E-04	0.04	0.03	66	0.008	2.3E-03	67
				0.67	2.4	5.2	4.5E-03	0.24	0.23	436	0.055	1.5E-02	442
2015	Tug	Decker Island	1,080	0.80	2.8	6.1	5.3E-03	0.28	0.28	512	0.065	1.7E-02	519
	Tug	SF Bay Anchorages 8/9	196	0.15	0.51	1.1	9.6E-04	0.05	0.05	93	0.012	3.2E-03	94
	Total			0.95	3.3	7.3	6.3E-03	0.34	0.33	605	0.077	2.1E-02	613
2024	Tug	Decker Island	1,080	0.79	3.9	4.0	5.3E-03	0.09	0.09	512	0.064	1.7E-02	519
	Tug	SF Bay Anchorages 8/9	196	0.14	0.72	0.72	9.6E-04	0.02	0.02	93	0.012	3.2E-03	94
	Total			0.93	4.7	4.7	6.3E-03	0.10	0.10	605	0.076	2.1E-02	613

Abbreviations:

µm - micrometer
CARB - California Air Resources Board
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
g/hp-hr - grams per horsepower hour
N_2O - nitrous oxide
NOx - nitrogen oxides
PM_{10} - particulate matter having a diameter ≤ 10 µm
$PM_{2.5}$ - particulate matter having a diameter ≤ 2.5
ROG - reactive organic gases
SO_2 - sulfur dioxide
yr - year

Notes:

1. This analysis is for the proposed period of sand mining from 2014 to 2024.
2. Tug boat hours of operation are provided by Hanson and Jerico. Hours of operation and associated emissions presented here refer to the tug as a whole, which consists of 2 main engines and 2 auxiliary engines.
3. Emissions were estimated as follows: E = EF0 * FC * (1 + DE * A/UL) * HP * LF * Hr * C

where,
EF0 - zero-hour emission factor [g/hp-hr] as shown in the previous table
FC - fuel correction factors for using low sulfur content diesel fuels
DE - deterioration rate of engine
A - age of the engine
UL - useful life of the engine
HP - equipment horsepower as provided by Jerico
LF - equipment load factor obtained from Harbor Craft EI Database
Hr - equipment hours were provided by Jerico
C - conversion constants

4. CO_2e emissions include the sum of CO_2 and CH_4 emissions multiplied by their respective global warming potentials, as follows: $CO_2e = (CO_2 \times 1) + (CH_4 \times 21) + (N_2O \times 310)$. Global warming potentials are from Appendix E of California Air Resource Board's (CARB's) Local Government Operations Protocol. As specified in the Protocol, the Intergovernmental Panel on Climate Change (IPCC)'s Second Assessment Report (SAR) global warming potentials are still used by international convention and in the United States, and are therefore used here.

Sources:

California Air Resources Board (CARB). Harbor Craft Emissions Inventory Database; available at http://www.arb.ca.gov/msei/categories.htm#chc_category

Table NP.12
No Project OGV Emission Factors
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Project Year[1]	Model Year[2]	Equipment[2]	Engine Type	Fuel[2]	Power (kW)[2]	Emission Factors (g/bhp-hr)[3]							
						ROG	CO	NOx	SO_2	PM_{10}	$PM_{2.5}$	CO_2	CH_4
2014	2012	OGV	Main	MGO 0.1	10,430	0.78	1.1	17	0.36	0.25	0.23	588	0.078
	2012	OGV	Main	MGO 0.5	10,430	0.78	1.1	17	1.90	0.38	0.35	588	0.070
	2012	OGV	Aux	MGO 0.1	2,500	0.52	1.1	12	0.40	0.25	0.23	690	0.090
	2012	OGV	Aux Boiler	MGO 0.1	109	0.11	0.20	2.0	0.58	0.13	0.13	922	0.032
2015	2012	OGV	Main	MGO 0.1	10,430	0.78	1.1	17	0.36	0.25	0.23	588	0.078
	2012	OGV	Main	MGO 0.5	10,430	0.78	1.1	17	1.90	0.38	0.35	588	0.070
	2012	OGV	Aux	MGO 0.1	2,500	0.52	1.1	12	0.40	0.25	0.23	690	0.090
	2012	OGV	Aux Boiler	MGO 0.1	109	0.11	0.20	2.0	0.58	0.13	0.13	922	0.032
2024	2012	OGV	Main	MGO 0.1	10,430	0.78	1.1	17	0.36	0.25	0.23	588	0.078
	2012	OGV	Aux	MGO 0.1	2,500	0.52	1.1	12	0.40	0.25	0.23	690	0.090
	2012	OGV	Aux Boiler	MGO 0.1	109	0.11	0.20	2.0	0.58	0.13	0.13	922	0.032

Abbreviations:

µm - micrometer
CARB - California Air Resources Board
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
g/bhp-hr - grams per brake horsepower hour
NOx - nitrogen oxides
PM_{10} - particulate matter having a diameter ≤ 10 µm
$PM_{2.5}$ - particulate matter having a diameter ≤ 2.5 µm
ROG - reactive organic gases
SO_2 - sulfur dioxide

Notes:

1. This analysis is for the proposed period of sand mining from 2014 to 2024.
2. OGV model years and power info are provided by Hanson and Jerico; for 2014 and 2015, use 0.1% sulfur fuel within SFAB and use 0.5% sulfur fuel to/from Vancouver; by 2024, use 0.1% sulfur fuel for the entire trip.
3. Emission factors were obtained from CARB's Marine Emissions Model for a Bulk Carrier.

Sources:

California Air Resources Board (CARB). Marine Emissions Model; available at http://www.arb.ca.gov/msei/categories.htm#ogv_category

Table NP.13
No Project OGV Emissions
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Project Year[1]	Equipment	Engine	Mode	Load Factor	Annual Hours by Operator[2]	Emissions (tons/yr)[3]						Emissions (tonnes/yr)[3,4]			
						ROG	CO	NOx	SO_2	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
2014	OGV	Main	Cruising	0.83	668	5.0	7.0	108	11.4	2.3	2.1	3,399	0.4	0.10	3,440
	OGV	Aux	Hotel&Anchor	0.1	820	0.12	0.25	2.6	0.09	0.06	0.05	141	0.02	0.004	143
	OGV	Aux Boiler	Hotel&Anchor	1	820	0.01	0.02	0.2	0.06	0.01	0.01	82	0.00	0.001	83
						5.1	7.3	111	12	2.4	2.2	3,623	0.4	0.11	3,666
2015	OGV	Main	Cruising	0.83	1,451	11	15	235	5.0	3.5	3.2	7,388	1.0	0.23	7,479
	OGV	Aux	Hotel&Anchor	0.1	1,782	0.26	0.54	5.7	0.20	0.12	0.11	307	0.04	0.008	311
	OGV	Aux Boiler	Hotel&Anchor	1	1,782	0.02	0.04	0.4	0.12	0.03	0.03	179	0.01	0.003	180
	Total					11	16	242	5.3	3.6	3.3	7,875	1.0	0.24	7,970
2024	OGV	Main	Cruising	0.83	1,451	11	15	235	5.0	3.5	3.2	7,388	0.98	0.23	7,479
	OGV	Aux	Hotel&Anchor	0.1	1,782	0.26	0.54	5.7	0.20	0.12	0.11	307	0.04	0.008	311
	OGV	Aux Boiler	Hotel&Anchor	1	1,782	0.02	0.04	0.4	0.12	0.03	0.03	179	0.01	0.003	180
	Total					11	16	242	5.3	3.6	3.3	7,875	1.0	0.24	7,970

Abbreviations:

µm - micrometer
CARB - California Air Resources Board
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
CSL - Canada Steamship Lines
g/hp-hr - grams per horsepower hour
N_2O - nitrous oxide
NOx - nitrogen oxides
PM_{10} - particulate matter having a diameter $\leq$ 10 µm
$PM_{2.5}$ - particulate matter having a diameter $\leq$ 2.5 µm
ROG - reactive organic gases
SO_2 - sulfur dioxide
yr - year

Notes:

1. This analysis is for the proposed period of sand mining from 2014 to 2024.
2. OGV cruising hours calculated by dividing the trip distance (measured with Google Earth) by the assumed speed of 12.5 kts; hours for hoteling and anchorage obtained from CARB's Marine Emissions Model.
3. Emissions were estimated as follows: E = EF * HP * LF * Hr * C

    where,
    EF - emission factor [g/hp-hr] as shown in the previous table
    HP - Power of a CSL based on research literature
    LF - load factor obtained from ARB's Marine Emissions Model for a Bulk Carrier
    Hr - hours estimated as described in Footnote (2) above
    C - conversion constants

4. CO_2e emissions include the sum of CO_2 and CH_4 emissions multiplied by their respective global warming potentials, as follows: $CO_2e = (CO_2 \times 1) + (CH_4 \times 21) + (N_2O \times 310)$. Global warming potentials are from Appendix E of California Air Resource Board's (CARB's) Local Government Operations Protocol. As specified in the Protocol, the Intergovernmental Panel on Climate Change (IPCC)'s Second Assessment Report (SAR) global warming potentials are still used by international convention and in the United States, and are therefore used here.

Sources:

California Air Resources Board (CARB). Marine Emissions Model; available at http://www.arb.ca.gov/msei/categories.htm#ogv_category

Table NP.14
No Project Marine Loader Emission Factors
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Project Year[1]	Equipment[2]	OFFROAD2011 Equipment Name[2]	Horsepower[2]	Emission Factors (g/bhp-hr)[3]							
				ROG	CO	NOx	SO_2	PM_{10}	$PM_{2.5}$	CO_2	CH_4
2014	Loader	Rubber Tired Loaders	195	0.25	1.2	2.6	0.0064	0.13	0.12	568	0.039
2015	Loader	Rubber Tired Loaders	195	0.27	1.2	2.6	6.4E-03	0.13	0.12	568	0.04
2024	Loader	Rubber Tired Loaders	195	0.30	1.2	2.7	6.4E-03	0.14	0.13	569	0.04

Abbreviations:

µm - micrometer
CARB - California Air Resources Board
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
g/bhp-hr - grams per brake horsepower hour
HP - horsepower
NOx - nitrogen oxides
PM_{10} - particulate matter having a diameter ≤ 10 µm
$PM_{2.5}$ - particulate matter having a diameter ≤ 2.5 µm
ROG - reactive organic gases
SO_2 - sulfur dioxide

Notes:

1. This analysis is for the proposed period of sand mining from 2014 to 2024.
2. Loaders aboard the dredge barge are model year 2007 and have an estimated power of 195 HP.
3. Emission factors were derived from CARB's OFFROAD2011 and OFFROAD2007 models.

Sources:

OFFROAD2011 and OFFROAD2007 models; available at http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

Table NP.15
No Project Marine Loader Emissions
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Project Year[1]	Equipment[2]	Horsepower[2]	Load Factor[2]	Total Annual Hours of Operation[2]	Emissions (tons/yr)[3]						Emissions (tonnes/yr)[3,4]		
					ROG	CO	NOx	SO_2	PM_{10}	$PM_{2.5}$	CO_2	CH_4	CO_2e
2014	Loader	195	0.3618	294	5.8E-03	0.027	0.059	1.5E-04	2.9E-03	2.7E-03	12	8.1E-04	12
2015	Loader	195	0.3618	408	8.7E-03	0.038	0.083	2.0E-04	4.2E-03	3.9E-03	16	1.2E-03	16
2024	Loader	195	0.3618	408	9.6E-03	0.038	0.085	2.0E-04	4.4E-03	4.1E-03	16	1.3E-03	16

Abbreviations:

µm - micrometer
CARB - California Air Resources Board
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
g/hp-hr - grams per horsepower hour
HP - horsepower
NOx - nitrogen oxides
PM_{10} - particulate matter having a diameter ≤ 10 µm
$PM_{2.5}$ - particulate matter having a diameter ≤ 2.5 µm
ROG - reactive organic gases
SO_2 - sulfur dioxide
yr - year

Notes:

1. This analysis is for the proposed period of sand mining from 2014 to 2024.
2. Loaders aboard the dredge barge are model year 2007 and have an estimated power of 195 HP.
3. Emissions were estimated as follows: E = EF * HP * LF * Hr * C

where,
EF - emission factor [g/hp-hr] as shown in the previous table
HP - equipment horsepower as provided by Jerico
LF - equipment load factor obtained from OFFROAD2011 model
Hr - equipment hours were provided by Jerico
C - conversion constants

4. CO_2e emissions include the sum of CO_2 and CH_4 emissions multiplied by their respective global warming potentials, as follows: $CO_2e = (CO_2 \times 1) + (CH_4 \times 21)$. Global warming potentials are from Appendix E of CARB's Local Government Operations Protocol. As specified in the Protocol, the Intergovernmental Panel on Climate Change (IPCC)'s Second Assessment Report (SAR) global warming potentials are still used by international convention and in the United States, and are therefore used here.

Sources:

OFFROAD2011 and OFFROAD2007 models; available at http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

Table NP.16
No Project Marine Tug and Loader Summary Emissions
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Project Year	Project Marine Source	Emissions (tons/yr)						Emissions (tonnes/yr)			
		ROG	CO	NOx	SO_2	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
2014	Tug Activities	0.67	2.4	5.2	4.5E-03	0.24	0.23	436	0.05	0.01	442
	Loader Activities	0.01	0.03	0.06	1.5E-04	0.003	0.003	12	0.001	N/A	12
	Total	0.68	2.4	5.2	4.7E-03	0.24	0.23	448	0.06	0.01	454
2015	Tug Activities	0.95	3.3	7.3	6.3E-03	0.34	0.33	605	0.08	0.02	613
	Loader Activities	0.01	0.04	0.08	2.0E-04	0.004	0.004	16	0.001	N/A	16
	Total	0.96	3.4	7.3	6.5E-03	0.34	0.33	621	0.08	0.02	629
2024	Tug Activities	0.93	4.7	4.7	6.3E-03	0.10	0.10	605	0.08	0.02	613
	Loader Activities	0.01	0.04	0.09	2.0E-04	0.004	0.004	16	0.001	N/A	16
	Total	0.94	4.7	4.8	6.5E-03	0.11	0.10	621	0.08	0.02	629

Abbreviations:

µm - micrometer
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
N/A - not applicable
N_2O - nitrous oxide
NOx - nitrogen oxides
PM_{10} - particulate matter having a diameter ≤ 10 µm
$PM_{2.5}$ - particulate matter having a diameter ≤ 2.5 µm
ROG - reactive organic gases
SO_2 - sulfur dioxide
yr - year

Table NPIBC.1
No Project - Increased British Columbia Contribution - Haul Truck Emissions
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Year	Scenario	Alternative Provider	Sand Delivered (tons/yr)	Emissions (tons/yr)						Emissions (tonnes/yr)			
				ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
2015	Original No Project	British Columbia	723,116	0.13	0.69	1.8	0.003	0.02	0.018	243	0.006	0.005	245
		All Land Based	2,132,884	2.4	11	55	0.12	1.5	1.0	11,325	0.10	0.39	11,447
		Total	**2,856,000**	**2.5**	**12**	**57**	**0.12**	**1.5**	**1.0**	**11,568**	**0.11**	**0.39**	**11,692**
	Increased British Columbia	British Columbia	1,446,232	0.26	1.4	3.5	0.005	0.05	0.04	487	0.011	0.010	490
		All Land Based	1,409,768	1.6	7.2	37	0.081	1.0	0.68	7,485	0.066	0.26	7,566
		Total	**2,856,000**	**1.8**	**8.6**	**40**	**0.086**	**1.1**	**0.71**	**7,972**	**0.077**	**0.27**	**8,056**
2024	Original No Project	British Columbia	723,116	0.14	0.78	0.84	0.003	0.02	0.011	223	0.006	0.005	224
		All Land Based	2,132,884	1.9	9.0	17	0.12	1.2	0.72	10,298	0.081	0.39	10,419
		Total	**2,856,000**	**2.1**	**9.8**	**18**	**0.12**	**1.2**	**0.73**	**10,521**	**0.087**	**0.39**	**10,643**
	Increased British Columbia	British Columbia	1,446,232	0.3	1.6	1.7	0.005	0.03	0.022	446	0.012	0.010	449
		All Land Based	1,409,768	1.3	6.0	11	0.080	0.79	0.48	6,807	0.053	0.25	6,887
		Total	**2,856,000**	**1.5**	**7.5**	**13**	**0.085**	**0.82**	**0.50**	**7,252**	**0.065**	**0.26**	**7,336**

Abbreviations:

µm - micrometer
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
N_2O - nitrous oxide
NOx - nitrogen oxides
PM_{10} - particulate matter having a diameter $\leq$ 10 µm
$PM_{2.5}$ - particulate matter having a diameter $\leq$ 2.5 µm
ROG - reactive organic gases
SOx - sulfur oxides
VMT - vehicle miles traveled
yr - year

Table PLBL.1
Project Lease-by-Lease Dredge Operation Parameters
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Year	Lease #	Lease Name	Operator	Sand (CY/yr)	Trips[1]	Hours per Mining Event			
						Cruise	Barge Main Pump	Barge Aux. Generator	Barge Thruster Pump
2014	PRC 709	Presidio Shoals	Hanson	290,000	128	3	9.5	12.5	0.5
	PRC 2036	Point Knox South	Hanson	252,500	112	3	9.5	12.5	0.5
	PRC 7779	Point Knox Shoal	Hanson	238,000	105	3	9.5	12.5	0.5
	PRC 7780	Alcatraz South Shoal	Hanson	0	0	3	9.5	12.5	0.5
	PRC 7781	Suisun Associates	Hanson	0	0	6	9.5	15.0	0.5
	PRC 7781	Suisun Associates	Jerico	85,000	50	12	4.7	4.7	N/A
	TLS 39	Grossi Middle Ground	Hanson	0	0	6	9.5	15.0	0.5
	TLS 39	Grossi Middle Ground	Jerico	130,000	77	12	4.7	4.7	N/A
2015	PRC 709	Presidio Shoals	Hanson	340,000	150	3	9.5	12.5	0.5
	PRC 2036	Point Knox South	Hanson	450,000	199	3	9.5	12.5	0.5
	PRC 7779	Point Knox Shoal	Hanson	550,000	243	3	9.5	12.5	0.5
	PRC 7780	Alcatraz South Shoal	Hanson	200,000	89	3	9.5	12.5	0.5
	PRC 7781	Suisun Associates	Hanson	150,000	67	6	9.5	15.0	0.5
	PRC 7781	Suisun Associates	Jerico	150,000	89	12	4.7	4.7	N/A
	TLS 39	Grossi Middle Ground	Hanson	50,000	23	6	9.5	15.0	0.5
	TLS 39	Grossi Middle Ground	Jerico	150,000	89	12	4.7	4.7	N/A
2024	PRC 709	Presidio Shoals	Hanson	340,000	150	3	9.5	12.5	0.5
	PRC 2036	Point Knox South	Hanson	450,000	199	3	9.5	12.5	0.5
	PRC 7779	Point Knox Shoal	Hanson	550,000	243	3	9.5	12.5	0.5
	PRC 7780	Alcatraz South Shoal	Hanson	200,000	89	3	9.5	12.5	0.5
	PRC 7781	Suisun Associates	Hanson	150,000	67	6	9.5	15.0	0.5
	PRC 7781	Suisun Associates	Jerico	150,000	89	12	4.7	4.7	N/A
	TLS 39	Grossi Middle Ground	Hanson	50,000	23	6	9.5	15.0	0.5
	TLS 39	Grossi Middle Ground	Jerico	150,000	89	12	4.7	4.7	N/A

Abbreviations:

CY - cubic yards
N/A - not applicable
yr - year

Notes:

1. Annual trips are calculated assuming 2,270 cubic yards per dredge operated by Hanson and 1,700 cubic yards for Jerico dredges.

Table PLBL.2
Project Lease-by-Lease Dredge Emissions
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Year	Lease #	Lease Name	Operator	Emissions (tons/yr)[1]						Emissions (tonnes/yr)[1]			
				ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
2014	PRC 709	Presidio Shoals	Hanson	2.4	7.5	19	7.3E-03	0.988	0.958	709	0.199	0.024	721
	PRC 2036	Point Knox South	Hanson	2.1	6.6	16	6.4E-03	0.864	0.838	621	0.174	0.021	631
	PRC 7779	Point Knox Shoal	Hanson	2.0	6.2	15	6.0E-03	0.810	0.786	582	0.163	0.020	591
	PRC 7780	Alcatraz South Shoal	Hanson	0	0	0	0	0	0	0	0	0	0
	PRC 7781	Suisun Associates	Hanson	0	0	0	0	0	0	0	0	0	0
	PRC 7781	Suisun Associates	Jerico	0.056	0.197	0.477	3.4E-04	0.025	0.024	38	0.005	0.001	39
	TLS 39	Grossi Middle Ground	Hanson	0	0	0	0	0	0	0	0	0	0
	TLS 39	Grossi Middle Ground	Jerico	0.086	0.304	0.734	5.2E-04	0.039	0.038	59	0.007	0.002	60
	Total			6.7	21	52	0.020	2.7	2.6	2,009	0.548	0.067	2,041
2015	PRC 709	Presidio Shoals	Hanson	0.13	1.4	3.1	8.5E-03	0.063	0.061	831	0.011	0.028	840
	PRC 2036	Point Knox South	Hanson	0.18	1.9	4.1	1.1E-02	0.083	0.081	1,103	0.014	0.037	1,114
	PRC 7779	Point Knox Shoal	Hanson	0.22	2.3	5.0	1.4E-02	0.102	0.099	1,346	0.018	0.045	1,361
	PRC 7780	Alcatraz South Shoal	Hanson	0.08	0.85	1.8	5.1E-03	0.037	0.036	493	0.006	0.017	498
	PRC 7781	Suisun Associates	Hanson	0.06	0.68	1.4	4.0E-03	0.028	0.027	391	0.005	0.013	395
	PRC 7781	Suisun Associates	Jerico	0.10	0.35	0.86	6.0E-04	0.046	0.044	68	0.008	0.002	69
	TLS 39	Grossi Middle Ground	Hanson	0.02	0.23	0.49	1.4E-03	0.010	0.009	134	0.002	0.005	136
	TLS 39	Grossi Middle Ground	Jerico	0.10	0.35	0.86	6.0E-04	0.046	0.044	68	0.008	0.002	69
	Total			0.89	8.1	18	0.045	0.41	0.40	4,434	0.073	0.149	4,482
2024	PRC 709	Presidio Shoals	Hanson	0.16	1.6	3.4	8.5E-03	0.080	0.078	831	0.013	0.028	840
	PRC 2036	Point Knox South	Hanson	0.21	2.1	4.4	1.1E-02	0.106	0.103	1,103	0.017	0.037	1,114
	PRC 7779	Point Knox Shoal	Hanson	0.26	2.6	5.4	1.4E-02	0.130	0.126	1,346	0.021	0.045	1,361
	PRC 7780	Alcatraz South Shoal	Hanson	0.09	0.94	2.0	5.1E-03	0.048	0.046	493	0.008	0.017	498
	PRC 7781	Suisun Associates	Hanson	0.07	0.75	1.5	4.0E-03	0.036	0.035	391	0.006	0.013	395
	PRC 7781	Suisun Associates	Jerico	0.03	0.20	0.31	6.0E-04	0.015	0.015	68	0.003	0.002	69
	TLS 39	Grossi Middle Ground	Hanson	0.03	0.26	0.53	1.4E-03	0.012	0.012	134	0.002	0.005	136
	TLS 39	Grossi Middle Ground	Jerico	0.03	0.20	0.31	6.0E-04	0.015	0.015	68	0.003	0.002	69
	Total			0.88	8.6	18	0.045	0.44	0.43	4,434	0.072	0.149	4,482

Abbreviations:

µm - micrometer
CARB - California Air Resources Board
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
NOx - nitrogen oxides
PM_{10} - particulate matter having a diameter ≤ 10 µm
$PM_{2.5}$ - particulate matter having a diameter ≤ 2.5 µm
ROG - reactive organic gases
SO_2 - sulfur dioxide

Notes:

1. Calculation of emissions are presented in previous tables.

Table PLBL.3
Project Lease-by-Lease Tug Operation Parameters
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Year	Lease #	Lease Name	Operator	Sand (CY/yr)	Trips[1]	Tug (hrs/trip)
2014	PRC 709	Presidio Shoals	Hanson	290,000	128	3
	PRC 2036	Point Knox South	Hanson	252,500	112	3
	PRC 7779	Point Knox Shoal	Hanson	238,000	105	3
	PRC 7780	Alcatraz South Shoal	Hanson	0	0	3
	PRC 7781	Suisun Associates	Hanson	0	0	6
	PRC 7781	Suisun Associates	Jerico	85,000	50	12
	TLS 39	Grossi Middle Ground	Hanson	0	0	6
	TLS 39	Grossi Middle Ground	Jerico	130,000	77	12
2015	PRC 709	Presidio Shoals	Hanson	340,000	150	3
	PRC 2036	Point Knox South	Hanson	450,000	199	3
	PRC 7779	Point Knox Shoal	Hanson	550,000	243	3
	PRC 7780	Alcatraz South Shoal	Hanson	200,000	89	3
	PRC 7781	Suisun Associates	Hanson	150,000	67	6
	PRC 7781	Suisun Associates	Jerico	150,000	89	12
	TLS 39	Grossi Middle Ground	Hanson	50,000	23	6
	TLS 39	Grossi Middle Ground	Jerico	150,000	89	12
2024	PRC 709	Presidio Shoals	Hanson	340,000	150	3
	PRC 2036	Point Knox South	Hanson	450,000	199	3
	PRC 7779	Point Knox Shoal	Hanson	550,000	243	3
	PRC 7780	Alcatraz South Shoal	Hanson	200,000	89	3
	PRC 7781	Suisun Associates	Hanson	150,000	67	6
	PRC 7781	Suisun Associates	Jerico	150,000	89	12
	TLS 39	Grossi Middle Ground	Hanson	50,000	23	6
	TLS 39	Grossi Middle Ground	Jerico	150,000	89	12

Abbreviations:

CY - cubic yards
hrs - hours
N/A - not applicable
yr - year

Notes:

1. Annual trips are calculated assuming 2,270 cubic yards per dredge operated by Hanson and 1,700 cubic yards for Jerico dredges.

Table PLBL.4
Project Lease-by-Lease Tug Emissions
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Year	Lease #	Lease Name	Operator	Emissions (tons/yr)						Emissions (tonnes/yr)			
				ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
2014	PRC 709	Presidio Shoals	Hanson	0.69	1.8	6.2	4.3E-03	0.33	0.32	416	0.057	0.014	422
	PRC 2036	Point Knox South	Hanson	0.61	1.6	5.4	3.8E-03	0.29	0.28	364	0.050	0.012	369
	PRC 7779	Point Knox Shoal	Hanson	0.57	1.5	5.1	3.5E-03	0.27	0.26	342	0.047	0.012	346
	PRC 7780	Alcatraz South Shoal	Hanson	0	0	0	0	0	0	0	0	0	0
	PRC 7781	Suisun Associates	Hanson	0	0	0	0	0	0	0	0	0	0
	PRC 7781	Suisun Associates	Jerico	0.44	1.5	3.4	2.9E-03	0.15	0.15	284	0.036	0.010	288
	TLS 39	Grossi Middle Ground	Hanson	0	0	0	0	0	0	0	0	0	0
	TLS 39	Grossi Middle Ground	Jerico	0.67	2.4	5.2	4.5E-03	0.24	0.23	438	0.055	0.015	444
	Total			3.0	8.9	25	0.019	1.3	1.2	1,845	0.24	0.06	1,870
2015	PRC 709	Presidio Shoals	Hanson	0.83	2.2	7.3	5.1E-03	0.39	0.38	488	0.068	0.017	495
	PRC 2036	Point Knox South	Hanson	1.10	2.9	9.7	6.7E-03	0.52	0.50	647	0.090	0.022	656
	PRC 7779	Point Knox Shoal	Hanson	1.34	3.5	11.8	8.2E-03	0.63	0.61	791	0.109	0.027	801
	PRC 7780	Alcatraz South Shoal	Hanson	0.49	1.3	4.3	3.0E-03	0.23	0.22	290	0.040	0.010	293
	PRC 7781	Suisun Associates	Hanson	0.68	1.8	6.0	4.1E-03	0.32	0.31	400	0.055	0.014	405
	PRC 7781	Suisun Associates	Jerico	0.79	2.8	6.1	5.2E-03	0.28	0.27	506	0.065	0.017	513
	TLS 39	Grossi Middle Ground	Hanson	0.23	0.6	2.0	1.4E-03	0.11	0.11	137	0.019	0.005	139
	TLS 39	Grossi Middle Ground	Jerico	0.79	2.8	6.1	5.2E-03	0.28	0.27	506	0.065	0.017	513
	Total			6.3	18	53	0.039	2.8	2.7	3,765	0.51	0.13	3,816
2024	PRC 709	Presidio Shoals	Hanson	0.76	3.8	3.9	5.1E-03	0.09	0.08	488	0.062	0.017	495
	PRC 2036	Point Knox South	Hanson	1.01	5.0	5.2	6.7E-03	0.11	0.11	647	0.082	0.022	656
	PRC 7779	Point Knox Shoal	Hanson	1.23	6.1	6.3	8.2E-03	0.14	0.13	791	0.101	0.027	801
	PRC 7780	Alcatraz South Shoal	Hanson	0.45	2.2	2.3	3.0E-03	0.05	0.05	290	0.037	0.010	293
	PRC 7781	Suisun Associates	Hanson	0.62	3.1	3.2	4.1E-03	0.07	0.07	400	0.051	0.014	405
	PRC 7781	Suisun Associates	Jerico	0.78	3.9	3.9	5.2E-03	0.09	0.08	506	0.064	0.017	513
	TLS 39	Grossi Middle Ground	Hanson	0.21	1.1	1.1	1.4E-03	0.02	0.02	137	0.017	0.005	139
	TLS 39	Grossi Middle Ground	Jerico	0.78	3.9	3.9	5.2E-03	0.09	0.08	506	0.064	0.017	513
	Total			5.8	29	30	0.039	0.66	0.64	3,765	0.48	0.13	3,815

Abbreviations:

µm - micrometer
CARB - California Air Resources Board
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
NOx - nitrogen oxides
PM_{10} - particulate matter having a diameter ≤ 10 µm
$PM_{2.5}$ - particulate matter having a diameter ≤ 2.5 µm
ROG - reactive organic gases
SO_2 - sulfur dioxide

Notes:

1. Calculation of emissions are presented in previous tables.

Table PLBL.5
Project Lease-by-Lease Marine Offloading Operation Parameters
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Year	Lease #	Lease Name	Operator	Sand (CY/yr)	Trips[1]	Loader (hrs/trip)
2014	PRC 709	Presidio Shoals	Hanson	290,000	128	N/A
	PRC 2036	Point Knox South	Hanson	252,500	112	N/A
	PRC 7779	Point Knox Shoal	Hanson	238,000	105	N/A
	PRC 7780	Alcatraz South Shoal	Hanson	0	0	N/A
	PRC 7781	Suisun Associates	Hanson	0	0	N/A
	PRC 7781	Suisun Associates	Jerico	85,000	50	6
	TLS 39	Grossi Middle Ground	Hanson	0	0	N/A
	TLS 39	Grossi Middle Ground	Jerico	130,000	77	6
2015	PRC 709	Presidio Shoals	Hanson	340,000	150	N/A
	PRC 2036	Point Knox South	Hanson	450,000	199	N/A
	PRC 7779	Point Knox Shoal	Hanson	550,000	243	N/A
	PRC 7780	Alcatraz South Shoal	Hanson	200,000	89	N/A
	PRC 7781	Suisun Associates	Hanson	150,000	67	N/A
	PRC 7781	Suisun Associates	Jerico	150,000	89	6
	TLS 39	Grossi Middle Ground	Hanson	50,000	23	N/A
	TLS 39	Grossi Middle Ground	Jerico	150,000	89	6
2024	PRC 709	Presidio Shoals	Hanson	340,000	150	N/A
	PRC 2036	Point Knox South	Hanson	450,000	199	N/A
	PRC 7779	Point Knox Shoal	Hanson	550,000	243	N/A
	PRC 7780	Alcatraz South Shoal	Hanson	200,000	89	N/A
	PRC 7781	Suisun Associates	Hanson	150,000	67	N/A
	PRC 7781	Suisun Associates	Jerico	150,000	89	6
	TLS 39	Grossi Middle Ground	Hanson	50,000	23	N/A
	TLS 39	Grossi Middle Ground	Jerico	150,000	89	6

Abbreviations:

CY - cubic yards
hrs - hours
N/A - not applicable
yr - year

Notes:

1. Annual trips are calculated assuming 2,270 cubic yards per dredge operated by Hanson and 1,700 cubic yards for Jerico dredges.

Table PLBL.6
Project Lease-by-Lease Marine Offloading Emissions
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Year	Lease #	Lease Name	Operator	Emissions (tons/yr)						Emissions (tonnes/yr)		
				ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	CO_2e
2014	PRC 7781	Suisun Associates	Jerico	0.006	0.027	0.061	1.5E-04	0.003	0.003	12	8.2E-04	12
	TLS 39	Grossi Middle Ground	Jerico	0.060	0.275	0.610	1.5E-03	0.030	0.028	121	8.3E-03	121
	Total			0.066	0.302	0.670	0.002	0.033	0.030	133	0.009	133
2015	PRC 7781	Suisun Associates	Jerico	0.011	0.050	0.109	2.7E-04	0.006	0.005	21	1.6E-03	21
	TLS 39	Grossi Middle Ground	Jerico	0.074	0.325	0.713	1.7E-03	0.036	0.033	140	1.0E-02	140
	Total			0.085	0.374	0.822	0.002	0.041	0.038	161	0.012	161
2024	PRC 7781	Suisun Associates	Jerico	0.013	0.050	0.112	2.7E-04	0.006	0.005	21	1.6E-03	21
	TLS 39	Grossi Middle Ground	Jerico	0.082	0.329	0.730	1.7E-03	0.038	0.035	140	1.1E-02	140
	Total			0.095	0.379	0.841	0.002	0.044	0.040	161	0.012	162

Abbreviations:

µm - micrometer
CARB - California Air Resources Board
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
NOx - nitrogen oxides
PM_{10} - particulate matter having a diameter $\leq$ 10 µm
$PM_{2.5}$ - particulate matter having a diameter $\leq$ 2.5 µm
ROG - reactive organic gases
SO_2 - sulfur dioxide

Notes:

1. Calculation of emissions are presented in previous tables.

Table PLBL.7
Project Lease-by-Lease Marine Summary Emissions
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Year	Lease		Operator	Offloading[1]	Emissions (tons/yr)						Emissions (tonnes/yr)			
				CY/yr	ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
2014	PRC 709	Presidio Shoals	Hanson	290,000	3.1	9.4	25	1.2E-02	1.3	1.3	1,126	0.26	0.038	1,143
	PRC 2036	Point Knox South	Hanson	252,500	2.7	8.2	22	1.0E-02	1.1	1.1	985	0.22	0.033	1,000
	PRC 7779	Point Knox Shoal	Hanson	238,000	2.6	7.7	20	9.5E-03	1.1	1.0	923	0.21	0.031	937
	PRC 7780	Alcatraz South Shoal	Hanson	0	0	0	0	0	0	0	0	0	0	0
	PRC 7781	Suisun Associates	Hanson	0	0	0	0	0	0	0	0	0	0	0
	PRC 7781	Suisun Associates	Jerico	85,000	0.50	1.8	3.9	3.4E-03	0.18	0.18	335	0.041	0.011	339
	TLS 39	Grossi Middle Ground	Hanson	0	0	0	0	0	0	0	0	0	0	0
	TLS 39	Grossi Middle Ground	Jerico	130,000	0.82	3.0	6.6	6.6E-03	0.31	0.30	618	0.070	0.017	624
	Total			995,500	9.8	30	78	4.1E-02	4.03	3.91	3,986	0.80	0.13	4,044
2015	PRC 709	Presidio Shoals	Hanson	340,000	0.96	3.61	10	1.4E-02	0.45	0.44	1,319	0.078	0.045	1,335
	PRC 2036	Point Knox South	Hanson	450,000	1.27	4.79	14	1.8E-02	0.60	0.58	1,750	0.104	0.059	1,771
	PRC 7779	Point Knox Shoal	Hanson	550,000	1.56	5.85	17	2.2E-02	0.73	0.71	2,137	0.127	0.072	2,162
	PRC 7780	Alcatraz South Shoal	Hanson	200,000	0.57	2.14	6.2	8.1E-03	0.27	0.26	783	0.047	0.026	792
	PRC 7781	Suisun Associates	Hanson	150,000	0.74	2.46	7.4	8.1E-03	0.35	0.34	791	0.060	0.027	800
	PRC 7781	Suisun Associates	Jerico	150,000	0.90	3.18	7.0	6.1E-03	0.33	0.32	596	0.075	0.019	603
	TLS 39	Grossi Middle Ground	Hanson	50,000	0.25	0.84	2.5	2.8E-03	0.12	0.12	271	0.021	0.009	275
	TLS 39	Grossi Middle Ground	Jerico	150,000	0.97	3.45	7.6	7.6E-03	0.36	0.35	714	0.083	0.019	722
	Total			2,040,000	7.2	26	72	8.6E-02	3.22	3.12	8,360	0.60	0.28	8,459
2024	PRC 709	Presidio Shoals	Hanson	340,000	0.92	5.37	7.26	1.4E-02	0.166	0.161	1319	0.07	0.045	1335
	PRC 2036	Point Knox South	Hanson	450,000	1.22	7.12	9.64	1.8E-02	0.220	0.213	1750	0.10	0.059	1770
	PRC 7779	Point Knox Shoal	Hanson	550,000	1.49	8.69	11.77	2.2E-02	0.268	0.260	2137	0.12	0.072	2162
	PRC 7780	Alcatraz South Shoal	Hanson	200,000	0.54	3.18	4.31	8.1E-03	0.098	0.095	783	0.04	0.026	792
	PRC 7781	Suisun Associates	Hanson	150,000	0.70	3.84	4.75	8.1E-03	0.106	0.103	791	0.06	0.027	800
	PRC 7781	Suisun Associates	Jerico	150,000	0.82	4.15	4.36	6.1E-03	0.108	0.104	596	0.07	0.019	603
	TLS 39	Grossi Middle Ground	Hanson	50,000	0.24	1.32	1.63	2.8E-03	0.036	0.035	271	0.02	0.009	275
	TLS 39	Grossi Middle Ground	Jerico	150,000	0.89	4.43	4.98	7.6E-03	0.140	0.134	714	0.08	0.019	722
	Total			2,040,000	6.8	38	49	8.6E-02	1.14	1.11	8,361	0.56	0.28	8,458

Abbreviations:

µm - micrometer
CARB - California Air Resources Board
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
CY - cubic yards
NOx - nitrogen oxides
PM_{10} - particulate matter having a diameter $\leq$ 10 µm
$PM_{2.5}$ - particulate matter having a diameter $\leq$ 2.5 µm
ROG - reactive organic gases
SO_2 - sulfur dioxide
yr - year

Notes:

1. Presented sand volumes represent volumes offloaded at Pier 92, Tidewater, or Collinsville and trucked to customers for delivery.

Table PLBL.8
Project Lease-by-Lease Offloading Site Emissions
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Year	Lease		Operator	Offloading[1]	Emissions (tons/yr)[2]						Emissions (tonnes/yr)[2]			
				CY/yr	ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
2014	PRC 709	Presidio Shoals	Hanson	290,000	0.044	0.25	0.54	5.0E-04	0.020	0.019	124	0.018	1.2E-03	124
	PRC 2036	Point Knox South	Hanson	252,500	0.038	0.22	0.47	4.4E-04	0.018	0.016	108	0.016	1.1E-03	108
	PRC 7779	Point Knox Shoal	Hanson	238,000	0.036	0.21	0.45	4.1E-04	0.017	0.015	101	0.015	1.0E-03	102
	PRC 7780	Alcatraz South Shoal	Hanson	0	0	0	0	0	0	0	0	0	0	0
	PRC 7781	Suisun Associates	Hanson	0	0	0	0	0	0	0	0	0	0	0
	PRC 7781	Suisun Associates	Jerico	17,107	0.002	0.01	0.02	2.0E-05	0.001	0.001	2	0.001	8.3E-06	2
	TLS 39	Grossi Middle Ground	Hanson	0	0	0	0	0	0	0	0	0	0	0
	TLS 39	Grossi Middle Ground	Jerico	26,164	0.003	0.01	0.04	3.1E-05	0.001	0.001	4	0.001	1.3E-05	4
	Total			823,771	0.12	0.7	1.5	1.4E-03	0.06	0.05	339	0.05	3.3E-03	341
2015	PRC 709	Presidio Shoals	Hanson	340,000	0.051	0.29	0.61	5.9E-04	0.023	0.021	145	0.021	1.4E-03	146
	PRC 2036	Point Knox South	Hanson	450,000	0.067	0.38	0.81	7.8E-04	0.031	0.028	192	0.028	1.9E-03	193
	PRC 7779	Point Knox Shoal	Hanson	550,000	0.082	0.46	0.99	9.5E-04	0.038	0.035	235	0.035	2.3E-03	236
	PRC 7780	Alcatraz South Shoal	Hanson	200,000	0.030	0.17	0.36	3.5E-04	0.014	0.013	85	0.013	8.4E-04	86
	PRC 7781	Suisun Associates	Hanson	150,000	0.022	0.13	0.27	2.6E-04	0.010	0.009	64	0.009	6.3E-04	64
	PRC 7781	Suisun Associates	Jerico	30,189	0.003	0.01	0.04	3.6E-05	0.001	0.001	4	0.001	1.5E-05	4
	TLS 39	Grossi Middle Ground	Hanson	50,000	0.007	0.04	0.09	8.6E-05	0.003	0.003	21	0.003	2.1E-04	21
	TLS 39	Grossi Middle Ground	Jerico	30,189	0.003	0.01	0.04	3.6E-05	0.001	0.001	4	0.001	1.5E-05	4
	Total			1,800,378	0.27	1.5	3.2	3.1E-03	0.12	0.11	751	0.11	7.4E-03	755
2024	PRC 709	Presidio Shoals	Hanson	340,000	0.03	0.17	0.21	5.9E-04	0.008	0.007	131	0.02	1.4E-03	132
	PRC 2036	Point Knox South	Hanson	450,000	0.03	0.22	0.28	7.8E-04	0.010	0.009	173	0.03	1.9E-03	174
	PRC 7779	Point Knox Shoal	Hanson	550,000	0.04	0.27	0.34	9.5E-04	0.013	0.012	211	0.03	2.3E-03	213
	PRC 7780	Alcatraz South Shoal	Hanson	200,000	0.02	0.10	0.12	3.5E-04	0.005	0.004	77	0.01	8.4E-04	77
	PRC 7781	Suisun Associates	Hanson	150,000	0.01	0.07	0.09	2.6E-04	0.003	0.003	58	0.01	6.3E-04	58
	PRC 7781	Suisun Associates	Jerico	30,189	0.00	0.01	0.01	3.6E-05	0.000	0.000	4	0.00	1.5E-05	4
	TLS 39	Grossi Middle Ground	Hanson	50,000	0.00	0.02	0.03	8.6E-05	0.001	0.001	19	0.00	2.1E-04	19
	TLS 39	Grossi Middle Ground	Jerico	30,189	0.00	0.01	0.01	3.6E-05	0.000	0.000	4	0.00	1.5E-05	4
	Total			1,800,378	0.13	0.9	1.1	3.1E-03	0.04	0.04	677	0.11	7.4E-03	682

Abbreviations:

µm - micrometer
CARB - California Air Resources Board
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
CY - cubic yards
NOx - nitrogen oxides
PM_{10} - particulate matter having a diameter ≤ 10 µm
$PM_{2.5}$ - particulate matter having a diameter ≤ 2.5 µm
ROG - reactive organic gases
SO_2 - sulfur dioxide
yr - year

Notes:

1. Presented sand volumes represent volumes offloaded at Pier 92, Tidewater, or Collinsville and trucked to customers for delivery.
2. Emissions are calculated by scaling the total offloading site emissions presented in Table P.14 by the fraction of total sand offloaded each lease represents.

Table PLBL.9
Project Lease-by-Lease Haul Truck Emissions
Hanson Marine Operations and Jerico Products, Inc.
San Francisco Bay Area

Year	Lease		Operator	Offloading[1]	Emissions (tons/yr)[2]						Emissions (tonnes/yr)[2]			
				CY/yr	ROG	CO	NOx	SOx	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O	CO_2e
	PRC 709	Presidio Shoals	Hanson	290,000	0.150	0.72	3.05	5.3E-03	0.076	0.055	497	6.3E-03	1.5E-02	502
	PRC 2036	Point Knox South	Hanson	252,500	0.130	0.63	2.66	4.6E-03	0.066	0.047	433	5.5E-03	1.3E-02	437
	PRC 7779	Point Knox Shoal	Hanson	238,000	0.123	0.59	2.50	4.4E-03	0.062	0.045	408	5.2E-03	1.3E-02	412
	PRC 7780	Alcatraz South Shoal	Hanson	0	0	0	0	0	0	0	0	0	0	0
2014	PRC 7781	Suisun Associates	Hanson	0	0	0	0	0	0	0	0	0	0	0
	PRC 7781	Suisun Associates	Jerico	17,107	0.032	0.15	0.77	1.4E-03	0.022	0.016	136	1.3E-03	4.6E-03	137
	TLS 39	Grossi Middle Ground	Hanson	0	0	0	0	0	0	0	0	0	0	0
	TLS 39	Grossi Middle Ground	Jerico	26,164	0.049	0.23	1.17	2.2E-03	0.033	0.024	208	2.1E-03	7.0E-03	210
	Total			823,771	0.48	2.3	10.2	1.8E-02	0.26	0.19	1,681	0.02	5.3E-02	1,698
	PRC 709	Presidio Shoals	Hanson	340,000	0.161	0.78	3.10	6.2E-03	0.073	0.050	575	6.8E-03	1.8E-02	581
	PRC 2036	Point Knox South	Hanson	450,000	0.213	1.03	4.10	8.2E-03	0.097	0.066	761	9.0E-03	2.4E-02	769
	PRC 7779	Point Knox Shoal	Hanson	550,000	0.260	1.26	5.01	1.0E-02	0.118	0.080	930	1.1E-02	2.9E-02	940
	PRC 7780	Alcatraz South Shoal	Hanson	200,000	0.095	0.46	1.82	3.6E-03	0.043	0.029	338	4.0E-03	1.1E-02	342
2015	PRC 7781	Suisun Associates	Hanson	150,000	0.071	0.34	1.37	2.7E-03	0.032	0.022	254	3.0E-03	7.9E-03	256
	PRC 7781	Suisun Associates	Jerico	30,189	0.049	0.23	1.15	2.5E-03	0.032	0.021	236	2.1E-03	8.1E-03	238
	TLS 39	Grossi Middle Ground	Hanson	50,000	0.024	0.11	0.46	9.1E-04	0.011	0.007	85	1.0E-03	2.6E-03	85
	TLS 39	Grossi Middle Ground	Jerico	30,189	0.049	0.23	1.15	2.5E-03	0.032	0.021	236	2.1E-03	8.1E-03	238
	Total			1,800,378	0.92	4.5	18.2	3.7E-02	0.44	0.30	3,416	0.04	1.1E-01	3,450
	PRC 709	Presidio Shoals	Hanson	340,000	0.15	0.75	1.10	6.1E-03	0.056	0.034	524	6.2E-03	1.8E-02	529
	PRC 2036	Point Knox South	Hanson	450,000	0.19	0.99	1.45	8.1E-03	0.074	0.045	693	8.2E-03	2.4E-02	701
	PRC 7779	Point Knox Shoal	Hanson	550,000	0.24	1.21	1.78	9.9E-03	0.091	0.055	847	1.0E-02	2.9E-02	856
	PRC 7780	Alcatraz South Shoal	Hanson	200,000	0.09	0.44	0.65	3.6E-03	0.033	0.020	308	3.6E-03	1.1E-02	311
2024	PRC 7781	Suisun Associates	Hanson	150,000	0.06	0.33	0.48	2.7E-03	0.025	0.015	231	2.7E-03	7.9E-03	234
	PRC 7781	Suisun Associates	Jerico	30,189	0.04	0.19	0.35	2.5E-03	0.025	0.015	215	1.7E-03	8.0E-03	217
	TLS 39	Grossi Middle Ground	Hanson	50,000	0.02	0.11	0.16	9.0E-04	0.008	0.005	77	9.1E-04	2.6E-03	78
	TLS 39	Grossi Middle Ground	Jerico	30,189	0.04	0.19	0.35	2.5E-03	0.025	0.015	215	1.7E-03	8.0E-03	217
	Total			1,800,378	0.83	4.2	6.3	3.6E-02	0.34	0.20	3,109	0.04	1.1E-01	3,143

Abbreviations:

µm - micrometer
CARB - California Air Resources Board
CH_4 - methane
CO - carbon monoxide
CO_2 - carbon dioxide
CY - cubic yards
NOx - nitrogen oxides
PM_{10} - particulate matter having a diameter ≤ 10 µm
$PM_{2.5}$ - particulate matter having a diameter ≤ 2.5 µm
ROG - reactive organic gases
SO_2 - sulfur dioxide
yr - year

Notes:

1. Presented sand volumes represent volumes offloaded at Pier 92, Tidewater, or Collinsville and trucked to customers for delivery.
2. Emissions are calculated by scaling the total haul truck emissions presented in Table P.19 by the fraction of total sand each lease represents.

Appendix B

EPS Economic Analysis

MEMORANDUM

To: Christian Marsh

Cc: Christine Boudreau, Jim Musbach, and Rebecca Benassini

From: Edward Sullivan

Subject: The Past as Prologue – Identifying the Appropriate Basis for Projecting Future Demand for Bay Sand and other Locally-Mined Construction Sand in the San Francisco Bay Region; EPS #131095

Date: December 30, 2014

Economic & Planning Systems has previously conducted and reported an economic impact assessment of Bay Sand mining operations. That effort included the preparation and documentation of projections of future demand for construction sand in that part of the San Francisco Bay Region wherein transportation and delivery of Bay Sand is economically practical and competitive with alternate sources (i.e., local land-based mining operations and imports from foreign quarries). The future time period chosen for the projection of construction sand demand in that previous analysis are the ten years from 2014 to 2024, the same period pertinent to the application for permit renewals for mining of sand on state-owned land in San Francisco and Suisun Bays by Hanson Marine Aggregates and Jerico Products.

This follow-up memorandum is intended to provide a concise summary of the reasoning and approach EPS followed in preparing the projection of demand for construction sand. It is also intended to explain why and how actual production and consumption of construction sand and gravel during the last decade, 2004-2013, is an inappropriate and unreliable basis for estimating likely demand for construction aggregate materials in general, and Bay Sand in particular, over the next 10 years. Finally, it is intended to provide a perspective on the importance of Bay Sand in the overall supply of available and permitted construction aggregate reserves in the San Francisco Bay region, *all of which* are currently estimated by the California Geological Survey to be depleted by 2023.

The Economics of Land Use

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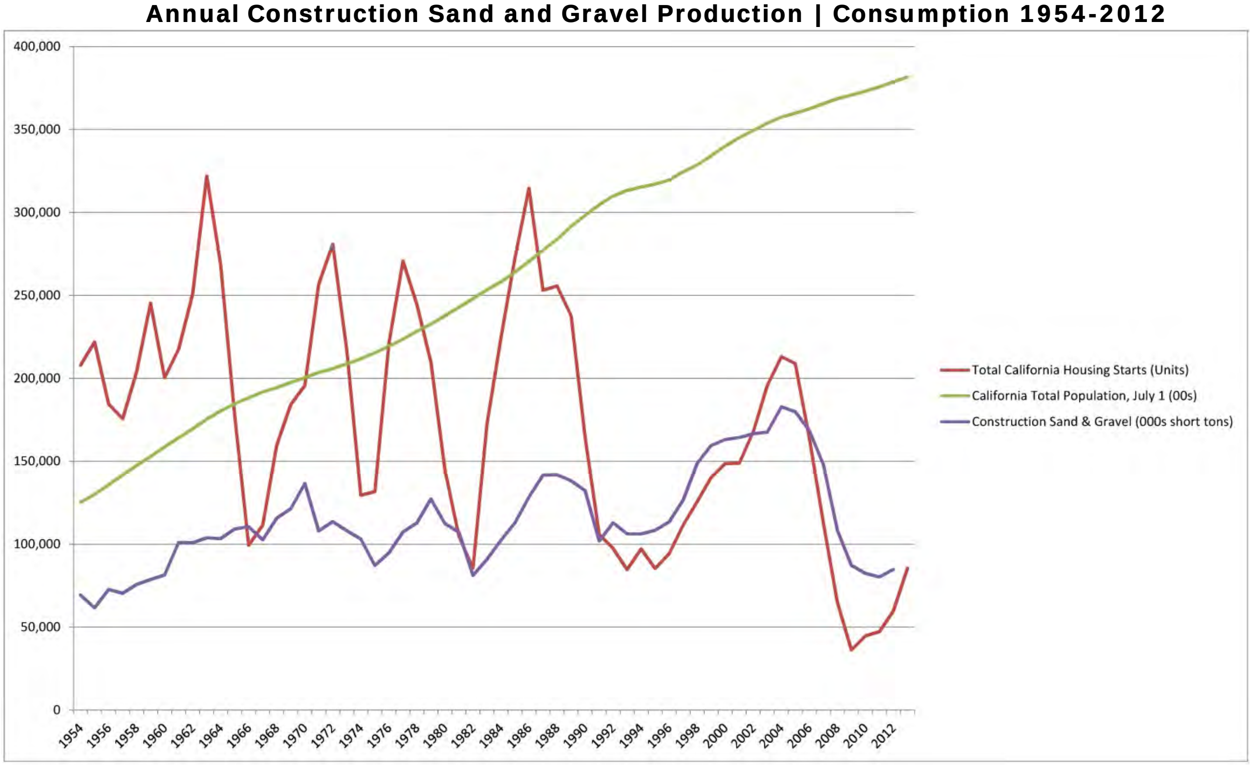
New Housing: The Most Important Component of Demand for Construction Sand and Gravel

Crucial to the discussion of sand mining in California is an understanding of the predominant importance of new housing construction to the overall demand for construction sand, and an appreciation of the severity of the fall-off in housing starts after 2007. As shown in **Figure 1,** during all five years from 2008 through 2012 the State of California produced the lowest numbers of new dwelling units built annually during the entire 60 years from 1954 through 2013. Consumption of construction sand and gravel statewide during the 2008-2012 five-year interval dipped to levels below those experienced during the previous major national recession of 1981-82, despite ongoing construction activities at previously started public works sites and new-ARRA-funded public works projects. Recent sand and gravel consumption statewide and in the San Francisco Bay Region, and production volumes across the State and at local mining operations, are historically anomalous and not a reliable foundation for projecting construction sand demand and production over the next ten years.

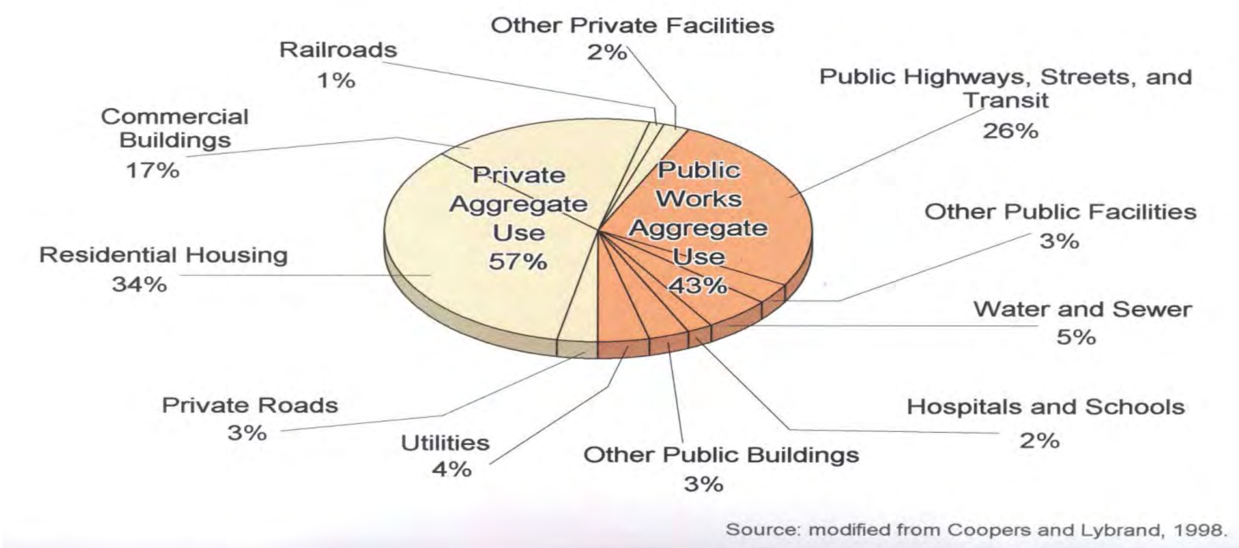
Figure 1 California Annual Housing Starts 1954-2013, Total Population 1954-2013 and Annual Construction Sand and Gravel Production | Consumption 1954-2012



Sources: California Building Industry Association, Annual Statewide Housing Starts 1954-2013; United States Geological Survey, Mineral Yearbooks 1954-2000; California Geological Survey, Non-Fuel Minerals Production 2001-2012; California Department of Finance, E-7 California Population Estimates, with Components of Change and Crude Rates, July 1, 1900–2014, December 2014; EPS

It is evident that since the late-1960s, the peaks and valleys of California's construction sand and gravel consumption trend lines have been increasingly 'in sync' with major changes in new housing starts, and the correspondence of the trend lines since 1990 has converged from the generally shared timings of major changes of direction and similarities of trend line shapes to increasingly closer parallels in year-to-year activity. The correspondence of construction sand and gravel consumption with housing starts since 1990 is not surprising, given that residential building activities now comprise the single largest segment (over one-third) of all uses of construction aggregates (see **Figure 2**).

Figure 2 The Uses of Construction Aggregate (Sand, Gravel and Crushed Stone)



From: "Do We Really Need to Protect our Mineral Resources?", presented by John Clinkenbeard, CA Geological Survey; Stephen Testa, Executive Officer, State Mining and Geology Board; Kerry Shapiro, General Counsel, CA Construction & Industrial Minerals Association, at the 2014 Annual Conference of the California Association of Local Formation Commissions, October 16, 2014.

Before 1990, California and the other states were engaged in building the Interstate Highway System, an effort that began in 1956 and was not completed until 1992.[1] Often called the Greatest Public Works Project in History, it is estimated that 1.5 *billion* metric tons of construction aggregates (sand, gravel and crushed stones) are now in the built structures of the existing Interstate Highway System.[2] Approximately 776,000 miles of non-interstate highways and 460,000 miles of secondary paved roads were also constructed across the United States during the same 1956-1991 interval, consuming an estimated additional 18 *billion* metric tons of aggregate.[3] Altogether, approximately 32 percent of total U.S. national construction aggregate production between 1956 and 1991 has been estimated to have been used in highway construction.[4]

California interstate highways and state freeways and expressways were constructed at the most rapid rates during the 1960s, when 2,215 centerline miles were added to the only 797 centerline miles of such freeway arterials that had existed statewide in 1960. The rate of California freeway construction slowed during the 1970s, with 925 additional centerline miles added. During the

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[1] The Interstate System was proclaimed completed on October 14, 1992 with the opening of I-70 through Glenwood Canyon, Colorado. Two of the original interstates authorized in the *Federal-Aid Highway Act of 1956*, I-95 and I-70 remain, discontinuous due to uncompleted interchanges.

[2] *Materials in Use in U.S. Interstate Highways*, United States Geological Survey, Fact Sheet 2006–3127, October 2006.

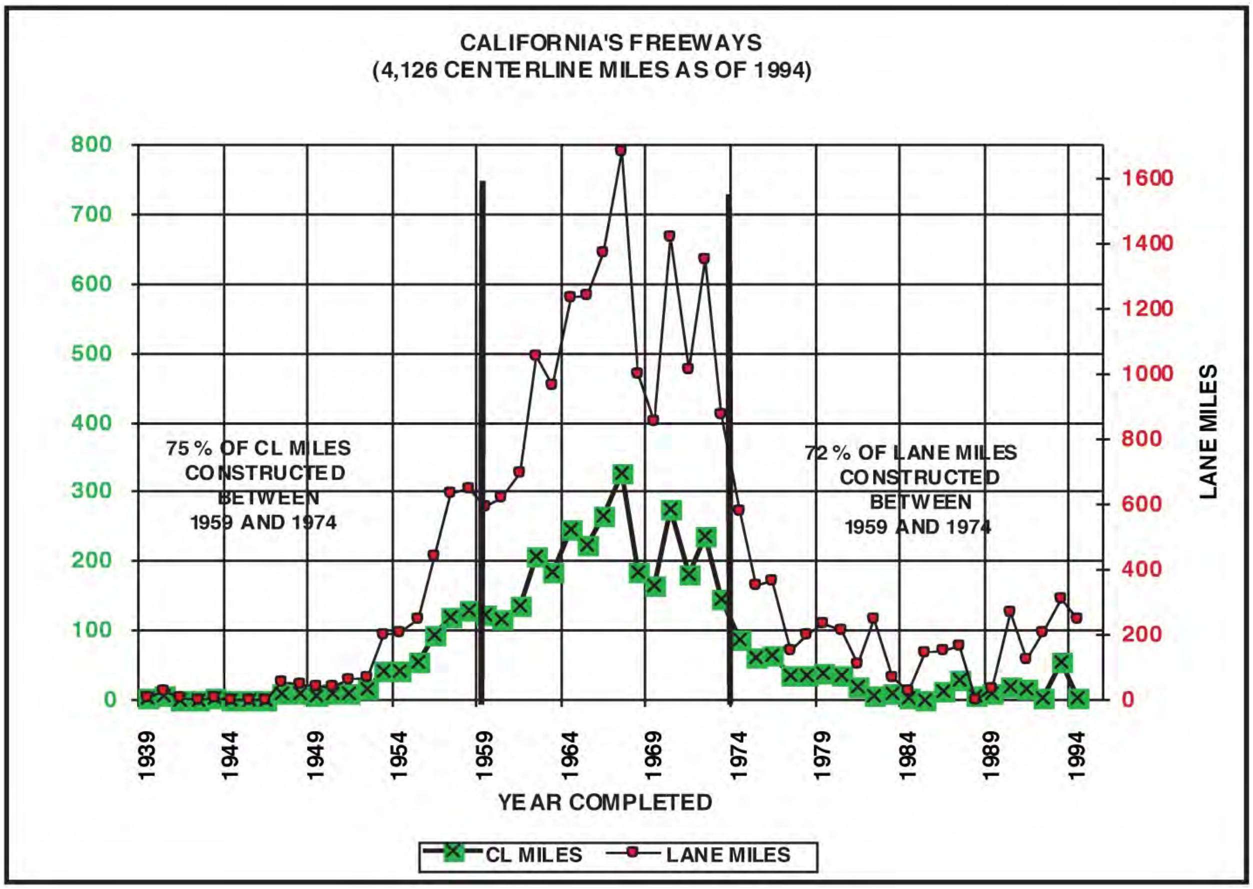
[3] *H is for Highway,* by William Langer, USGS Research Geologist for Aggregates 1976-2011, Randall Reilly Publishing, v. 15, 2010.

[4] William Langer, *ibid*.

decades of the 1980s and 1990s, only 115 and 136 centerline miles were constructed, respectively.[5]

As is shown in **Figure 3**, the State's freeway construction boom era peaked in 1966, which was also the peak construction year for the Interstate Highway System nationally. Massive public investments in and construction of infrastructure for California water projects and higher education facilities also occurred during the 1950s through 1970s, but those major construction activities also tapered off during the 1970s and 1980s and had effectively bottomed-out by 1990.[6]

Figure 3 Centerline and Lane Miles of Paved Freeway Constructed in California: 1939-1994



From: Review of Caltrans Concrete Pavement Sealed and Unsealed Pavement Performance: Field Review Observations [and Caltrans/Concrete Industry Meeting Notes] by Larry Scofield, American Concrete Pavement Association, Page 3 Figure 2, October 15, 2010.

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[5] *Pat Brown's Building Boom: Water, Highways, and Higher Education*, by Kenneth W. Umbach, Ph.D., Umbach Consulting and Publishing, August 2006

[6] Public investment in major California infrastructure projects has generally increased since 1990, but not to levels experienced from about 1964-1974. For historical review and statistics, see: *Pat Brown's Building Boom: Water, Highways, and Higher Education*, ibid.*; California Comes of Age: Governing Institutions, Planning, and Public Investment,* Elisa Barbour and Paul G. Lewis, Public Policy Institute Of California Occasional Paper, 2005; *Making Room for the Future: Rebuilding California's Infrastructure,* by David E. Dowall and Jan Whittington, Public Policy Institute Of California, 2003

The California freeway system construction 'boom', together with the parallel post-WWII 'booms' in construction of State water projects and higher education facilities, account for a great deal of the implicit differences in year-to-year per-capita or per-household ratios of construction sand and gravel consumption that can be derived from the time-series shown in **Figure 1**.

While construction sand and gravel demand may be correlated with increases in resident population over the long term, over the midterm and near term, such demand correlates more closely to the contemporary segments and scales of construction activity.[7] Since 1990, demand for construction sand and gravel statewide has been closely tied to housing starts. When the California Housing Bubble grew from 2001-2004, sand and gravel consumption increased as in tandem, both trends peaking in 2004. After a decline in 2005, housing construction plummeted until 2009, and was effectively stagnant from 2009 through 2011; annual consumption of construction sand and gravel continued to decline until 2011.[8]

Projecting Bay Area Demand for Construction Sand as Function of Forecast New Housing

Economic and Planning Systems (EPS) and Environ staff collaborated in defining the study market area for Bay Sand under Project (Hanson and Jerico obtain permits to mine up to 2.040 million cubic yards per year), No Project (permits for Bay sand mining are not obtained and other local and Canadian mining companies supply replacement of 2.040 million cy per year), and Reduced Project (Bay Sand mining permitted up to 1.346 million cy per year and other local and Canadian sand mining companies supply 694,000 cy per year) scenarios. Records of the permit applicants' actual 2012 deliveries of Bay Sand were reviewed in this process, and the market area was defined as that portion of the San Francisco Bay region that is located within 20 mile radii of the major Hanson and Jerico offloading sites. The defined area is consistent with the construction industry norm that truck delivery of construction sand is economically feasible to a maximum of 20 to 23 miles in the Bay Area.[9]

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[7] For its 50-year projections of construction aggregate demand, the California Geological Survey uses historical and projected population changes and a per capita aggregate consumption forecast model. However, the methodology and correspondence sensitivity sections of CGS *Aggregate Sustainability* and *Mineral Land Classification of Aggregate Materials* updates explicitly recognize that significant changes in housing starts, major public construction projects, and periods of significant economic growth or contraction are among the factors that can strongly affect year-to-year consumption and production figures. See: *Update of Mineral Land Classification of Aggregate Materials in the North San Francisco Bay P-C Region* [Page 27], by Russell V. Miller and Lawrence L. Busch, California Geological Survey Special Report 205, 2013; *Aggregate Sustainability In California*: *Map Sheet 42 (Updated 2012)* [Pages 8 and 19], by John P. Clinkenbeard, California Geological Survey, 2012

[8] The 2009-2012 bottom for construction aggregates was not quite as deep or steep as for housing starts, a situation which market analysts attribute in large part to the ongoing construction of previously committed large public works projects and some private commercial developments, and in the more recent years to the gradual application of American Recovery and Reinvestment Act (ARRA) stimulus funds to construction and repair of public infrastructure.

[9] See *Assessment of Economic Impacts Associated with Sand Mining in San Francisco Bay*, prepared by Economic and Planning Systems, Inc., Chapter 4, September 18, 2014

A decision was made to base the projection of construction sand demand from 2014 to 2024 permit application period on forecast housing construction over the same ten-year interval, consistent with the historical trend line analysis summarized above. This decision required the additional selection of a reference projection of household growth for the Bay Region and the defined market area, and the definition of a factor for estimating the volume of sand assumed to be required in the construction of each new dwelling unit, including the consideration of the associated residential-neighborhood infrastructure demand for additional streets, schools, churches and meeting places, municipal construction projects, retail outlets, etc.

Table 1 Construction Sand Demand

Tons of Sand per new Dwelling, No Supporting Infrastructure			
Rock and gravel	1.0	*Ton*	*a*
Sand	0.7	*Ton*	*b*
Aggregate	1.0	*Cubic Yard of Aggregate*	*c=a+b*
1500 sq. ft. dwelling	67.0	*Cubic Yards of aggregate*	*d*
Sand in 1500 sq. ft. dwelling	**46.9**	***Tons of Sand (short tons - 2,000 pounds)***	*e=b*d*
Neighborhood Supporting Infrastructure, per Dwelling			
Fill Sand for Neighborhood Infrastructure			
Neighborhood Aggregate	328	*tons per dwelling with neighborhood infrastructure*	*f*
Proportion that is Sand	41%		*g=b/(a+b)*
Sand per dwelling with neighborhood infrastructure	**135**	***Tons of Sand (short tons - 2,000 pounds)***	*h=f*g*
Concrete Sand for Neighborhood Infrastructure	202	*Cubic Yards per dwelling with neighborhood infrastructure*	*i*
Concrete recipe:			
Sand	1,700	*pounds*	*j*
Gravel	1,450	*pounds*	
Cementitious material	500	*pounds*	
Water	36	*gallons*	
Concrete	1	*cubic yard of concrete*	
Sand in 202 cubic yards of concrete	343,400	*pounds of sand*	*k=i*j*
Sand in 202 cubic yards of concrete	**172**	***Tons of Sand (short tons - 2,000 pounds)***	*l=k / 2000*
Key Derived Factors			
Each new 1,500 sq. ft. dwelling generates demand for:			
Sand related to dwelling construction materials	46.9	*tons*	*m=e*
Sand related to neighborhood infrastructure construction materials	306.8	*tons*	*n=h+l*
Total sand demanded for each new dwelling	**353.7**	***Tons of Sand (short tons - 2,000 pounds)***	*o*
Estimated Sand Demand for 9-County San Francisco Bay Region, ABAG Jobs-Housing Connection Scenario, 2010-2023			
Bay Region Jobs-Housing Connection Scenario:			
Projected New Dwelling Units, 2010-2040	660,000	*dwelling units*	*p*
Horizon Year for Sand Demand Estimates	2024	*calendar year*	*q*
Effective Years of Sand Production	10	*production interval in years*	*r=q-2014*
Interpolated Estimate of New Dwelling Units by 2024	220,000	*dwelling units*	*s=p/30*r*
Total Sand Demanded for All Dwellings and Infrastructure	**77,804,941**	***Tons of Sand (short tons - 2,000 pounds)***	*t=s*o*
Average Sand Demanded per Year	**7,780,494**	***Tons of Sand per Year (short tons - 2,000 pounds)***	*u=t/r*
Estimated Sand Demand for Bay Sand Market Area, 2010-2023			
Bay Sand Market Area Growth Scenario:			
Estimate of New Dwelling Units by 2024	133,859	*dwelling units*	*v*
Total Sand Demanded for All Dwellings and Infrastructure	**47,340,558**	***Tons of Sand (short tons - 2,000 pounds)***	*w=v*o*
Average Sand Demanded per Year	**4,734,056**	***Tons of Sand per Year (short tons - 2,000 pounds)***	*x=w/r*

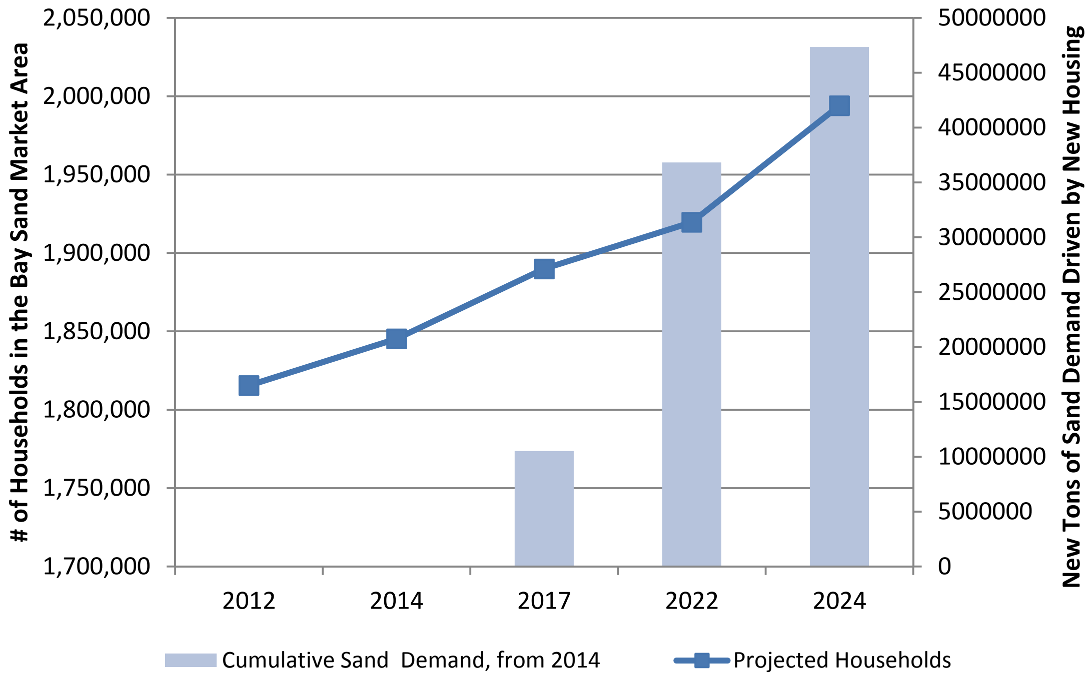
Sources: Where the Sidewalk Begins, Mineral Information Institute; Consumer Uses of Industrial Minerals in the San Francisco Bay Area—Houses to Interstates, USGS; G.E. Bridges & Associates Inc.; California Geological Survey, CALCIMA, U.S. EPA, USGS, Hanson Marine Operations, Aggregate Industry trade magazines and publications; and EPS.

As shown in **Table 1,** the chosen reference projection of housing growth is ABAG's Jobs-Housing Connection Scenario, one of the final working drafts of the now-adopted *Projections 2013* official Bay Area regional growth forecasts. The Jobs-Housing Connection Scenario was available as small-area transportation analysis zone tabulations (below county- and city-levels) at the time of the EPS economic assessment, facilitating proportional allocation of the regional growth forecast to the specific subarea defined as the Bay Sand Market Area. In order to meet the ABAG projection of 660,000 new dwelling units in the Bay Region by 2040, EPS estimates as many as 133,859 new units would need to be constructed within the Bay Sand Market Area by 2024.

Table 1 also shows the assumptions and calculations supporting EPS estimate of 353.7 short tons of construction sand as the extended demand multiplier for each new future dwelling unit. This factor was calculated from standard industry sources and reviewed by the permit applicants and other experts in the construction aggregates industry. It has been found to be similar to independent estimates found in trade publications and used in other construction sand demand projections. As the factor does not include assumptions for uses such as major new region-serving infrastructure (interstate freeway and expressway additions, new airports, water projects, etc.) or major new commercial development projects, it can be considered as a conservative (relatively low) estimate of demand.

However, based on the forecast of new housing growth (and associated neighborhood infrastructure demand) over the next 10 years, the Bay Sand Market Area is estimated to need an average of 4,734,056 short tons annually or about 47.341 million tons of construction sand between 2014 and 2024 (see **Table 1 and Figure 4**).

Figure 4 Projected Housing Growth and Associated Cumulative Construction Sand Demand for the Bay Sand Market Area: 2014-2024



The Hanson and Jerico pending applications for renewing permission to mine Bay Sand would permit production up to 2,856,000 short tons annually, or 28.56 million tons over the ten-year permit period. While not all of that production, if permitted, can be assumed to be used solely for the construction of future housing and neighborhood-serving infrastructure, in simple numerical terms the ratio of the Bay Sand permit application volume to projected demand for housing-related demand over the period is 28.56/47.34 or 60 percent. Bay Sand production therefore merits significant consideration in practical planning to meet the anticipated demand for construction sand in its market area.

Replacing Bay Sand, or any other major existing local and permitted supply of construction aggregate to the San Francisco Bay Region, will be a formidable challenge for the foreseeable future. In its most recent assessments of demand for and permitted supplies of construction aggregate materials in the North and South San Francisco Bay Production-Consumption Regions, the California Geological Survey has projected effective depletion of *all* remaining permitted Bay Area reserves by 2023.[10]

Within the depleting supply of permitted Bay Area local aggregate reserves, replacing Bay Sand production volumes as applied for in the requested permit renewals, 2.856 million tons annually, would require from 54 percent to 33 percent of the estimated 5.250 to 8.750 million short tons of permitted alternate annual production capacity from existing local producers that might be able to transport sand at economically feasible costs to users in the Bay Sand Market Area (see **Table 2**).

Note that EPS conservative demand estimate projection of 4.734 million tons of sand per year for the Bay Sand Market Area (see **Table 1**) would consume from 90 to 54 percent of the total estimated local alternate production capacity (see **Table 2**).

Table 2 Permitted Reserves for Alternative Mining Sites (Potential Alternate Suppliers of Construction Sand if Bay Sand Permit Renewal Applications are not Approved)

Location	**Range of Permitted Reserves (annually, tons) (1)**
Antioch	250,000
British Columbia (2)	1,250,000 - 1,800,000
Cache Creek	500,000-1,000,000
Half Moon Bay area (unincorporated County)	500,000
Lathrop	250,000
Mare Island	250,000
Pleasanton	2,000,000 - 4,500,000
Sunol	1,500,000 - 2,000,000
Total	**6,500,000-10,550,000**
Tons Required Under No Project Alternative	**2,856,000**
Amount of Permitted Material Required to Satisfy Demand Under No Project Alternative	**44%-27%**

(1) Permitted reserve ranges provided by California Geological Survey for California mines and Environ's research, documented in Air Emissions technical appendix.

(2) Amounts for British Columbia reflect the level of Canadian imports between 2001 and 2010. Based on the large amount of aggregate resources on Canada's west coast, it can be assumed that imports of Canadian aggregates could be increased significantly, if the California market could bear the higher cost of the imported material.

Sources: California Geological Survey, 2012 Aggregate Sustainability in California; USGS Mineral Yearbook series

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[10] *Update of Mineral Land Classification of Aggregate Materials in the North San Francisco Bay P-C Region,* by Russell V. Miller and Lawrence L. Busch, California Geological Survey Special Report 205, 2013; *Aggregate Sustainability In California*: *Map Sheet 42 (Updated 2012)*, by John P. Clinkenbeard, California Geological Survey, 2012

British Columbia, Canada (BC) has extensive reserves of high quality sand and gravel. Polaris Minerals Corporation currently develops and operates quarries on Vancouver Island, and its subsidiary Eagle Rock Aggregates, headquartered in Richmond, California, imports and distributes large quantities of construction aggregates mined by Polaris to consumers in Hawaii and the San Francisco Bay Area. Eagle Rock has received Federal and California State permits for a new terminal in Long Beach to serve the Greater Los Angeles Region; Polaris Minerals and its jointly owned subsidiary Cemera San Diego LLC are currently evaluating the feasibility of opening other terminals at the Ports of San Diego and Hueneme to expand deliveries of BC sand to additional Southern California markets.[11]

BC sand is of high quality and in demand for major public works projects and commercial developments, in particular for use in high-strength concrete mixes. In the San Francisco Bay Area in recent years, major public works projects managed and funded by Caltrans and other government agencies have required BC sand for Portland Cement Concrete (PCC) and other public construction uses. With regard to private housing construction, Polaris Minerals' *Management's Discussion and Analysis: Quarter Ending June 30, 2014* market outlook section includes the acknowledgment that, "this sector is less influential on the demand for Orca Quarry materials than private commercial investment".[12]

Circa 2011 and 2012, BC sand was about 40 percent more costly than the estimated $13.50 per ton material cost of locally-mined construction sand, and BC sand is therefore not generally competitive with locally-mined sand for fill or construction uses other than PCC-grade applications and major public works or commercial development projects. The cost of BC sand is sensitive to marine fuel prices and the enforcement of a 1 percent sulfur content limit under the first phase of the United States and Canadian North American Emission Control Area (ECA) agreement resulted in fuel surcharges of 20 percent over pre-ECA 2012 rates to the consumers. The second phase of the ECA, which would reduce allowable sulfur content for marine fuels within 200 miles of the coasts of the U.S and Canada to 0.1 percent, is scheduled to begin January 1, 2015. Eagle Rock representatives have testified that enforcement of the ECA second phase restrictions may increase gross fuel costs at least 40 percent above pre-ECA rates.[13]

By comparison, only a fraction of Bay Sand is suitable for PCC-grade uses; the 2013 CGS report update for the North San Francisco Bay P-C Region cites the estimate from the 1996 report for the South Bay P-C Region that, "About 25 percent of the coarse fraction of these [Bay] sands can

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[11] *Management's Discussion and Analysis: Quarter Ending June 30, 2014,* Polaris Minerals Corporation; *Testimony of William Terry, President and Chief Executive Officer of Eagle Rock Aggregates Incorporated, before the Subcommittee on Coast Guard and Marine Transportation House of Representatives Committee on Transportation and Infrastructure regarding the Economic Impacts of the North American Emission Control Area*, March 4, 2014

[12] *Management's Discussion and Analysis: Quarter Ending June 30, 2014,* Polaris Minerals Corporation, Page 7

[13] *Testimony of William Terry, President and Chief Executive Officer of Eagle Rock Aggregates Incorporated, before the Subcommittee on Coast Guard and Marine Transportation House of Representatives Committee on Transportation and Infrastructure regarding the Economic Impacts of the North American Emission Control Area*, March 4, 2014, Page 5

be used for making PCC aggregate. The finer 75 percent fraction is used as fill material."[14] Given the demand for BC sand for high-strength concrete mixes and major public and commercial projects; the planned and in-progress expansion of BC sand imports to Southern California markets; and the much higher current and (under scheduled enforcement of the ECA low-sulfur marine fuel restrictions) anticipated cost per ton of BC sand to the end-consumer – BC sand therefore cannot be assumed to provide an economically feasible alternative for more than a fraction of the Bay Sand production volume requested under the Hanson and Jerico permit renewal applications. Under the No Project alternative evaluated in EPS' economic impact assessment, BC sand is assumed to comprise only about 24 percent of all sand produced by alternate providers to Bay Sand (**Table 3**).

Table 3 Project Description

Leases	Alt 1: Proposed		Alt 2: Reduced Volume		Alt 3: No Project	
Bay Sand	#	%	#	%	#	%
Cubic Yards	2,040,000		1,346,267		0	
Tons	2,856,000	100%	1,884,774	66%	0	0%
Alternative Sand Providers, Backfilling Reduction in Bay Sand Production						
Cubic Yards	0		547,965		1,545,030	
Tons (Other Local Providers)	0	0%	767,151	27%	2,163,043	76%
Cubic Yards	0		145,767		494,970	
Tons (British Columbia Imports)	0	0%	204,074	7%	692,957	24%
Cubic Yards	0		693,732		2,040,000	
Tons (All Alternative Providers)	0	0%	971,225	34%	2,856,000	100%
Total Sand						
Cubic Yards	2,040,000		2,040,000		2,040,000	
Tons	2,856,000	100%	2,856,000	100%	2,856,000	100%

(1) Cubic yards converted to tons based on a factor of 1.4 tons per cubic yard, consistent with the weight of Bay sand.

Cessation or significant reduction of Bay Sand construction sand production would exacerbate demand for alternate local permitted aggregate reserves in the San Francisco Bay Region, already projected by the California Geological Survey to be depleted by 2023. The strength of the Bay Area economy and the high prices for new Bay Area housing make it likely that construction would continue, albeit with increased construction sand costs per ton that would be passed on to the end users, employers, residents and tax-payers.

The impacts of not permitting or reducing production of Bay Sand would not be restricted to building costs; as the California Geological Survey's most recent *Aggregate Sustainability in California* update states, "The importation of aggregate from neighboring regions typically results in longer haul distances, higher costs, and increased carbon dioxide emissions, air pollution, traffic congestion, and highway maintenance. The shift in supply area also results in more rapid depletion of permitted reserves in neighboring regions."[15] Making quantitative estimates of those impacts was the purpose guiding EPS' economic impact assessment.

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[14] California Geological Survey, Department of Conservation, *Update of Mineral Land Classification: Aggregate Materials in the North San Francisco Bay Production-Consumption Region, Sonoma, Napa, Marin, and Southwestern Solano Counties, California, Special Report 205* – 2013, Page 32

[15] *Aggregate Sustainability In California*: *Map Sheet 42 (Updated 2012)*, by John P. Clinkenbeard, California Geological Survey, 2012, Page 10

Appendix C

Technical Feasibility Analysis

Feasibility Analysis of Minimization Measures and Project Alternatives to Support BCDC's Application of Bay Plan Subtidal Policies

Hanson/Lind Marine Applications for 10-Year Permits to Continue Mining Construction-Grade Sands

March 17, 2014

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I. INTRODUCTION

Hanson Marine Operations ("Hanson") and Lind Marine, Inc. ("Lind Marine," formerly Jerico Products) harvest sand commercially from the San Francisco Bay and western Delta and are seeking renewal of their existing permits from BCDC to continue for another 10 years (the "Project"). As part of its consideration of the renewal applications, BCDC will assess the Project's consistency with policies enumerated in the San Francisco Bay Plan, in particular Subtidal Policies 1 and 2. Both of these policies require BCDC to apply the concept of feasibility. Subtidal Policy 1 requires that "[p]rojects in subtidal areas should be designed to minimize and, *if feasible*, avoid any harmful effects." Under Subtidal Policy 2, dredging projects and changes in use in scarce subtidal areas are allowed only if: "(a) there is no *feasible* alternative and (b) the project provides substantial public benefits."

The State Lands Commission ("SLC"), over a six-year environmental review process, analyzed the Project's environmental impacts and evaluated numerous alternatives to the Proposed Project, some of which were rejected as infeasible or contrary to the project's key objectives. This supplemental analysis provides further information concerning the feasibility of minimization measures and project alternatives and to support the Bay Conservation and Development Commission's ("BCDC's") finding of consistency with Subtidal Policies 1 and 2. This supplemental analysis also provides a summary of the substantial public benefits of the Project under Subtidal Policy 2.

Based on the analysis provided below, as well as evidence provided to BCDC in support of Hanson's and Lind's applications to continue sand mining, BCDC can and should determine that continued sand mining at the proposed levels is consistent with Subtidal Policies 1 and 2. As provided in Section IV, numerous design, minimization, and mitigation measures have been applied to the proposed Project, which avoid or minimize harmful effects on subtidal areas within the San Francisco Bay, if any. In addition, the replacement of Bay sands with sand from either land-based quarries or British Columbia (including as part of any reduced project alternative) is not reasonable, practical, or feasible for economic, environmental, technical, and policy reasons, as explained in Section V. Finally, as detailed in Section VI, the proposed Project would deliver substantial public benefits to the State and the region.

II. DESCRIPTION OF PROPOSED PROJECT

Hanson and Lind Marine currently harvest sand commercially from Central San Francisco Bay ("Central Bay") Middle Ground, and Suisun Bay and are seeking the renewal of their existing permits from BCDC to continue these sand mining activities for an additional 10 years. Hanson and Lind originally applied to continue sand mining at volumes not to exceed 2.04 million cubic yards ("cy") annually. The SLC approved those lease volumes after conducting a thorough evaluation in its 2012 Environmental Impact Report ("EIR"). The San Francisco Bay Regional Water Quality Control Board ("RWQCB") on January 21, 2015 reduced the Project to a maximum average annual volume of 1.613

million cy and peak annual volume of 1.950 million cy.[1] Hanson and Jerico on February 19, 2015 formally amended their respective BCDC permit applications to conform to the RWQCB-authorized volumes. The specific volumes now sought in each lease area—as authorized by the RWQCB—are provided below in **Table 1**.

Table 1: Proposed Annual Volumes

Location/Lease No.	Originally Proposed Annual Volumes (cubic yards)	Amended Annual Average Volumes (cubic yards)	Amended Annual Peak Volumes (cubic yards)
PRC 709.1: Presidio Shoals, Alcatraz, Point Knox Shoals	340,000	232,000	290,000
PRC 2036.1: Point Knox South	450,000	360,000	450,000
PRC 7779.1: Point Knox Shoal	550,000	484,000	550,000
PRC 7780.1: Alcatraz South Shoal	200,000	127,000	160,000
Hanson Middle Ground	50,000	40,000	50,000
Lind Marine Middle Ground	150,000	125,000	150,000
Suisun Associates	300,000	245,000	300,000
Total Volume	**2,040,000**	**1,613,000**	**1,950,000**

Hanson and Lind harvest sand from specified areas of San Francisco Bay that are leased from the California State Lands Commission ("SLC") or, in the case of Middle Ground, are leased privately from the Grossi family. Hanson's and Lind Marine's fundamental project objective is to continue sand mining at an economically viable level in San Francisco Bay and Suisun Bay for the next 10 years to help meet the significant overall demands for construction-grade sand in the Bay Area market.

A. Hanson Marine Operations

Hanson proposes to mine sand from a 2,601-acre area consisting of eight (8) parcels of submerged lands that comprise four (4) leases from the SLC, identified as Mineral Extraction Lease Nos. 709.1, 2036.1, 7779.1, and 7780.1 (Central Bay Leases). Hanson is now seeking authorization to mine up to an annual average of 1,203,000 cy (with 1,430,000 cy peaks) of sand from the Central Bay lease areas. Hanson is currently the only sand mining company operating in the Central Bay. Hanson is also seeking authorization to mine up to an annual average of 40,000 cy (with 50,000 cy peaks) from a 367-acre area identified as the Middle Ground lease area.

[1] All other regulatory agencies that have acted on the Project to date authorized full volumes of 2.04 million cy, including the California Department of Fish & Wildlife ("CDFW"), U.S. Fish & Wildlife Service ("USFWS"), and National Marine Fisheries Service ("NMFS").

B. Lind Marine – Middle Ground

Lind Marine proposes to mine sand from a 367-acre area identified as Middle Ground lease area in Suisun Bay. Lind Marine has mined sand historically from this location since 1979 under BCDC Permit 16-78(M) and subsequent amendments. Lind Marine is now seeking authorization to mine up to an annual average of 125,000 cy (with 150,000 cy peaks) of sand from Middle Ground over the next 10 years.

C. Suisun Associates (A joint venture including Hanson and Lind Marine)

Hanson and Lind Marine mine sand from the SLC Suisun Bay Lease parcel as joint venture partners in Suisun Associates. Suisun Associates proposes to mine sand from a 938-acre lease area within the Suisun Channel in Suisun Bay leased from the SLC as Mineral Extraction Lease Parcel No. 7781.1. Suisun Associates has mined sand historically from this location since 1999 under BCDC Permit M99-7(M) and subsequent amendments. Suisun Associates is now seeking authorization to mine up to an annual average of 245,000 (with 300,000 cy peaks) of sand from the Suisun Associates Lease over the next 10 years. For purposes of the feasibility analysis below, the Suisun Associates leases are addressed as to each member's share (e.g., 142,500 cy for Hanson and 142,500 cy for Lind).

III. LEGAL BACKGROUND ON ASSESSING FEASIBILITY

The term "feasible" appears in the Bay Plan's Subtidal Policies 1 and 2. Neither the Bay Plan nor the McAteer Petris Act ("MPA") defines the term. In response to a separate memorandum prepared by counsel for Hanson and Lind, the applicants and BCDC staff have concurred that the term "feasible" as employed in the Bay Plan should be given the same meaning commonly applied in State law, particularly under the California Environmental Quality Act ("CEQA"), where the word means "capable of being accomplished in a successful manner within a reasonable period of time taking into account economic, environmental, legal, social and technological factors."[2] The question of feasibility is not simply whether an alternative or mitigation measure is literally possible, but whether it is reasonable and practical in light of these and other factors.[3] Alternatives can also be rejected as infeasible if they conflict with certain overarching policies (e.g., a conflict with State's Global Warming Solutions Act of 2006, or AB 32).[4] A project

[2] *CEQA Guidelines*, § 15364; Pub. Resources Code, § 21061.1.

[3] *No Slo Transit, Inc. v. City of Long, Beach* (1987) 197 Cal.App.3d 241, 256 (mitigation is infeasible if it is impractical).

[4] *Defend the Bay v. City of Irvine* (2004) 119 Cal.App.4th 1261, 1269-1270 [mitigation measures rejected as infeasible where they conflicted with the objectives of a city's general plan and other city policy concerns]; *Sierra Club v. Gilroy City Council* (1990) 222 Cal.App.3d 30, 44 [alternatives rejected as infeasible based on a conflict with the need for housing]; *In re Bay-Delta*, 43 Cal.4th at 1162-1169 [rejected alternative calling for reduced water exports because it would not have achieved the project's "underlying fundamental purpose" of improving water supply reliability and providing water for beneficial uses]; *Sierra Club v. County of Napa*, 121 Cal.App.4th at 1498-1512 [rejected alternative calling for offsite

alternative can be eliminated from consideration based on any one factor. Consequently, if an alternative is infeasible for noneconomic reasons, it can be rejected on that basis alone without having to evaluate other factors (including economics).[5]

In addition to the factors readily applied under CEQA, the analysis of alternatives under the MPA is likewise bound by concepts of "cost, logistics, local land use policies, the project's relationship to San Francisco Bay or other factors."[6] In the First Appellate District's decision in *Save San Francisco Bay Ass'n*, the court emphasized that in evaluating alternatives BCDC is not required to "launch a search of alternative sites outside the San Francisco Bay Area."[7] Thus, as a matter of law, BCDC need not evaluate alternatives that necessitate importing construction-grade sand from surface resources in California beyond the immediate Bay Area or from marine or surface resources in foreign countries.

As to the consideration of economics, an alternative may be rendered "economically infeasible" if the additional costs or lost profitability are sufficiently severe as to render it "impractical" to proceed with the project. Thus, if the marginal costs of the alternative as compared to the cost of the proposed project are so great that a reasonably prudent person would not proceed with the alternative project, then that alternative may be deemed "infeasible."[8] In that circumstance, the agency (or applicant) need only show that the alternatives are "economically [un]reasonable."[9]

Further, the evidence of economic infeasibility need not be detailed or exhaustive; indeed, "courts have eschewed requiring any particular economic showing, and have, instead, recognized that what is sufficient will depend on the particular context."[10] For example, in *Sierra Club v. County of Napa*, the Court upheld the county's decision to reject a smaller project alternative as "economically infeasible" on the basis of a letter from a winemaker explaining the "project is the only place on the property to construct a facility of the size and layout that we must have to meet our fundamental business needs of operational efficiency and consolidation, which is the justification for this large and expensive project."[11] Similarly, the Court in *SPRAWLDEF* held that BCDC had properly rejected a reduced-size alternative as "unreasonable" where the alternative significantly reduced landfill capacity and revenues without a commensurate reduction in capital costs

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wastewater disposal since one of the specific project objectives was to irrigate the winery with wastewater onsite].

[5] *SPRAWLDEF v. San Francisco Bay Conservation and Dev. Comm.* (2014) 226 Cal.App.4th 905, 921 [an alternative can be rejected as "infeasible for noneconomic reasons, such as a failure to achieve project goals"].

[6] *Save San Francisco Bay Ass'n v. San Francisco Bay Conservation and Dev. Com.* (1992) 10 Cal.App.4th 908, 926.

[7] *Id.*, at 929.

[8] *See SPRAWLDEF*, 226 Cal.App.4th at *918*.

[9] *Id.*

[10] *Id.*, at 921.

[11] 121 Cal.App.4th at 1506.

to operate the landfill.[12] But again, "[i]f an alternative is infeasible for noneconomic reasons, such as a failure to achieve project goals, it can be rejected on that basis without any economic feasibility analysis."[13]

IV. FEASIBILITY OF CHANGES IN PROJECT DESIGN TO MINIMIZE OR AVOID HARM

The term "feasible" first appears in Subtidal Policy 1:

> Any proposed filling or dredging project in a subtidal area should be thoroughly evaluated to determine the local and Bay-wide effects of the project on: (a) the possible introduction or spread of invasive species; (b) tidal hydrology and sediment movement; (c) fish, other aquatic organisms and wildlife; (d) aquatic plants; and (e) the Bay's bathymetry. Projects in subtidal areas should be designed to minimize and, *if feasible*, avoid any harmful effects.

Thus, under Subtidal Policy 1, the Commission may approve projects with harmful effects so long as the projects are designed to avoid those effects to the extent feasible. This section addresses whether continued sand mining in Central Bay, Middle Ground, or Suisun Bay will result in "harm" under any of the criteria specified in Subtidal Policy 1, as well as whether there are any feasible project design elements available (beyond those already incorporated) that might help further minimize or avoid harmful effects (if any).

A. Sand Mining As Proposed Does Not Result In Any Significant Measurable Or Detectable Harm

In order to trigger Subtidal Policy 1, there must first be substantial evidence of harm (i.e., adverse effects) related to the areas specified in the policy. (Historically, BCDC staff has taken the position that such harm must also be "substantial.")[14] The State's EIR, its appended studies, and additional information provided to date by the applicants well document the lack of harmful effects of sand mining on invasive species, non-aquatic

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[12] 226 Cal.App.4th, at 920.

[13] *Id.*, at 919-921 [finding that a reduced project alternative was unreasonable because it would have reduced the capacity of the landfill but would not have avoided all environmental impacts], citing *Save Round Valley Alliance*, 157 Cal.App.4th at 1462 n.13.

[14] In a staff report to the Commission dated August 6, 2004, BCDC's executive director took the position that Subtidal Policy 2 reflected "the staff's understanding that the resource protection objectives of the policy are directed only at those activities that would *substantially harm* areas that are scarce or rich in aquatic life." While directed at Subtidal Policy 2, this position applies equally to Subtidal Policy 1 (which includes "harm" as a necessary prerequisite). Moreover, limiting Subtidal Policies 1 and 2 to only those activities that "substantially harm" subtidal areas is consistent with the Commission's position generally that it can interpret its authorities "pragmatically and reasonably." *See Save San Francisco Bay Assn.*, 10 Cal.App.4th at 926 [despite the seemingly strict and unequivocal language of the MPA compelling the Commission to consider upland alternatives to filling the Bay, the Commission took the position—and the First Appellate District agreed—that even the strictest provisions of the MPA could be applied "pragmatically and reasonably" to avoid "extreme result[s]. . . ."].

wildlife, and aquatic plants. BCDC staff have, as we understood, generally concurred in these conclusions. There has been greater uncertainty among staff, however, with regards to the other elements of Subtidal Policy 1—i.e., tidal hydrology, sediment movement, Bay bathymetry, and fish and other aquatic organisms (e.g., benthic habitats). Here too, the SLC in its EIR and related findings has concluded that continued sand mining for ten years will not result in any "measurable" or "detectable" adverse physical harm to these areas. For example:

- On Bay bathymetry and sediment transport, the State concluded that the Project is not expected by itself, or in combination with other projects, to result in any substantial alteration of sediment transport patterns or the morphology of the seabed outside of the immediate vicinity of the lease areas and is not expected to result in a significant decrease in the supply of sediment to the San Francisco Offshore Bar or Ocean Beach. (Final EIR, pp. II-21; 4.3-41 and -42.) More specifically, however, the Final EIR, expressly found that continued sand mining in Central Bay and Suisun Bay during the proposed 10-year renewal period "is not likely to cause measurable sediment depletion" (FEIR, pp. 4.3-30, -31) and "would not affect sediment transport outside of the immediate vicinity of the mining leases areas" (FEIR, p. II-4).

- With regard to benthic habitats, the EIR found that there would be no significant adverse effect on those habitats, and summarized the appended study prepared by Applied Marine Sciences ("AMS") as follows:

  > In its assessment of the benthic infaunal communities in the Bay-Delta mining leases in Central Bay, Suisun Bay, and the western Delta, AMS investigated whether sand mining activities had *any detectable effect* on community composition and abundance (AMS 2009a [Appendix F]). AMS reported that the benthic infauna community in Central Bay was very low in species diversity and individual species abundances compared to other areas of the Bay-Delta and that sandy sediments with little silt and clay fractions, and low organic composition, characterized the sediment composition in the areas of the mining leases where mining occurs (AMS 2009a [Appendix F]). . . . AMS also reported that *they could detect no effect* of sand mining in the Central Bay leases, and surmised that this is attributable to the natural instability of the sediments in this area caused by the high-energy regime that is present in west Central Bay (AMS 2009a [Appendix F]). (FEIR, p. 4.1-43, emphasis added.)

- As to sensitive fish species that inhabit parts of the Bay, the State found that changes were incorporated in the Project that would "substantially lessen" the Project's significant effects on fish (e.g., Delta and longfin smelt) and that "such changes . . . can and should be adopted by" the California Department of Fish & Wildlife ("CDFW"). (SLC CEQA Findings, p. D-9.) CDFW has, since that time,

> issued an Incidental Take Permit ("ITP") to each of the applicants and made the express finding that the ITP "minimizes and fully mitigates" any taking of the species caused by the Project. (CDFW ITP, p. 16.) These measures will also serve to minimize and mitigate impacts to more common fish species and habitats.

These findings of the SLC affirm that there is no substantial evidence of harm to the Bay resources delineated in Subtidal Policy 1.[15] Even if there remains disagreement or uncertainty with regard to these effects, Subtidal Policy 1 does not call on the Commission to disapprove projects. On the contrary, the policy simply calls on the Commission to design projects so as to minimize or avoid harm "if feasible" to do so.

B. Existing Practical And Technical Limitations On Mining Locations That Minimize Effects

For a number of practical and technical reasons, sand mining is already limited to specific areas, methods, and equipment. For these reasons, as well as natural fluctuations in the market, sand mining already occurs in a manner that minimizes or avoids disturbance of the Bay to a great extent. As a result, there are few design elements that can be added to the process of mining that would minimize or avoid disturbances and still allow the applicants to achieve their fundamental objectives for this Project—to mine construction-grade alluvial sand from the Bay for the Bay Area market. This subsection addresses some of those practical limits of mining that render many further design elements infeasible.

First, Hanson and Lind have limited storage capacity for sand at offloading facilities, and therefore inventories are small and sand must be mined in immediate response to increases in demand. Mining volumes are also largely dictated by customer demand for product and the weather (seasonality). Historically, mining activity in the four-month period of July through October has comprised about 43% of total annual volumes.

Second, mining is limited to specified lease areas. Actual mining locations are not uniformly distributed across the lease areas, but rather are clustered within areas where suitable sand deposits are known to occur, where mining equipment can reach the sand resource, and where sand mining has not been otherwise restricted. In Central Bay, for example, Hanson seeks to mine those sands that are coarser-grained (having a lower percentage of silts, clay, and mud). In Middle Ground and Suisun Bay, Hanson and Lind Marine seek to mine sands that are finer-grained, but still contain a lower percentage of silts, clay, and mud. As with overall volumes, the type of sands targeted in a given year depend on the market, and can vary.

[15] It has been suggested that any physical change to Bay bathymetry or benthic habitat evinces "harm," but this is belied by the word itself. "Harm" does not encompass any physical change; rather, harm encompasses only those physical changes that are adverse or detrimental or cause injury.

Third, due to equipment constraints, Hanson cannot practically mine in areas with less than 20 feet of water. Thus, in Central Bay, sand mining typically occurs in water greater than -30 feet. In Suisun Bay, sand mining typically occurs in water depths ranging from -15 ft to -45 ft MLLW. Within Middle Ground only a portion of the lease is even feasible to mine due to depth and other restrictions. Indeed, the mineable area within Middle Ground constitutes approximately 50.4 acres, mainly within the shipping channel, which is only about 14% of the total lease area of 367 acres.

Fourth, while the entire area within any given lease is permitted to be mined, only certain areas within the lease are mined on a regular basis. Individual sites are not necessarily mined each month or even each year, and portions of each lease area may never be mined. Using eTrac mining track logs from 2005 (a high production year), as well as 2011 to 2013, and accounting for the width of the drag head and the length of track lines, estimates of benthic disturbance within each of the lease areas was calculated, as presented in **Table 2** below. Of the total lease areas within Central Bay, the total area disturbed from mining events ranged between 0 to 92.5 acres, and yearly percentages of disturbance over all lease areas ranged between 0% and 31% within each lease site. However, when looking at total sandy habitat within the Bay (12,800 acres[16]), the percentage of disturbed area in comparison to available habitat was only 2.2%.

Table 2: Hanson's Estimated Benthic Disturbance (Acres) on an Annual Basis

	Lease	Total Lease Acreage	Disturbance Zone (acres)	% Disturbed per lease area	# of mining events/ year	Avg Disturbance per event (acres)	Avg% disturbance per event w/in lease
YEAR 2011							
Point Knox South	2036	232.06	2.7	1.16%	8	0.34	0.15%
Presidio Shoals	709 E	121.92	0.0	0%	0	0	0%
	709N	445.44	0.0	0%	0	0	0%
	709S	308.16	14.9	4.84%	56	0.27	0.09%
Point Knox Shoal	7779E	230.14	0.0	0%	0	0	0%
	7779W	922.88	26.0	2.82%	57	0.46	0.05%
Alcatraz South Shoal	7780N	29.06	0.0	0%	0	0	0%
	7780S	232.96	0.0	0%	0	0	0%
Central Bay Total		**2522.62**	**43.6**	**1.73%**	**121**	**0.36**	**0.01%**
Suisun Channel	7781N	75.20	0.0	0%	0	0	0%
	7781S	860.16	3.1	0.37%	12	0.26	0.03%
	Total	**935.36**	**3.1**	**0.34%**	**12**	**0.26**	**0.03%**
YEAR 2012							
Point Knox South	2036	232.06	7.7	3.31%	16	0.48	0.21%

[16] *See* Hanson Environmental (2004) and Green (1969).

	Lease	Total Lease Acreage	Disturbance Zone (acres)	% Disturbed per lease area	# of mining events/ year	Avg Disturbance per event (acres)	Avg% disturbance per event w/in lease
Presidio Shoals	709 E	121.92	0.0	0%	0	0	0%
	709N	445.44	0.0	0%	0	0	0%
	709S	308.16	11.0	3.56%	49	0.22	0.07%
Point Knox Shoal	7779E	230.14	0.0	0%	0	0	0%
	7779W	922.88	24.2	2.62%	41	0.59	0.06%
Alcatraz South Shoal	7780N	29.06	0.0	0%	0	0	0%
	7780S	232.96	0.0	0%	0	0	0%
Central Bay Total		**2522.62**	**42.8**	**1.70%**	**106**	**0.40**	**0.02%**
Suisun Channel	7781N	75.20	0.0	0%	0	0	0%
	7781S	860.16	0.5	0.05%	2	0.23	0.03%
	Total	**935.36**	**0.5**	**0.05%**	**2**	**0.25**	**0.03%**
YEAR 2013							
Point Knox South	2036	232.06	26.5	11.43%	93	0.29	0.12%
Presidio Shoals	709 E	121.92	0.0	0%	0	0	0%
	709N	445.44	0.0	0%	0	0	0%
	709S	308.16	12.2	3.96%	46	0.27	0.09%
Point Knox Shoal	7779E	230.14	0.0	0%	0	0	0%
	7779W	922.88	5.8	0.63%	13	0.45	0.05%
Alcatraz South Shoal	7780N	29.06	0.0	0%	0	0	0%
	7780S	232.96	0.0	0%	0	0	0%
Central Bay Total		**2522.62**	**44.5**	**1.76%**	**152**	**0.29**	**0.01%**
Suisun Channel	7781N	75.20	0.0	0%	0	0	0%
	7781S	860.16	0.0	0%	0	0	0%
	Total	**935.36**	**0.0**	**0%**	**0**	**0**	**0%**
YEAR 2005							
Point Knox South	2036	232.06	71.5	30.8%	118	0.61	0.26%
Presidio Shoals	709 E	121.92	0.0	0%	0	0	0%
	709N	445.44	35.6	8%	91	0.39	0%
	709S	308.16	24.3	7.9%	93	0.26	0.08%
Point Knox Shoal	7779E	230.14	14.0	6%	22	0.64	0%
	7779W	922.88	92.5	10.0%	152	0.61	0.07%
Alcatraz South Shoal	7780N	29.06	0.0	0%	0	0	0%
	7780S	232.96	35.1	15.1%	74	0.47	0.20%
Central Bay Total		**2522.62**	**273.1**	**10.8%**	**550**	**0.50**	**0.02%**
Suisun Channel	7781N	75.20	0.0	0%		0	0%
	7781S	860.16	9.9	1%	21	0.47	0.06%

	Lease	Total Lease Acreage	Disturbance Zone (acres)	% Disturbed per lease area	# of mining events/ year	Avg Disturbance per event (acres)	Avg% disturbance per event w/in lease
	Total	935.36	9.9	1%	21	0.47	0.06%

Similarly, Lind Marine estimated the area of benthic disturbance by using location data from 2005, and 2011-2013, and taking into account volume mined and potential geometries from the stationary potholing method. As shown in **Table 3**, at Middle Ground, on average Lind Marine only disturbed 2.6% to 5.1% of the lease area. Within Suisun Channel the combined disturbance within the lease from Hanson and Lind Marine's mining activities was significantly less at between 0.09% and 1.0%. However, when looking at the percentage of disturbance over all lease areas, annual percentages of disturbance ranged between 5.6% and 6.6%. These are conservative estimates as they assess general areas of potential disturbed areas over the course of a year.

Table 3: Lind Marine's Estimated Benthic Disturbance (Acres) on an Annual Basis

Middle Ground				Suisun Channel		
Total Mineable area w/in Lease 50.4 acres; total lease acreage = 367 acres				Total Acreage = 860.16+75.2		
Events/ month	Disturbance (acres)	% Disturbance within feasible mining area	% Disturbance within lease area	Events/ Month	Disturbance (acres)	% Disturbance within lease area
Year 2011						
54	10.1	20.1%	2.8%	14	2.6	0.3%
Year 2012						
50	9.4	18.6%	2.6%	2	0.4	0.04%
Year 2013						
52	9.8	19.3%	2.7%	10	1.9	0.2%
Year 2005						
142	18.7	37.2%	5.1%	0	0.00	0.00%

C. Existing Avoidance, Minimization, And Mitigation Measures

In addition to the significant technical and practical limits of mining within each lease area and over the course of the seasons or years, Hanson and Lind have worked diligently with the host of regulatory agencies (U.S. Army Corps of Engineers ("USACE"), Bay Area Air Quality Management District ("BAAQMD"), SLC, USFWS, NMFS, CDFW, RWQCB, and BCDC) to add design elements and mining limits (e.g., depth, timing, and volume restrictions) to help avoid, minimize, or mitigate the potential impacts of sand mining on Bay resources. Many of these design elements and mining limits have been summarized for BCDC staff in a separate submittal. Following are several example elements that have been incorporated in or agreed to by the applicants that further minimize the harmful effects of sand mining (if any):

Operational Measures:

- No mining can occur within 200 ft of any shoreline. Within Central Bay, mining cannot occur within 250 ft of depths less than -30 ft MLLW. For lease areas in Suisun Bay, mining cannot occur within 250 ft of depths less than -9 ft MLLW, within depths less than -25 ft MLLW between December and June, and within depths less than -15 ft MLLW between July and November.
- Hanson must establish 100-foot buffers from the outward edge of hard bottom features within and adjacent to the Central Bay mining leases.
- Fish screens have been installed on Hanson and Lind mining equipment to minimize or avoid risks associated with entrainment of fish.
- To avoid or minimize disturbance of sandy deep water habitat, Hanson and Lind must keep the end of the pipe and drag head as close to the bottom as possible, and no more than three feet from the bottom whenever feasible when clearing the pipe. When priming the pump the drag head is put on the bottom.
- Sand mining is restricted to specific lease areas and is not permitted outside of these areas. In addition, Hanson and Lind are restricted to specific volumes per year in each of these lease areas. Together, these restrictions reduce the potential risk of adverse effects of sand mining on subtidal habitat and aquatic resources.
- To minimize or avoid potential impacts on larval Delta smelt in Suisun Bay, Hanson and Lind recently agreed with the fisheries agencies (USFWS, NMFS, and CDFW) to restrict mining volumes during the more sensitive months (December through June).
- The total unscreened water diversions from sand mining are limited to 261 acre-feet annually. This restriction also helps reduce entrainment and water quality impacts.

Monitoring and Verification Studies:

- To ensure that mining operations are effectively avoiding and minimizing harm, Hanson and Lind have agreed to provide quarterly monitoring information to the resource agencies (NMFS, USACE, BCDC, and CSLC) from mining locations including detailed tracking and accounting of the specific locations of each mining event.
- A designated biologist will conduct monthly compliance inspections when covered activities occur.
- Hanson and Lind have agreed to conduct supplemental benthic, water quality, and bathymetry studies during the next 10-year permit term.

Compensatory Mitigation:

- Where complete avoidance was determined infeasible (e.g., for larval-stage Delta and longfin smelt), Hanson and Lind have agreed to "fully mitigate" possible incidental take by purchasing mitigation credits for shallow water habitat.
- To address potential impacts to essential fish habitat, Hanson and Lind have proposed to contribute to Cal Recycle's Estuary Cleanup Project, which will help fund removal of abandoned vessels and restore benthic habitats.

Taken together with the practical and technical limits on sand mining, the above operational avoidance and minimization measures severely constrain the applicants' ability to meet the fluctuating demands of the market and individual production objectives from month to month. And because all construction-grade sands (both course and fine) within the Bay occur within subtidal areas, there is little more that the applicants can do to further design the Project to avoid subtidal disturbance short of simply not mining, which Subtidal Policy 1 does not require. Indeed, as outlined above, sand mining occupies a very small part of much larger sandy bottom areas, and the mined areas within each lease are much smaller than the leases themselves. Thus, the areas mined on an annual basis constitute only a small percentage of overall sandy habitat within the Bay.

V. FEASIBILITY ANALYSIS OF PROJECT ALTERNATIVES

Hanson and Lind Marine must also satisfy Subtidal Policy 2, a policy which likewise employs the concept of "feasibility." Under this second policy, however, feasibility is tied to the Commission's consideration of alternatives:

> Subtidal areas that are scarce in the Bay or have an abundance and diversity of fish, other aquatic organisms and wildlife (e.g., eelgrass beds, sandy deep water or underwater pinnacles) should be conserved. Filling, changes in use; and dredging projects in these areas should therefore be allowed only if: (a) there is no *feasible* alternative; and (b) the project provides substantial public benefits.

Under Subtidal Policy 2, therefore, the Commission may approve projects in scarce sandy deep water areas with harmful effects so long as there are no feasible alternatives. As outlined in Section III, above, neither the Bay Plan nor the MPA defines the term "feasible," and so we turn to the widely accepted definition in CEQA.

Under settled legal authority, "feasibility" does not turn on whether an alternative is literally "possible," but instead on whether the alternative is "reasonable" and "practical."[17] The BCDC Commission itself, in interpreting its land-use authorities under the MPA, has taken the position that the MPA and its provisions requiring consideration of alternatives (in that case, for Bay shoreline developments):

[17] *No Slo Transit, Inc.,* 197 Cal.App.3d, at 256.

> must be interpreted pragmatically and reasonably and . . . take[] into consideration the physical characteristics of the particular use, the relation of the use to the Bay, the cost of the proposed project and alternatives to it, logistics, local land use policies and other relevant factors.[18]

The Commission may therefore reject alternatives that are unreasonable or impractical in light of any of the factors listed in CEQA's definition and as interpreted by the courts, including economic, environmental, social, technological, legal, and policy factors.

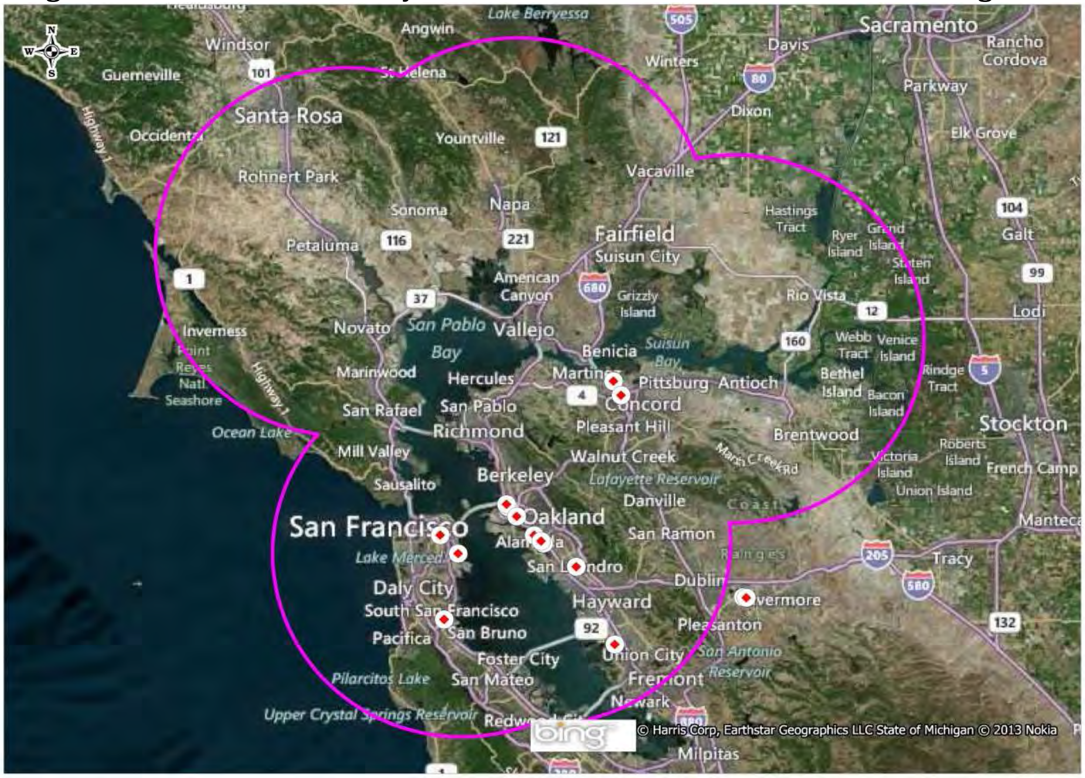
Here, four alternatives were initially considered but eliminated based on their infeasibility, potential to cause additional or more severe impacts, or inability to meet the basic objectives of the Project. Those alternatives were: (1) Mining of Shipping Channels Alternative; (2) Import of Sand Alternative (3) Central Bay Only Alternative; and (4) Suisun Bay and Delta Only Alternative. (FEIR, p. 3-4.) The EIR fully evaluated four alternatives with respect to their environmental advantages, technical and legal feasibility, and consistency with Project objectives: (1) Long-Term Management Strategy Alternative; (2) Clamshell Dredge Mining Alternative; (3) Reduced Project Alternative; and (4) No Project Alternative. (FEIR, p. 3-4.)

In the process of considering Subtidal Policy 2, BCDC staff has stated that further information concerning the feasibility of alternatives would aid them in presenting the Project to the Commission. Without specifying which alternatives the Commission might consider, staff has generally asked whether importing surface or marine resources from other areas in California or from British Columbia might serve as a feasible alternative to continued sand mining in the Bay. This section evaluates further the feasibility for Hanson and Lind to produce sand from alternative resources, including:

> (1) <u>Import of Sand Alternative</u>: It has been suggested that Lind and Hanson can substitute Bay sands with imports from British Columbia. This alternative would involve importing 50% to 100% of proposed volumes by ocean barge or ship. This alternative is similar to the No Project Alternative analyzed in the SLC EIR.
>
> (2) <u>Land-Based Quarries Alternative</u>: This alternative involves mining sand from land-based quarries in the greater Bay Area. This alternative shares many similarities with the No Project Alternative analyzed in the SLC EIR. **Figure 1**, below, depicts the general market area for Bay sands.

[18] *Save San Francisco Bay Ass'n*, 10 Cal.App.4th, at 926.

Figure 1: Market Area for Bay Sand – 20-Mile Radius Around Off-Loading Sites



Economic & Planning Systems, Inc. P:\131000s\131095BaySand\Maps\MapInfo\Figure_X.wor

(3) Reduced Project Alternative: This alternative would reduce permitted annual mining volumes in all of the lease areas to a level equivalent to baseline mining volumes. The total volume of sand under this alternative would be reduced to 1,426,650 cubic yards ("cy") per year, approximately 613,350 cy less than the originally proposed Project. **Table 4**, below, provides the overall volumes under the Reduced Project Alternative. All lease areas would experience a reduction in volume, with the exception of Lind Marine's Middle Ground lease.

Table 4: Comparison of Volumes Under Proposed and Reduced Project Alternative

Lease Area	Originally Proposed Project	Reduced Project	% Reduction
Hanson – Central Bay	1,540,000	1,141,039	-25.91%
Hanson – Suisun Associates	150,000	42,738	-71.5%
Lind – Suisun Associates	150,000	42,738	-71.5%
Hanson – Middle Ground	50,000	0	-100%
Lind – Middle Ground	150,000	199,866	+33.24%
Total – All Lease Areas	**2,040,000**	**1,426,650**	**-30.07%**

A. Lind Marine Cannot Feasibly Substitute Bay Sands

(1) <u>Lind – Import of Sand Alternative</u>:

This alternative would fail to meet the fundamental project objective to continue sand mining in San Francisco Bay and Suisun Bay, and would be infeasible based on environmental, technical, economic, practical, and policy factors.

First, the proposed Project is *geographically tied* to the San Francisco Bay Area—and thus under both CEQA and the McAteer Petris Act, an evaluation of importing sand resources from foreign countries is not legally required.[19]

Second, sand mined from Suisun Bay is Lind Marine's sole source of sand for their market. Lind Marine is not in the business of importing sand or any other resources from foreign countries and cannot be expected under any scenario to enter a new market, particular given the substantial barriers to entry.

Third, importing sand from British Columbia would require Lind to abandon its existing rights in several leases (SLC and private), and would involve an entirely different set of aggregate resources, entitlements, facilities, transportation distances and costs, and aggregate product values. The State Lands Commission during the approval process expressly found that the Project objective to continue mining sand at an economically viable level in San Francisco Bay for the next 10 years would not be met if the sand mining leases were not approved and sand resources would have to be imported from foreign countries. (SLC Findings, p. D-38.)

Fourth, importing sand from British Columbia is environmentally unreasonable and impractical. Indeed, the SLC eliminated an import-only alternative from full evaluation in the EIR based on its failure to meet the basic objectives of the Project and its substantial increase in greenhouse gas emissions that would conflict with California climate change policy. (FEIR, p. 3-4 and -5.) The No Project Alternative (which is similar to an import-only alternative in terms of impacts)[20] would generate up to 88 times more emissions than the Project scenario, depending on the pollutant and the operational year. (ENVIRON, pp. 29, 31; FEIR, p. 4.5-27.)

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[19] *Save San Francisco Bay Ass'n*, 10 Cal.App.4th at 926; *SPRAWLDEF*, 226 Cal.App.4th at 929.

[20] The No Project Alternative evaluated in the EIR evaluated air emissions based on the assumption that approximately half of the proposed Project volume of sand would be sourced from land-based quarries, with the other half being sourced from British Columbia. (See FEIR, Appx. D, p. 27.) The ENVIRON Report evaluated emissions under two No Project scenarios: (1) the Original No Project scenario, with approximately 1/4 of total sands being delivered from British Columbia and 3/4 being sourced from land-based providers; and (2) the Increased British Columbia scenario, with an approximately 50/50 split between imports and land-based sources. (ENVIRON Appendix, p. 27.) The figures provided in this section are based on total emissions in 2015 under the Increased British Columbia scenario (ENVIRON Appendix, p. 29), as those figures are more reflective of the Import of Sand Alternative.

Fifth and finally, the sands that Lind mines at Middle Ground and Suisun are fill sands, used in asphalt, for backfill materials, and concrete. This quality of sand is currently not available for import from British Columbia. Thus, it is practically infeasible for Lind to substitute Bay sands with sands from British Columbia.

(2) <u>Lind – Land-Based Quarries Alternative</u>:

This alternative would not only fail to meet the fundamental project objective to continue sand mining in Middle Ground, and Suisun Bay, but would be infeasible based on environmental, technical, economic, and practical factors.

First, as with an import-only alternative, sand mined from Suisun Bay is Lind Marine's sole source of sand for their market. Under the Land-Based Quarries Alternative, Lind Marine would be forced to forfeit its existing rights to mine private and SLC lease areas in Middle Ground and Suisun Bay. In addition, this alternative would involve an entirely different set of aggregate resources, entitlements, facilities, and transportation distances and costs. Lind does not currently own or operate any land-based quarries and is not in the business of producing land-based sand resources. Lind cannot be expected under any scenario to abandon one market and enter an entirely new market and, to the extent this alternative would compel Lind to develop or entitle new sand mining sites beyond the Bay, it is not legally required.

Second, a land-based quarry alternative would present significant and unreasonable increases in environmental impacts:

- Supply from land-based quarries that have suitable alternative sand would involve significant increases in road transportation and would result in new effects on Bay Area roadways. As the SLC stated in its Findings approving the Project, "[t]he combination of use of efficient suction dredge equipment for extraction of the sand resource from the Bay floor; barge transportation of large loads (up to 2,000 cubic yards) of sand to off-loading facilities located throughout the region; and the resulting relatively limited use of ground transportation to ship the material to its point of use, result in a relatively limited use of ground transportation to ship the material to its point of use, result in a relatively energy efficient means of producing and transporting construction aggregate." (SLC Findings, p. D-35.)

- Local mining minimizes fuel consumption associated with transport, as well as associated air pollution (including greenhouse gas emission), traffic congestion, and road maintenance." (FEIR, p. 4.2-3.) Indeed, when nearby sources of aggregate do not exist, [t]ransporting aggregate from distant sources results in increased construction costs, fuel consumption, greenhouse gas emissions, air pollution, traffic congestion, and road maintenance." (California Geological Survey, *Aggregate Sustainability in California*, 2012, p. 1.)

- In the context of air quality impacts, "increased production at land-based quarries may lead to higher health risks, since toxic air contaminant emissions from land-based quarries may be more likely to impact residential developments and other sensitive receptors than offshore mining activities and transportation" and these effects "could be significant and unavoidable" (FEIR, pp. ES-18, 4.5-28).

- This alternative, like the import-only alternative, would result in a substantial increase in greenhouse gas emissions that would conflict with California climate change policy. Again, the No Project Alternative (which is similar in some impact calculations to a land-based quarries alternative)[21] would generate up to 45 times more emissions than the Project scenario, depending on the pollutant and the operational year. (ENVIRON, p. 31; *see also* FEIR, p. 4.5-27.)

For all of the above reasons, a land-based quarry alternative is unreasonable, impractical, and infeasible for Lind Marine.

(3) <u>Lind – Reduced Project Alternative</u>:

This alternative would reduce permitted annual mining volumes in all of the Lind and Hanson lease areas to a level equivalent to the overall baseline mining volume of 1,426,650 cubic yards annually. For Lind, that would equate to a volume of 242,739[22] cubic yards annually (a reduction of 57,261 cubic yards per year) in the Suisun and Middle Ground lease areas. (FEIR, p. 2-24, Table 2-3.) The SLC expressly found that the Reduced Project Alternative (baseline volumes at almost all lease areas) is "infeasible" based on "economic and other environmental/biological considerations. . . ." (SLC Findings, pp. D-14, -20, -23, -25, and -34.)[23] These findings are supported for a number of reasons summarized below.

First, the Final EIR evaluated a similar Reduced Project Alternative and found that it would have "greater impacts than the proposed Project, since it is assumed that sand would be mined from the Bay only up to the volume of the baseline scenario and that the remainder of sand would be replaced with sand mined at land-based quarries (e.g., half

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[21] See Footnote 19 regarding the evaluation of emissions in the EIR and the ENVIRON Appendix. The ENVIRON Appendix figures referenced in this paragraph are based on total emissions in 2015 under the Original No Project scenario, as those figures are more reflective of the Land-Based Quarries Alternative. (ENVIRON Appendix, p. 31.)

[22] This is calculated as 199,866 for Lind Middle Ground and half of the Suisun Associates lease volumes of 85,746.

[23] The Reduced Project Alternative evaluated by the State Lands Commission in its EIR omitted baseline volumes from PRC 5871 as that lease area was not proposed to be mined as part of the proposed Project. Nevertheless, the baseline volumes determined for impact purposes equated to the total annual average between 2002 and 2007 of 1,426,000 cy.

from local quarries and half from British Columbia)." (FEIR, p. ES-18.) Consequently, the Reduced Project Alternative would result in:

- Higher PM_{10} emissions within the Bay Area Air Basin;

- Higher emissions of greenhouse gas emissions due to the assumed ocean transport of some sand to the Bay Area from British Columbia[24]; and

- Higher health risks from toxic air contaminant emissions from land-based quarries due to increases in emissions and closer proximity of those emissions sources to residential homes and other sensitive receptors.

Thus, "with *each increment* of reduced sand mining from the Bay and Delta—assuming that the demand for sand would be met from other sources—emissions of NO_x, PM_{10}, and $CO2_e$ rise *substantially*." (FEIR, p. 4.5-29, emphasis added; *see also* SLC Findings, pp. D-18 and D-19.) Because the Reduced Project Alternative would result in a contribution of substantial new greenhouse gas emissions, the State Lands Commission found that this alternative would conflict with California's climate change policy and thus would be infeasible for environmental and policy reasons. (SLC Findings, pp. D-20, -23, and -25.)

Second, the State Lands Commission in referencing Hanson's Central Bay leases noted that the leases "will provide jobs for tug and barge operators and other employees associated with Hanson's [and Lind's] mining operations, that otherwise might not be provided if the economy strengthens but Hanson [or Lind] is unable to supply construction-grade sand under the Reduced Project Alternative to meet local demand." (SLC Findings, p. D-14.) "This," the State found, "would negatively affect the Bay Area economy." (*Id.*)

Third, under a reduced volume alternative, Lind would not be able to meet peak customer demands in the San Francisco Bay Area that would otherwise be met under the proposed Project scenario. Citing the California Geological Survey report on Aggregate Sustainability, the EPS Report emphasized that "construction aggregates are essential for modern society and the construction and maintenance of infrastructure and buildings we rely on." (EPS Report, p. 17.) Demand and consumption of aggregate (and specifically sand) is only projected to increase in the coming years (*id.*, pp. 20-32), and yet the North and South San Francisco Bay Area regions have only "11 to 12 years of permitted aggregate supply" (*id.*, p. 17). Further, not all surface quarries or BC resources have suitable replacement materials for Bay sands, and some of those replacement materials would be considerably more expensive for the local market. (*See, e.g.*, *id.*, pp. 6, 13, 35.)

[24] As analyzed by ENVIRON, the Reduced Project Alternative analyzed in the EIR would likely generate 15 times more greenhouse gas emissions than under the Project scenario. (ENVIRON Appendix, pp. 1, 31.)

For all of these reasons, and the reasons stated in Subsections V.A.1 and A.2, above, a reduced volume alternative would be unreasonable, impractical, and undesirable from a climate policy perspective.

B. Hanson Cannot Feasibly Substitute Bay Sands

(1) <u>Hanson – Import of Sand Alternative</u>:

This alternative would fail to meet Hanson's fundamental project objective to mine sand in Central Bay, Suisun Bay, and Middle Ground to satisfy regional market demands, and would be infeasible based on environmental, technical, economic, practical, and policy factors.

First, the proposed Project is *geographically tied* to the San Francisco Bay Area—and thus under both CEQA and the McAteer Petris Act, an evaluation of importing sand resources from foreign countries is not legally required.[25]

Second, importing sand from British Columbia would require Hanson to abandon its existing rights in several leases (SLC and private), and would involve an entirely different set of aggregate resources, entitlements, facilities, transportation distances and costs, and aggregate product values. The State Lands Commission during the approval process expressly found that the Project objective to continue mining sand at an economically viable level in San Francisco Bay for the next 10 years would not be met if the sand mining leases were not approved and sand resources would have to be imported from foreign countries. (SLC Findings, p. D-38.)

Third, importing sand from British Columbia is environmentally unreasonable and impractical. Indeed, the SLC eliminated an import-only alternative from full evaluation in the EIR based on its failure to meet the basic objectives of the Project and its substantial increase in greenhouse gas emissions that would conflict with California climate change policy. (FEIR, p. 3-4 and -5.) The No Project Alternative (which calculated increased emissions from both sand imports and land-based quarries)[26] would generate up to 88 times more emissions than the Project scenario, depending on the pollutant and the operational year. (ENVIRON, pp. 29, 31; FEIR, p. 4.5-27.)

Fourth, while Hanson currently imports sand from British Columbia, it is not feasible for Hanson to replace Central Bay sands with imported sands for the following reasons:

- Hanson's existing off-loading facilities that are used to receive Central Bay sands cannot currently receive ships from Canada due to the depth of the water at these offloading locations. The ships that come in from Canada require deep

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[25] *Save San Francisco Bay Ass'n,* 10 Cal.App.4th at 926; *see also SPRAWLDEF,* 226 Cal.App.4th at 929.

[26] See Footnote 19.

berths for offloading material. Hanson's two off-loading facilities used for the proposed Project have insufficient depth for these ships.

- Hanson's current barge is not designed to be top loaded, engineering and modifications to make it suitable for loading and unloading would be impractical. Therefore, Hanson would have to acquire an additional barge suitable for lightering cargo from a ship and would also have to acquire several like barges to lighter economically. Thus, transferring sand from the large ships coming from Canada is economically impractical for Hanson.

- The off-loading facilities have inadequate capacity to receive imports. The combined capacity of Hanson's two offloading facilities is 40,000 tons. However, the capacity at Pier 94 (where imported sand and hard rock is offloaded) is 120,000 tons. Delivery of sand imports from British Columbia (which are always accompanied by hard rock) in smaller shipment volumes that Hanson's existing offloading facilities could accommodate is not economically practical or feasible due to the high transportation costs associated with each individual trip.

- British Columbia mines involve sand and gravel alluvial deposits, which produce sand and rock together during the production process. Neither rock nor sand can be made by itself, because the material in the pit is a mixture of sand and rock. When sand is produced, there must also be an immediate market identified for the associated rock deposits. Thus, contracts for import of sand from British Columbia must be "balanced" with rock. There is no current market in the Bay Area and Hanson has no way to stockpile the additional rock produced.

Fifth, and finally, the sand that Hanson mines at Middle Ground is fill sand, used in asphalt and concrete. This quality of sand is currently not available for import from British Columbia. Thus, the Import of Sand Alternative is not practical or reasonable and is technically infeasible for Hanson.

(2) <u>Hanson – Land-Based Quarries Alternative</u>:

This alternative would not only fail to meet the fundamental project objective to continue sand mining in Central Bay, Middle Ground, and Suisun, but would be infeasible based on environmental, technical, economic, and practical factors.

First, this alternative would require Hanson to abandon its existing rights in SLC and private leases, and would involve an entirely different set of aggregate resources, entitlements, facilities, and transportation distances and costs. And to the extent this alternative would compel Hanson to develop or entitle new sand mining sites from sites beyond the immediate Bay Area, it is not legally required.

Second, the sands available at land-based quarries do not share the same characteristics as Bay Sands. "Bay sands are preferred sands to use in the concrete industry" because they "have rounded edges as a result of erosive forces acting on the surface of the sand grains that cause less wear on pumping equipment used to direct concrete and related construction materials." (SLC Findings, D-35.)

Third, the transportation issues alone present significant additional environmental impacts:

- Land-based quarries would involve significant increases in road transportation and would result in new effects on Bay Area roadways. As the SLC stated in its Findings approving the Project, "[t]he combination of use of efficient suction dredge equipment for extraction of the sand resource from the Bay floor; barge transportation of large loads (up to 2,000 cubic yards) of sand to off-loading facilities located throughout the region; and the resulting relatively limited use of ground transportation to ship the material to its point of use, result in a relatively limited use of ground transportation to ship the material to its point of use, result in a relatively energy efficient means of producing and transporting construction aggregate." (SLC Findings, p. D-35.)

- Local mining minimizes fuel consumption associated with transport, as well as associated air pollution (including greenhouse gas emission), traffic congestion, and road maintenance." (FEIR, p. 4.2-3.) Indeed, when nearby sources of aggregate do not exist, [t]ransporting aggregate from distant sources results in increased construction costs, fuel consumption, greenhouse gas emissions, air pollution, traffic congestion, and road maintenance." (California Geological Survey, *Aggregate Sustainability in California,* 2012, p. 1.)

- From Hanson's two key off-loading sites in San Francisco and Oakland a majority of the sand (approximately 85 percent) is trucked within only 10 miles to concrete and asphalt plants. Only a small percentage of Bay sand is trucked to concrete and asphalt plants as far north as Martinez, as far east as Pleasanton, and as far south as Union City in the East Bay and South San Francisco on the peninsula (see **Figure 1** for illustration).

- In the context of air quality impacts, "increased production at land-based quarries may lead to higher health risks, since toxic air contaminant emissions from land-based quarries may be more likely to impact residential developments and other sensitive receptors than offshore mining activities and transportation" and these effects "could be significant and unavoidable" (FEIR, pp. ES-18, 4.5-28).

- This alternative, like the Import of Sand Alternative, would result in a substantial increase in greenhouse gas emissions that would conflict with California climate change policy. As analyzed by ENVIRON, the No Project Alternative[27] would generate up to 45 times more emissions than the Project scenario, depending on the pollutant and the operational year. (ENVIRON, p. 31, see also FEIR, p. 4.5-27.)

Fourth, unlike Lind, Hanson does operate land-based quarries for sand and gravel. The majority of Hanson's land-based resources, however, do not produce sand and gravel of the type produced from marine-based areas and thus would not serve as alternative sources of sand for Hanson. Sunol, a quarry in Alameda County operated by Hanson Aggregates, does produce some sand of the similar type to Bay sands. In addition to increases in environmental impacts associated with operation of the quarry (e.g., climate, air quality, and surface transportation), there are a number of technical, economic, and other considerations that render Sunol an infeasible alternative to Bay sand mining.

Hanson holds a lease and permits to mine the Sunol quarry for the next 35 years. Sunol is a sand and gravel alluvial deposit, which produces sand and rock together during the production process. Neither rock nor sand can be made by itself, because the material in the pit is a mixture of sand and rock. There are significant limits on the quarry's operations. First, the mine is only permitted to produce between the hours of 6:00 a.m. and 10:00 p.m. The plant can run at approximately 800 tons per hour, 30% of which is waste. Of the remaining volume, only about 25% is suitable for construction-grade sand, while the remaining 75% is suitable to produce various sizes of rock. This amounts to a maximum annual production capacity for sand of approximately 328,000 cubic yards. This amount is sold out today and therefore there is no replacement capacity for the marine sands.

Further, Hanson has a limited ability to stockpile rock and sand. Thus, when sand is produced, there must also be an immediate market identified for the associated rock deposits. Otherwise, the quarry will produce an overabundance of rock at great cost and no immediate value. For example, in 2013 Sunol produced a total of 925,000 tons of sand and rock. Of the total amount produced, 22% was sand (202,000 tons or 146,000 cubic yards). To address the quarry's inventory, production of sand and rock had to be balanced, and all of the produced sand was sold. If Hanson needed to double production of sand to 292,000 cubic yards (an amount that would never replace Hanson's supply of Bay sands), production at the Sunol quarry would have to double to a total of 1.8 million tons of sand, rock, and waste material. But there is no current market for the extra 723,000 tons of rock that would be produced. Consequently, Sunol simply cannot produce more sand at this time due to market and other technical reasons.

The only other land-based quarry operated by Hanson that might produce some construction-grade sands is the Clayton Quarry. That quarry, however, is a blast quarry, meaning it produces sand by blasting the rock out of the ground and then breaking it down to varying sizes. The quarry produces approximately 60,000 cubic yards of manufactured sand—that is, sand manufactured from rocks that are continually crushed to the appropriate gradation. Manufactured sand is quite distinct from alluvial and Bay sands, as

[27] See Footnotes 19 and 20.

it has an angular-shaped grain. Also, to crush rock down to sand takes a considerable amount of energy. Once again, to address inventories, production must be "balanced" between rock and sand. The quarry is sold out in 2014 and has no spare capacity.

To produce enough construction-based sand to replace a portion of its currently permitted volumes of Bay sands, Hanson would be forced to entitle new quarries within reasonable distance from current offloading sites or purchase the rights to other quarries currently owned and operated by others. New sites, however, are impossible to permit at this time, and it is impractical and unreasonable to consider forcing Hanson to operate land-based quarries which it has no rights to. Consequently, it is infeasible for Hanson to seek these alternative sources.

(3) <u>Hanson – Reduced Project Alternative</u>:

The alternative would reduce Hanson's volumes to baseline volumes overall at Central Bay and Suisun Bay of 1,141,039 and 42,738, respectively, for a total of only 1,183,777 cy annually.

Under the Reduced Volume Alternative, Hanson would not be able to meet peak customer demand within the San Francisco Bay Area that would otherwise be met under the proposed Project scenario. As with the No Project Alternative, it is assumed under a Reduced Project Alternative that the construction industry's demand for sand beyond that supplied by this alternative would be met by land-based Bay Area quarries, aggregate recycling facilities, and imports from Mexico or British Columbia (though not necessarily from Hanson).

The Reduced Project Alternative would result in a substantial increase in environmental impacts over the proposed Project:

- For "each increment of reduced sand mining from the Bay and Delta – assuming that the demand for sand would be met from other sources – emissions of NOx, PM10, and CO2e rise substantially." (FEIR, p. 4.5-29.) Because the Reduced Project Alternative would result in a contribution of substantial new greenhouse gas emissions, the SLC found that this alternative would specifically conflict with California climate change policy. (SLC Findings, pp. 12, D-19, D-21.)

- "[I]ncreased production at land-based quarries may lead to higher health risks, since toxic air contaminant emissions from land-based quarries may be more likely to impact residential developments and other sensitive receptors than offshore mining activities and transportation; such effects could be significant and unavoidable." (FEIR, p. 4.5-29.) As analyzed by ENVIRON, the Reduced Project Alternative would generate 15 times more emissions than the Project scenario. (ENVIRON, p. 1.)

Finally, a reduction in peak mining volumes for the Central Bay leases by 31.97%, from 1,740,000 originally proposed to 1,183,777 in the Reduced Project Alternative over the 10-year permit term would render the Project economically unreasonable and impractical as it would not allow Hanson to respond to fluctuations in customer demand for sand in the Bay Area. Further, the costs of sand mining operations is relatively fixed, and thus any further reductions in volumes limit Hanson's ability to cover those costs on a year to year basis.[28] The ability to address market peaks is crucial to the ongoing viability of the operation.

VI. SUBSTANTIAL PUBLIC BENEFITS OF BAY SAND MINING

The final prong of the analysis and findings under Subtidal Policy 2 addresses the public benefits of the project. Specifically, the policy states that dredging projects in scarce subtidal areas "should be allowed only if . . . the project provides substantial public benefits." This section summarizes several of the substantial public benefits of sand mining in the Bay.

A. The Legislature Has Declared That Development Of The State's Mineral Resources Is An Important State Policy

Almost forty years ago the California Legislature unequivocally declared, in enacting the Surface Mining and Reclamation Act of 1975 ("SMARA"), that "the extraction of minerals is *essential* to the continued economic well-being of the state and to the needs of the society."[29] The Legislature also declared that "the production and development of local mineral resources that help maintain a strong economy and that are necessary to build the state's infrastructure are vital to reducing transportation emissions that result from the distribution of hundreds of millions of tons of construction aggregates that are used annually in building and maintaining the state."[30] It is therefore "the continuing policy of the State of California . . . *to foster and encourage* private enterprise in . . . [t]he orderly and economic exploration, development, and utilization of the state's mineral resources…."[31] This is echoed in the McAteer-Petris Act itself, which explained "that the public interest in the San Francisco Bay is in its beneficial use for a *variety of purposes* . . . ."[32] Indeed, the Act requires that the San Francisco Bay Plan include provisions concerning "development of the Bay" for a variety of uses and industries.[33]

The SLC in its EIR echoed these sentiments, and acknowledged the strong "[s]tate and local policy that recognizes the importance of mineral resources in meeting society's needs. . . ." (FEIR, p. 4.2-9.) Bay sand mining fulfills these important public policies of the State, in that it fosters the utilization of the State's mineral resources, provides a local

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[28] See *SPRAWLDEF*, 226 Cal.App.4th at 918-921 [BCDC found a reduced-project alternative to be infeasible based on the relatively fixed costs of the enterprise and the impracticality of satisfying those cases with reduced revenues].

[29] Pub. Resources Code, § 2711(a), emphasis added.

[30] *Id.*, § 2711(d).

[31] *Id.*, § 2650(a), emphasis added.

[32] *Id.*, § 66600, emphasis added.

[33] *Id.*, § 66651(c).

resource for building the regional economy and infrastructure while reducing transportation emissions, and contributes to the continued economic well-being of the State and needs of the surrounding community.

B. Bay Sands Are An Important Resource For Construction

Sand mining has occurred in the San Francisco Bay and Delta for more than 70 years, "providing jobs and supplying high quality sand to the Bay Area construction industry." (SLC Findings, p. D-34.) The sand resource mined by Hanson is composed of alluvial sand and gravel, which is valuable as construction aggregate or as construction fill material. As a construction aggregate resource, alluvial sand and gravel have some advantages over crushed stone in terms of concrete workability and impacts on equipment. For example, a wet mix of construction-grade concrete made from crushed stone aggregate is generally more difficult to work with than the same mix made from alluvial aggregate, as the sharp edges of angular fragments of crushed stone increase wear and damage to pumping equipment. Due to its inherent properties and more reasonable price, Bay sands are one of the preferred sands to use in the concrete industry. Local resources of sand are also in short supply. For these and other reasons, the State Lands Commission declared in its EIR that there is a "clear and substantial benefit to maintaining a local source of construction material" in the Bay Area. (FEIR, p. 4.7-27.)

C. Bay Sands Generate Significant Revenues For State And Local Agencies

Continuing Hanson and Lind Marine's existing mining operations for an additional 10 years will have "numerous benefits to the State of California and Bay-Delta region, including generation of substantial royalties to the state." (SLC Findings, p. D-34.) Indeed, annual royalties and rent to the California State Lands Commission and rent to the Port of San Francisco could reach as high as $3.1 million (Reduced Project) to $4.6 million (Proposed Project), a total of $31 to $46 million over the life of the permit. (EPS, *Assessment of Economic Impacts Associated with Sand Mining in San Francisco Bay* (Sept. 18, 2014), p. 37, Table 13.) What is more, as rents from public trust resources, those revenues must in turn be used for statewide or public trust purposes (i.e., for the benefit of the public).

D. Bay Sands Are An Important Resource For Addressing Resiliency To Climate Change and Other Public Projects Around The Bay

In the future, warmer temperatures worldwide will result in accelerated sea-level rise from the thermal expansion in ocean water and the melting of glaciers and ice sheets. This rising water will both erode and inundate existing intertidal wetlands and beaches. To address this issue, the California Coastal Commission, in its recent draft Sea-Level Rise Policy Guidance document, recommends that (as an alternative to "hard armoring" such as seawalls) sand be placed on beaches to reduce erosion, enhance recreation, and preserve and enhance aesthetic and habitat values. (California Coastal Commission, *Sea-Level Rise Policy Guidance Public Review Draft* (Oct. 14, 2013), p. 153.) BCDC's response to global warming, with its recently adopted Bay Plan climate change amendments, makes regional sediment management particularly important. Without the benefit of sand supplies from the Bay, the sand needed for sea-level rise adaptation projects (not to mention the construction industry in the Bay Area) would have to be transported long distances by train or truck or shipped from foreign sources. In addition to the increased economic cost of this shipping, the greenhouse gases emitted in transportation of those resources would contribute to global warming and adversely impact air quality in the Bay region, contrary to Bay Plan policies.

E. Bay Sands Benefit The Greater San Francisco Bay Region Economy

1. Bay sands help fulfill regional demands and address shortfalls in permitted reserves

California is the nation's largest producer of sand and gravel, yet due to a growing population and associated infrastructure needs, demand has historically outstripped supply. As the State Lands Commission found, "[a]lthough the downturn in the economy has temporarily reduced the need for sand and gravel, the overall trend is expected to rise substantially in the future." (SLC Findings, p. D-35.) Yet permitted reserves in the North San Francisco Bay Region comprise only 8 percent of the expected 50-year demand of 647,000,000 tons…." (SLC Findings, p. D-36.) The State Lands Commission in its findings explained the problem as follows:

> A 2006 CGS study on aggregate availability estimates that demand for construction aggregate in California in the next 50 years will total approximately 13.5 billion tons, not including increased demand following major bond initiatives, e.g., for major public infrastructure projects, or from reconstruction following a major earthquake. The study identifies approximately 74 billion tons of non-permitted construction aggregate resources in California, but points out that these resources are not likely to be fully exploited due to social, environmental, and economic concerns. The report assesses the current availability of California's permitted aggregate resources, based on a series of mineral land classification reports completed between 1981 and 2005 that identify and assess economically significant aggregate deposits in 31 study areas across the state, including two in the greater San Francisco Bay Area. . . . The CGS report concludes that four of the 31 aggregate study areas were projected to have less than 10 years of permitted resources remaining. This includes the North San Francisco Bay Production-Consumption (P-C) Region. (SLC Findings, page D-36.)

More recent assessments of long-term demand and permitted reserves vary little in their pessimism. While Bay sands comprise only a fraction of the resources needed to meet projected shortfalls, they nonetheless provide an important piece. This problem is even more acute in the immediate Bay Area, where local land-based quarries are running low on reserves and it has become essentially impossible to permit any new quarries. This local source of sand to address the shortfalls in permitting reserves provides a substantial public benefit.

2. Bay sand mining reduces transportation and construction costs

As the State Lands Commission expressly found in its approvals of the lease extensions, "transportation cost is the primary constraint that defines the market area for an aggregate mining operation." (SLC Findings, pp. D-36 and -37.) Aggregate is a high weight-to-unit value commodity such that demand for aggregate tends to be met with local supply where possible. The more efficient equipment for extraction of the sand resource from the Bay floor and relatively limited use of ground transportation to ship the material to its point of use, results in a relatively energy-efficient and cost-effective means of producing and transporting construction aggregate for local uses. If Bay sand mining is eliminated or reduced substantially and demand for aggregate must be fulfilled from local or foreign land-based sources, Bay Area local governments—in the form of higher construction costs and additional road maintenance—could incur an added $1.5 million to $4 million on an annual basis. (EPS Assessment, p. 9-10.) Increased construction sand and road maintenance costs to public agencies, in turn, could increase by $14.8 million and $46.2 million over the 10-year permit period. Avoiding these added costs for Bay Area governments and public agencies provides a substantial public benefit.

3. Bay sand mining helps maintain local jobs

Sand and gravel mining has occurred in the San Francisco Bay and Delta for more than seven decades, providing jobs and supplying high quality sand to the Bay Area construction industry. Bay sand mining will continue to provide jobs for tug and barge operators and other employees associated with mining operations that otherwise might be lost. This will, in turn, benefit the Bay Area economy. (SLC Findings, p. D-37.)

F. Bay Sands Provide Direct And Indirect Environmental Benefits

As the State Lands Commission concluded in its EIR, there is a "clear and substantial public benefit" to maintaining a local source of construction material, including reduced environmental impacts over land-based quarries or imported sources. (FEIR, p. 4.7-27; SLC Findings, p. D-37.) Specifically, marine-based sources of sand provide numerous environmental benefits:

- Marine-based sand reduces air emissions from operations (PM_{10} and NO_X) and transportation source emissions associated with land-based quarries and imports from British Columbia;

- Marine-based sand reduces local traffic congestion from trucks associated with sand deliveries to local customers from land-based quarries and resources in British Columbia, and could take as many as 19,336 haul-truck roundtrips off local roads (ENVIRON, *Air Quality Technical Appendix* (Dec. 9, 2013), p. 1 and Tables P.17 and NP.7); and

- Marine-based sand reduces projected greenhouse gas emissions from land-based quarries and British Columbia resources by as much as 10,135 to 18,004 metric tons annually (FEIR, pp. 4.5-21 and -28; ENVIRON Appendix, pp. 22 and 29).

The evidence is clear that transporting aggregate from distant sources results in increased fuel consumption, greenhouse gas emissions, air pollution, and traffic congestion. (California Geological Survey, *Aggregate Sustainability in California* (2012), p. 1.) Bay sand mining will provide a substantial public benefit in helping to reduce these significant regional and global environmental problems.

VII. SUMMARY AND CONCLUSIONS

As stated in the Introduction, Subtidal Policy 1 requires that "[p]rojects in subtidal areas should be designed to minimize and, *if feasible*, avoid any harmful effects." Under Subtidal Policy 2, dredging projects and changes in use in scarce subtidal areas are allowed only if: "(a) there is no *feasible* alternative and (b) the project provides substantial public benefits."

The proposed Project has been thoroughly evaluated to determine local and Bay-wide effects as supported by the EIR, additional supplemental analysis for BCDC and USACE, as well as through the consultation process with NMFS, USFWS, and CDFW. Over the past 8 years, Hanson and Lind have developed new operational measures, monitoring, and verification studies to avoid and minimize harmful effects as detailed in Section IV.C, above. A prime example was the installation of fish screens. The design was developed through a collaborative process with resource agency scientists and engineers to be protective of the most sensitive species and thus help protect non-sensitive fish species as well. Furthermore, any unavoidable potential impacts have been fully mitigated through compensatory mitigation, as well as substantial reduction in volumes imposed by the RWQCB.

Data gaps in scientific knowledge about sandy habitats within the lease areas have been addressed through coordination with various regulatory agencies and as detailed in Section IV.C, above, and additional studies will be implemented to further increase the understanding of habitat and bathymetric changes within the lease areas. The percentage of disturbance area due to sand mining activities within each lease area is extremely small. When looking at the total available sandy habitat within the Bay, the percentage of disturbed area in comparison to available habitat was only 2.2%. This indicates that only a small portion of available habitat is disturbed due to sand mining activities within this large, dynamic system. The EIR and the best scientific evidence available (AMS 2009 and Hanson 2004) indicate there is no discernable adverse effect on Bay habitats due to sand mining activities.

Sand mining within the lease areas of Central Bay, Middle Ground, and Suisun Bay is important not just to the continuing operations of Hanson and Lind Marine, but more so to the San Francisco Bay Region. Sand mining fulfills a basic resource need, and locally produced sand results in significant revenues to public agencies and substantial reductions in the economic and environmental costs to the region. The replacement of Bay sands with sand from either land-based quarries or British Columbia, or the Reduced Project Alternative, are neither reasonable nor feasible alternatives due to the economic, policy, and environmental reasons cited in Sub-Sections V. A, B, and C above.

Finally, as detailed in Section VI the proposed Project would deliver substantial public benefits to the State and the regional economy, including providing an important mineral resource of the State to Bay Area communities and for public infrastructure. Thus, the analysis presented within this supplemental analysis supports the conclusion that the project as proposed is consistent with Subtidal Policy 1 and 2.

Appendix D

COAST & HARBOR ENGINEERING

Technical Analysis

Technical Report: Analysis of Impacts of Sand Mining in San Francisco Bay on Sediment Transport and Coastal Morphology in San Francisco Bay, Suisun Bay and outside the Golden Gate[1]

EXECUTIVE SUMMARY

The purpose of this Technical Report is to provide information concerning ten-year permit extensions for the mining of construction-grade sand at seven existing lease areas within Central San Francisco Bay (Central Bay), Suisun Bay, and the western Delta (Project).

In 2006 Hanson Marine Operations (Hanson) and Jerico Products, Inc. (Jerico) submitted applications to the California State Lands Commission (CSLC) for the renewal of five sand and gravel leases.[2] Pursuant to the California Environmental Quality Act (CEQA), in October 2012 the CSLC certified a Final Environmental Impact Report (FEIR) examining the potential environmental effects of the proposed Project. In December 2012, Hanson and Jerico submitted an application for a Section 10 permit with the United States Army Corps of Engineers (USACE). Thereafter, in February 2013, Hanson and Jerico submitted permit applications with the Bay Conservation and Development Commission (BCDC) for the Project.

This Technical Report has been prepared to support an Environmental Assessment (EA) of the Project for the USACE under the National Environmental Policy Act (NEPA), respond to comments submitted to the USACE concerning the Project's impacts on sediment supply to the San Francisco Bar (Bar) and coastal erosion, and address whether recently published studies on sediment transport pathways and coastal morphology necessitate supplemental environmental review under CEQA by any responsible agencies.

This Technical Report summarizes the CSLC's previous analysis of the Project's impacts on sediment transport and coastal morphology in the 2012 FEIR, provides a review of both historical sediment supplies and large-scale sediment transport dynamics in the San Francisco Bay Coastal System, and summarizes available field data and modeling efforts of coastal morphology and sediment transport processes and resource availability, including recently published studies by the United States Geological Survey (USGS). The Report is structured as follows:

- Section 1: Introduction and Background
- Section 2: San Francisco Bay Coastal System Geologic Regime and Large-Scale Transport Processes
- Section 3: Summary of Field Data Analysis
- Section 4: Summary of Numerical Modeling
- Section 5: Summary of Recently Published Studies on Sediment Transport and Coastal Erosion

[1] Scott Fenical, Matteo Tirindelli – Coast & Harbor Engineering, Inc.; Christine Boudreau – Boudreau Associates LLC; Barry Keller.

[2] No CSLC lease is required for the two Middle Ground Shoal leases in Suisun Bay as those two parcels are privately owned.

- Section 6: Conclusions

Below is a summary of the key findings of this Technical Report:

- The FEIR and independent studies by USGS and others agree that a historically dominant sediment transport pathway for beach-sized sand towards the open coast exists from the Sacramento River, through Suisun Bay/San Pablo Bay and Central Bay, and seaward across the Golden Gate.
- Bathymetric changes, numerical modeling, grain size data, independent studies by USGS and others, and the FEIR confirm that contraction of the Bar and related coastal erosion (including erosion along some areas of Ocean Beach) are governed by much larger and longer-term physical processes (natural and anthropogenic).
- Numerical computer modeling performed for the FEIR demonstrates that the Project's incremental potential contribution to a further deficit of Bar sediment is likely to be less than 0.2 to 0.3 percent of the annual ongoing observed Bar erosion volume. The FEIR also analyzed bottom changes from multi-beam bathymetric data, which shows that the mining depressions in Central Bay did not significantly fill in with sand during the period 1997-2008. Therefore, the FEIR found that mining in the lease areas is not likely to result in measurable sediment deficit (i.e. erosion) at the Bar or coastal beaches outside the Golden Gate, including Ocean Beach, due to sediment impoundment in the mining holes.
- The CSLC concluded in the FEIR that the proposed Project will not, in combination with other past, present, and reasonably foreseeable future actions, result in a cumulatively significant impact on sediment supply to the Bar or coastal erosion in areas outside of the Golden Gate such as southern Ocean Beach.
- The conclusions developed in recently published studies by USGS and others concerning sediment transport pathways and coastal morphology are consistent with the findings and conclusions in the FEIR.
- Recently published USGS studies, including Barnard *et al.* 2013a, do not present any new information of substantial importance, as the studies do not show that the Project will either (1) have one or more significant effects not discussed in the previous EIR, or (2) that any significant effects previously examined will be substantially more severe than shown in the previous EIR. Therefore, the studies do not necessitate the preparation of any subsequent EIR under CEQA.

1. Introduction and Background

In 2006, Hanson and Jerico submitted an application to the CSLC for the renewal of five sand and gravel leases of California sovereign lands in Central San Francisco Bay (Central Bay) and Suisun Bay/western Delta, as well as the modification of annual volume limits, for another ten-year term. Pursuant to CEQA, the CSLC prepared an EIR analyzing Hanson's and Jerico's continued mining of construction-grade sand for an additional ten years within the five CSLC leases and two private leases in Central Bay, Suisun Bay, and the western Delta. (CSLC, 2012). The CSLC certified the FEIR in October 2012, after an extensive five-year environmental review process.[3] Table 1 provides a chronology of the public review process for the EIR.

Table 1. EIR versions and agency comments

Item	Issued by	Date(s) of Issue
Notice of Preparation (NOP) of Draft Environmental Impact Report (DEIR)	CSLC	July 2007
Agencies comments to NOP	Agencies	August 2007
Draft Environmental Impact Report (DEIR)	CSLC	July 2010
Agencies comments to DEIR	Agencies	August – September 2010
Revised Draft Environmental Impact Report (RDEIR)[4]	CSLC	November 2011
Agencies comments to RDEIR	Agencies	November 2011 – January 2012
Final Environmental Impact Report (FEIR)[5]	CSLC	October 2012
Agencies comments to RDEIR	Agencies	October 2012 – August 2013

Early in the environmental review process, the CSLC received several public comments regarding the Project's potential impacts on sediment supply to the Bar and possible contribution to erosion at Ocean Beach and other coastal areas outside the Golden Gate. The Bar is an area directly west of the Golden Gate Bridge where sand and sediments flow through at high velocities from the narrow gate and are deposited into a wide and shallow horse-shoe shaped plateau. CSLC staff explored these possible Project impacts at all stages of its environmental review and reviewed research and analyses on the subject from both the CSLC's own expert and other experts in the field, including those at USGS. (CSLC, 2012 (Chapter 9.0 References, Chapter 4.3: Hydrology and Water Quality).) In conjunction with preparing the Draft EIR, CSLC staff engaged Coast & Harbor Engineering (CHE) to conduct a sand mining resource evaluation and impact assessment for the proposed Project through analysis of measured bathymetric changes and hydrodynamic modeling. (CSLC, 2012, Appendix G).

[3] A summary table with the complete list of comments is shown in Appendix A. Appendix B contains the original comments.
[4] RDEIR (2011) includes responses to the agencies' comments of 2010.
[5] FEIR (2012) includes responses to the agencies' comments of 2011 – 2012.

Independent studies and the FEIR have shown that a historically dominant pathway for beach-sized sand material destined for the open coast outside (west) of the Golden Gate originated from the Sacramento-San Joaquin Delta (Delta), moved through Suisun Bay, San Pablo Bay, and Central Bay before leaving the Golden Gate.[6] The FEIR documented that this pathway is only active for sand-sized material during high river flows such as those in 1996 (the water year modeled in the FEIR). The 1996 peak flood event was the largest that occurred during the ten-year period between 1996 and 2006.

The FEIR also evaluated the potential impacts to the Bar morphology from mining activities, using analysis of bathymetry data and numerical modeling. The magnitude of the potential linkage between the sand mining lease areas in Central Bay and sand delivered to areas outside the Golden Gate (Bar and Ocean Beach) was analyzed in the FEIR and the question was addressed whether the linkage is strong, such that removing sand from the lease areas would result in similar volumetric sand loss on the Bar. Barnard and Kvitek (2010) reported that the Bar is presently losing sand at a rate of 2.5 million CY/year (1.9 million m^3/year). The computer modeling conducted for the FEIR showed that for certain, worst-case hypothetical mining scenarios, the volume of mining proposed over ten years—if it all occurred in the first year of mining—could result in a reduction of sediment supplies to the Bar of up to a maximum of 0.2% to 0.3% of the total annual erosion of the Bar. Due to the conservative assumptions incorporated in the model, the Project's actual reductions in sediment supplies at the Bar were expected to be less than the modeling results and deemed immeasurable. The FEIR analysis did show that, while not a significant factor in Bar erosion, some mining areas do have a stronger linkage to the offshore areas, such as those in southern Central Bay where net transport predicted by all available studies (including the FEIR) is directed seaward, and sand material is most similar in size to sand at the Bar and Ocean Beach.

The FEIR, using direct analysis of USGS multi-beam bathymetry data, also showed that the mining holes in Central Bay did not significantly fill back in during the period 1997 – 2008. Approximately 95% of the sand mined from Central Bay lease/mining areas in the period 1997 – 2008 was not replenished, indicating that sand impoundment in the mining lease areas was minimal. Therefore, the mining areas did not capture a significant amount of sand otherwise directed elsewhere, and therefore did not induce sand deficit in other areas (including the Bar and Ocean Beach) that resulted in measurable erosion. The observed lack of sedimentation in the mining areas confirms that the linkage between the mining areas and the Bar (and therefore Ocean Beach) is weak (i.e. sand volume deficits at the Bar are not similar to sand volumes mined from the lease areas).

Also, sediment transport patterns, as reported in Barnard *et al.* (2013a) and in the FEIR, show that some lease areas of Central Bay are in fact characterized by net sediment transport directed inside Central Bay and not towards the Golden Gate. Analysis of the USGS survey data also indicates that observed migration of bottom erosion (i.e. widening/shallowing of the mining pits), is limited to the immediate vicinity of the mining areas. This is the classic evolution of a dredged hole in an area of medium-coarse sand subject to bedload transport conditions.

[6] It is generally accepted that the Bar supplies sand to Ocean Beach through wave and current-induced transport pathways, Barnard *et al*. (2012), though the Bar's contribution to Ocean Beach has not been quantified. It is unclear to what degree the erosion at southern Ocean Beach (and accretion at northern Ocean Beach) is due to changes in sediment supply to the Bar.

Hanson and Jerico have submitted permit applications to the USACE, BCDC, and the Regional Water Quality Control Board to renew existing permits in order to continue mining sand over the next 10 years. The USACE distributed Public Notices for each of these permit applications in April 2013. As previously stated the USACE received public comments which this technical paper addresses and those comments are identified in Appendix A. In response to Hanson and Jerico's permit renewal application, BCDC provided preliminary comments on the application and requested additional information pertaining to sediment transport, mining area replenishment, and sediment supply downstream of the lease areas. The RWQCB has requested the information generated from these responses as well.

2. Background on San Francisco Bay Coastal System Geologic Regime and Large-Scale Transport Processes

2.1 San Francisco Bay Coastal System Geologic Regime

San Francisco Bay is both an inland extension of the marine waters of the Pacific Ocean and the mouth of a major river system, whose watershed drains 40% of the area of California. Erosion in that watershed is the long-term primary source of sediment that is transported through, and deposited in, the Bay. However, near the Golden Gate sediment also enters the Bay from the ocean coast. The sediment within the Bay has been deposited both under marine conditions, and in a dry, on-land valley, during low sea level episodes of the ice ages. The sediment has been deposited in a geologic regime that includes major active faults, which have moved during the period of deposition. During the past 170 years, human influences have had a significant impact on the Bay.

Sand-sized sediment (the resource that is mined) is transported along the bay floor by currents, which may be generated by tides, breaking waves, or even tsunamis. In contrast, suspended silt-sized sediment is transported in the water column, moving along within the moving water. It happens that the latter, transported suspended sediment, is relatively easy to quantitatively measure, using optical instruments in the water. However, the quantity of sand-sized sediment being transported is very difficult to measure directly, but may be estimated by numerical computer models on the basis of grain size and current velocity.

An important result of the quantitative measurements of suspended sediment is that the amount of material transported from the river watershed has decreased in the past decade – a "tipping point" or "sediment deficit" that may be related to dams in the upper part of the drainage area. However, because the amount of sand-sized transport cannot be quantified, there is no direct evidence as to whether such a phenomenon has occurred with this resource.

Sand-sized unconsolidated sediment in the San Francisco Bay Coastal System is made up of small rock grains that were eroded from the Sierra Nevada and other inland mountain ranges. In the case of Central Bay the sediment also includes rock grains that were eroded from coastal cliffs near the Golden Gate. The sediment is deposited on top of rocks that are divided into northwest-trending geographic areas, divided by active earthquake faults. This includes the San Andreas Fault, located offshore of Golden Gate, beneath the Bar (Jachens *et al*. 2002).

In Suisun Bay, the sand-sized sediment is transported by the modern flow of the Sacramento River, and sand mining occurs in the main flow channel, within the Bay. The shallow sediment overlies a geographic area that has had sedimentary deposition, mainly under the sea, for about 100 million years. These sediments extend downwards tens of thousands of feet (Lauerbach 1951, Parsons *et al*. 2002).

In Central Bay, the sand-sized sediment overlies hard rock, which is at depths up to about 300 feet; this is the thickness of the sand resource. This sediment has all been deposited in the past 2 million years, geologically speaking a short time. It was deposited both under the Bay when it was full of water (such as the present time), and as on-land alluvial deposits when sea level was much lower during ice ages (Chin *et al*. 2004 and McGann *et al.* 2002).

Offshore of the Golden Gate at low sea level stands are sediments transported by the Sacramento River in the geologic pas. Some of this material may have been transported back up toward the Gate and the Bar as sea level rose. Ocean Beach sand is mainly from the Colma and Merced formations, which are very similar unconsolidated sand deposits. This sand would have a chemical signature similar to the sediment in the Delta, but might not be derived from modern transport through Central Bay (Schlocker 1974).

2.2 Large-Scale Transport Processes

The sediment transport dynamics of the San Francisco Bay Coastal System have undergone major natural and anthropogenic changes in the last two centuries. In the 1800s, the Bar was significantly larger in terms of sediment volume and radius, and located farther seaward than present day. Dallas and Barnard (2011) report that "in 1873 the San Francisco ebb-tidal delta [Bar] had a continuous crest, with a broad outer region where depths ranged from 10 to 11 m […]." The record of reliable bathymetric measurements of the Bar began in 1873. However it is not known whether the size of the Bar was stable prior to 1873. From 1873 to present, the Bar lost a total volume of approximately 100 – 150 million m^3 (approximately 130 – 200 million CY) of fine- to coarse-grained sand (Dallas and Barnard, 2011). This documented radial shrinking and volume loss of the Bar is evidence of major changes to the San Francisco Bay Coastal System in the last two centuries. Ganju *et al*. (2008), cited in Barnard *et al*. (2013c) estimated a decrease in mean annual sediment loads to the Delta from a high of greater than 10 Mt/year in the late 1800s to less than 3 Mt/year in the latter half of the 1900s. This change in bar configuration and location is due to combinations of many different factors, including the following:

- <u>Onset and cessation of hydraulic mining activities</u>. Large-scale hydraulic gold-mining in the Sierra Nevada from 1852 to 1884 (Gilbert, 1917 and Krone, 1979 cited in Barnard *et al*., 2013c) increased supply of sand to Suisun Bay, Central Bay and outside the Golden Gate during episodic flood events. This likely caused the Bar to grow considerably and manifest the large-volume, broad-radius picture of the end of the 1800s. With the cessation of hydraulic mining in 1884, a massive source of sediment supply to the San Francisco Bay Coastal System was abruptly interrupted.

- Reduction in tidal prism. The Bay tidal prism has been reduced by approximately 9% in the last century (Dallas and Barnard, 2011) due to infilling of the Bay surface area between low and high tide, therefore reducing the strength of the tidal currents. Since the tidal currents lose strength required to transport the sand further away from the Golden Gate, the sand is deposited landward of the Bar, and the outer portion of the Bar is continually eroded by waves. Therefore the erosion on the offshore side of the Bar and accretion on the on-shore side of the Bar results in an apparent shoreward migration.
- Navigation channel dredging. USACE has dredged the entrance channel to San Francisco Bay directly through the Bar since 1931, constituting direct removal of sand from the Bar itself. The dredging area is 26,000 feet long, 2,000 feet wide and maintained at a depth of 55 feet (MLLW). The rate of sand removal from the Bar through dredging has varied historically. The maximum annual dredging volume during this period of 1,430,000 cubic yards was removed in 1975, and the mean annual dredging volume from 1931 to present was approximately 510,000 cubic yards (Dingler *et al.*, 2012).
- River damming. Construction of dams, reservoirs and flood-control bypasses in the 1900s trapped and/or reduced the transport of sediment to the San Francisco Bay Coastal System (Brice, 1977; Wright and Schoellhamer, 2004 and Whipple et al., 2012, cited in Barnard *et al*., 2013c).
- River bank protection. Construction of river bank protection in the 1900s stabilized the banks of the Sacramento River and the San Joaquin River, which were previously constantly meandering with their banks eroding as a natural process. Bank stabilization decreased the potential for natural erosion, therefore decreasing sediment supply to the rivers and to the whole San Francisco Bay Coastal System.
- Potential Subsidence of the Bar. The Bar lies directly over the various splays of the San Andreas Fault system. This is the location of the epicenter of the 1906 San Francisco earthquake, during which sea floor changes are known to have occurred, resulting in a small tsunami. An actively subsiding graben lies under the north part of the Bar, in the area of 1906 lateral fault motions (earthquake) of more than 15 feet. It is possible that graben subsidence contributed to morphologic changes in the Bar (Bruns *et al*. 2002).

3. Summary of Field Data Analysis

Several different analyses of field data have been performed in the last ~50 years that address morphology and sediment transport processes in San Francisco Bay, San Pablo Bay, Suisun Bay and areas outside the Golden Gate. A comprehensive review of many of these analyses can be found in Barnard *et al.* (2013a)[7]. The following sub-sections provide summaries of the most relevant and recent field study efforts and their main results, including the studies summarized in Barnard *et al.* (2013a) and the work described in the FEIR.

3.1 Older Studies Reviewed by Barnard *et al*. (2013a)

Barnard *et al.* (2013a) provide a summary of the primary findings from several older studies that were based on field data analysis and are relevant to the sediment transport pattern dynamics in the San Francisco Bay Coastal System. These studies include measurements of discharges across Golden Gate (Fram *et al.*, 2007), measurements of chlorophyll flux at Golden Gate (Martin *et al.*, 2007), and measurements of suspended sediment transport across Golden Gate (Teeter *et al.*, 1996). All of these studies indicate net sediment transport outside the Golden Gate.

3.2 Grain Size Morphometrics (Spatial Variation in Grain Size Parameters)

Grain size morphometrics (spatial variation in grain size parameters) conducted by USGS is summarized in Barnard *et al*. (2013a) and was performed by evaluating spatial variations in grain size parameters (mean grain size, sorting, and skewness) throughout the San Francisco Bay Coastal System using a Geographic Information System (GIS). Results from the analysis indicate that there is a transport trend outside (west) of the Golden Gate, with sediments traveling south-west through the mouth. The studies of grain size morphometrics, did not detect any distinct sediment transport patterns inside (east) the Golden Gate (Barnard *et al*., 2013a). An earlier study conducted by Chin *et al.* (2010), which evaluated transport patterns based on factors beyond grain size data (e.g., multibeam bathymetry, backscatter records, and sidescan imagery, Greene and Bizarro, 2003), concluded that "the large sand mass located west of Angel Island is derived either from outside the Bay or from the shoreline rocks and sediments near and beyond the Golden Gate Bridge."

3.3 Geochemical Analysis

Geochemical analysis is summarized in Barnard *et al.* (2013a) and consists of isotopes and rare earth elements, heavy minerals, and semi-quantitative X-ray diffraction. Results from the geochemical analysis show overall that sand in the areas outside the Golden Gate (including the Bar and Ocean Beach) is from different sources, including material transported alongshore from north of the Golden Gate, sediment derived from within the Bay, primarily from the Sacramento River, and material derived from local outcrops and creeks. The geochemical analysis alone does not indicate clear sand transport pathways. However, it should be noted that geologic characterization of sand types (Schlocker, 1974, Barnard *et al*., 2013) indicates that the sand at south Ocean Beach, where there is erosion, is quite different from that in Central Bay and on the Bar, so direct transport does not appear to be occurring.

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[7] Barnard *et al.* (2013) references many studies conducted by USGS and elsewhere, which are included in a special issue of Marine Geology journal, focused on sediment transport patterns in the San Francisco Bay Coastal System. The referenced papers are: Barnard *et al*. (2013b, 2013c); Elder (2013); Erikson *et al.* (2013); Hansen *et al*. (2013); Hein *et al.* (2013); McGann *et al.* (2013); McKee *et al.* (2013); Rosenbauer *et al.* (2013); Wong *et al.* (2013).

3.4 Biologic, Anthropogenic, and Volcanic Constituents Analysis

Biologic, anthropogenic, and volcanic constituent analysis is summarized in Barnard *et al.* (2013a) and consists of comparing bulk sediment samples collected at different locations within Central Bay and Suisun Bay. Bulk sediment samples for constituent analysis were collected between 1995 and 2010 and analyzed for organic and inorganic sediment constituents. Results of the analysis show that sediment is transported both from the Central Bay / Suisun Bay system to the offshore areas, and vice versa.

3.5 Bedform Asymmetry Analysis

Bedform asymmetry analysis (analysis of asymmetry in the shape of sand bed morphological features, i.e. sand waves) is summarized in Barnard *et al.* (2013a). The asymmetry of ~45,000 bedforms was analyzed using 13 multi-beam bathymetry surveys performed between 1999 and 2010 in the San Francisco Bay Coastal System with the goal of inferring bedload transport directions. Results suggest an ebb-dominated system (i.e. net transport directed as the ebb tide) in many areas, mainly outside the Golden Gate, in San Pablo Bay and in Suisun Bay. Central Bay shows only a slight ebb preference, and also areas of flood-dominated transport.

3.6 Measured Residual Currents Analysis

Measured residual current analysis is summarized in Barnard *et al.* (2013a). Residual current direction is a good proxy for long-term net sediment transport direction at a single point location. Several different datasets of measured currents collected and processed in the period 1984 – 2011 were analyzed. The results of the net residual current analysis show that Suisun Bay and south Central Bay (Crissy Field) have an ebb-dominated residual current.

3.7 Measured Bathymetry Changes from USGS, E-Trac and PLS Surveys

Analysis of measured bathymetry changes in Central Bay and Suisun Bay is described in Barnard and Kvitek (2010), and in the FEIR. Barnard and Kvitek (2010) analyzed two multi-beam sonar surveys of Central Bay, conducted in 1997 and 2008 (from herein referred as to USGS bathymetries). Within the framework of the FEIR, analysis of bathymetry changes in Central Bay and Suisun Bay was performed using the 1997 and 2008 USGS bathymetries as well as other available survey data (E-Trac and PLS surveys). The following sub-sections provide a summary of the analyses, with respect to its implications on potential sand deficits (impacts) caused by sand mining and future sand resource availability.

3.7.1 Analysis of Potential Sand Deficits Caused by Mining Holes

Barnard and Kvitek (2010)

Barnard and Kvitek (2010) use the 1997 and 2008 USGS bathymetry datasets to quantify the volumetric bed changes in Central Bay. They calculated that the difference between sand volume in Central Bay lease areas in the period 1997 – 2008 was 12.0 million CY (9.2 million m^3). The analysis did not quantify the precise contribution of sand mining to the reported bed volumetric changes, but the paper suggests that a strong correlation may exist between sediment loss and sand mining activities.

FEIR

Within the framework of the FEIR, Central Bay bottom changes evident in the 1997 and 2008 USGS bathymetries were analyzed in combination with reported mining volumes and locations to establish a correlation between observed bottom erosion and sand mining, and to determine if the mining depressions were being replenished. A close correlation between the mining volumes removed and observed bathymetry changes indicates that sand mining is not likely to cause potential impacts to areas outside the Golden Gate such as the Bar and Ocean Beach. The analysis of USGS bathymetries shows that the amount of sand impounded in the mining depressions in the period 1997 – 2008 was only 5% of the sand mined in the same period, therefore the mining depressions did not act as sediment traps for sand that would otherwise have been directed elsewhere (i.e. no sand deficit was created elsewhere). Figure 1 (adapted from the FEIR) shows the Central Bay bottom changes in the period 1997 – 2008, calculated from the USGS bathymetries, along with the lease area footprints and sand mining "worm tracks," or GPS coordinates of actual mining event locations.

Mining also occurred in other areas and the "worm tracks" are not a complete record. The multi-beam bathymetry data clearly show measured erosion in the locations of mining events. As stated above, only 5% of the mined sand in the Central Bay lease areas seems to be replenished by natural factors (i.e. the mining holes do not fill). This leads to the conclusion that the depressions in Central Bay created by sand mining performed between 1997 and 2008 did not result in a measurable deficit of sand elsewhere, such as the Bar and Ocean Beach. The maximum cumulative deficit created in all other areas anywhere in the system combined was 5% of the mined volume. Had the pits been filled back in, it could be concluded that sand was being captured in the pits rather than transported to other locations. However, this mostly did not occur.

For Suisun Bay, with the exception of the small deep area of the Middle Ground lease area, the volume changes over time in each lease area were without a clear pattern. It seems likely that sedimentation in the lease areas and navigation channels in recent years is mostly a result of local sediment transport, and that net transport through the area is small except during flood events.

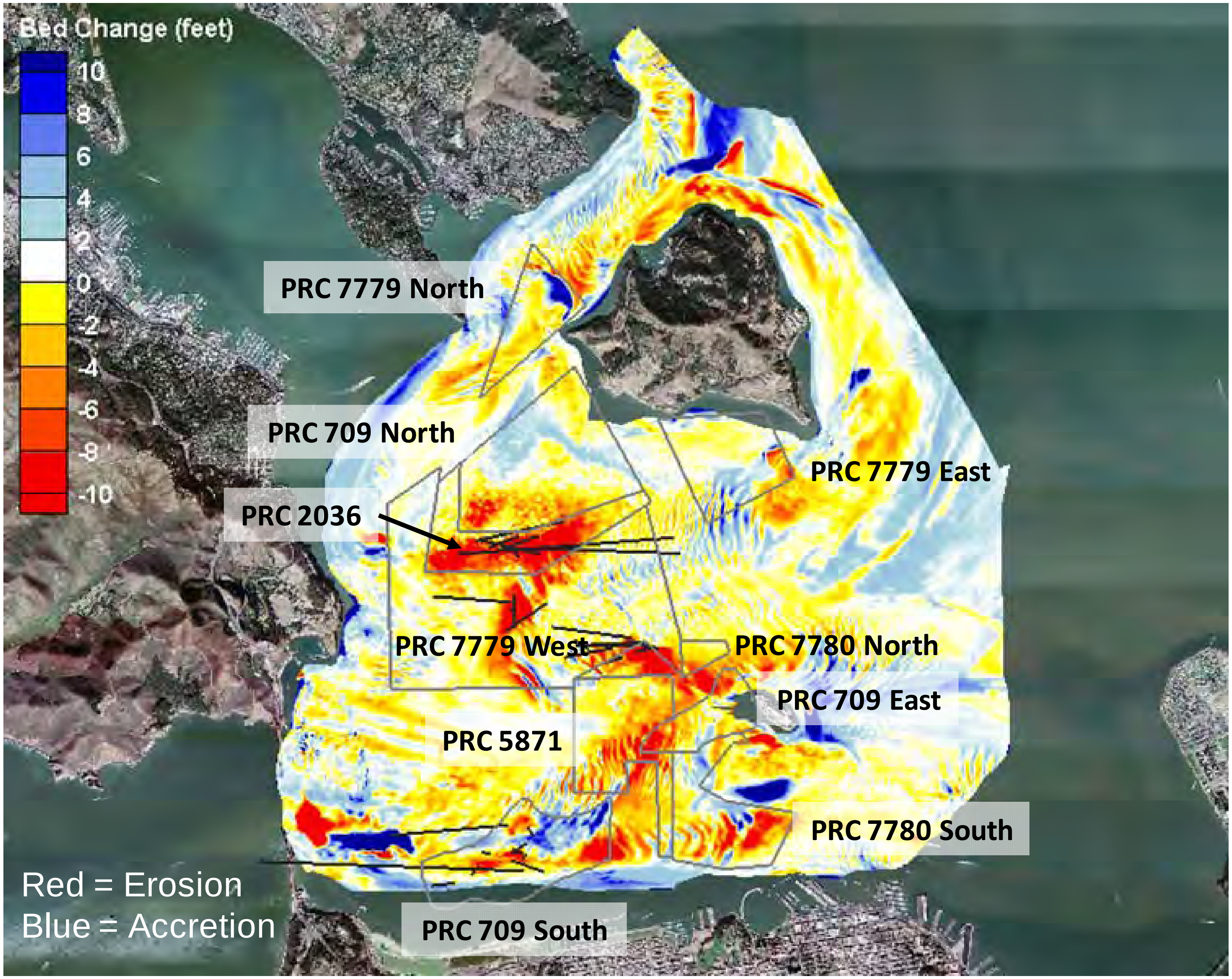

Figure 1. Central Bay depth changes between 1997 and 2008 calculated from USGS multi-beam bathymetry data sets (aerial photo USGS 2004) with lease areas footprints and sand mining location "worm tracks" (adapted from the FEIR).

3.7.2 Analysis of Resource Availability

Barnard and Kvitek (2010)

Barnard and Kvitek (2010) report that Central Bay bathymetric change analysis between the two USGS surveys indicates a loss of 18.4 million CY (14.1 million m^3) sediment, the majority of which (12.0 million CY, 9.2 million m^3) was located within sand mining lease areas. Considering the amount of mined material in the period 1997 – 2008 as reported by the miners, the analysis reported in Barnard and Kvitek (2010) indicates a rate of sand replenishment within the lease areas of approximately 15%. However, the analysis does not take into account bulking[8] factors, resulting in a weaker correlation between observed bottom erosion and mining in the mining areas. By accounting for bulking, the rate of sand replenishment within the lease areas would have been lower than 15%[9].

FEIR

The FEIR (2012) also includes analysis of bathymetry changes in the Central Bay lease areas, performed using the 1997 and 2008 USGS bathymetries. This analysis shows that a total of 11.6 million CY (8.9 million m^3) were lost in the Central Bay lease areas in the period 1997 – 2008[10]. The amount of mined material in the period 1997 – 2008, was 13.5 million CY, as measured in the barges after bulking. Assuming a bulking rate of 10%, the volume of sand mined from the bottom is estimated at 12.3 million CY. According to this calculation, the measured change in bed elevation (11.6 million CY of erosion) is approximately 95% of the volume of sand mined. The 5% difference is likely attributable to replenishment of sand in the Central Bay lease areas from natural processes.

For Central Bay, bathymetry data analysis indicates recognizable trends of reduced sediment availability in most lease areas, with available sand assumed to lie above 90 feet Mean Lower Low Water (MLLW). Analysis of the calculated sediment volumes shows that sediment availability is reduced at rates between 0.6% and 2.5% per year. These yearly rates were calculated over a variable number of years within the period 1996 – 2007 for each lease area, depending on the available bathymetry data. In general, areas that were mined show clear erosion trends, and sites that were not mined do not show clear trends. For Suisun Bay there is a recognizable trend of reduced sediment availability in the deeper parts of the Middle Ground lease area of approximately 1.0% per year. The Suisun Associates lease areas (West and East) do not show a clear trend in reduced sediment availability.

[8] Bulking is defined as an increase in sand volume due to introduction of water and air in the sand matrix from the mining process. Mined sand, as measured in the barges, has undergone a bulking process, which can be estimated in an approximate 10% volume increase.

[9] Assuming a bulking factor of 10%, the rate of replenishment within the lease areas would have been of approximately 5%.

[10] The difference in the amount of lost sand in Central Bay in the period 1997 – 2008 between Barnard and Kvitek (2010) and FEIR estimates is small (approximately 3%) and likely due to different volume calculation tools.

3.8 Summary of Conclusions Obtained from Field Data Analysis

The most relevant studies based on analyses of field data addressing morphology and sediment transport processes in the San Francisco Bay Coastal System suggest that a historically dominant pathway for beach-sized sand material (medium to coarse) destined for the open coast outside (west) of the Golden Gate originates from the Delta, moves through Suisun Bay, San Pablo Bay, and Central Bay before leaving the Golden Gate.

Direct analysis of USGS multi-beam bathymetries of 1997 and 2008 show that the vast majority of material mined from Central Bay in the period 1997 – 2008 is still absent from the lease areas, therefore significant sand impoundment in the depressed mining areas did not occur. The mining areas are not likely to capture sand that would induce measurable deficits in other areas (including the Bar and Ocean Beach) and thus, do not result in measureable erosion. Analysis of the USGS bathymetries indicates that observed bottom erosion is limited to the immediate vicinity of the mining areas. Results from the bathymetry change analysis also indicate that since Central Bay lease areas were not significantly replenished by natural processes in the period of 1997 to 2008, Central Bay sand mining resources are mostly limited to sand already in place.

For Suisun Bay, analysis of USGS and E-Trac bathymetries show that erosion and accretion patterns for most lease areas fluctuate with magnitudes larger than the mining volumes; therefore, potential impacts of mining are unclear using survey data alone. Sand mining resources appear to be limited in the deeper areas of Middle Ground, but have not been significantly reduced in West or East Suisun Bay. Sand appears to be primarily arriving in the mining areas under transport from the surrounding areas. The large surrounding areas of ongoing sand transport and lack of observed change in surrounding morphology during the study period indicate that deposition in the mining areas is likely to continue at similar rates in the near future (next ten years).

4. Numerical Modeling

4.1 Numerical modeling of Sediment Transport

4.1.1 Barnard *et al*. (2013a)

Barnard *et al.* (2013a)[11] describe a numerical modeling effort performed to investigate physical processes and sediment transport in the San Francisco Bay Coastal System. A coupled wave-flow model with the addition of a morphology module was used to simulate residual transport in the system. The bed was schematized as having sand median diameter (D_{50}) of 0.25 mm, which is a large assumption, considering the large variation in sand median grain size in the San Francisco Bay Coastal System. The patterns of the modeled sediment transport appear to be complex in the whole system. Figure 2 (adapted from Barnard *et al.*, 2013a) shows the results of modeled residual sediment transport in Central Bay. As shown in Figure 2, the results presented in Barnard *et al.* (2013a) show that inside Central Bay, transport directed outside the Golden Gate dominates along the periphery shorelines, including the southern area near Crissy Field and northwest

[11] More details on this numerical modeling effort can be found in Elias and Hansen (2013).

areas. In the central portion of western Central Bay, transport directed inside the Bay is more prevalent.

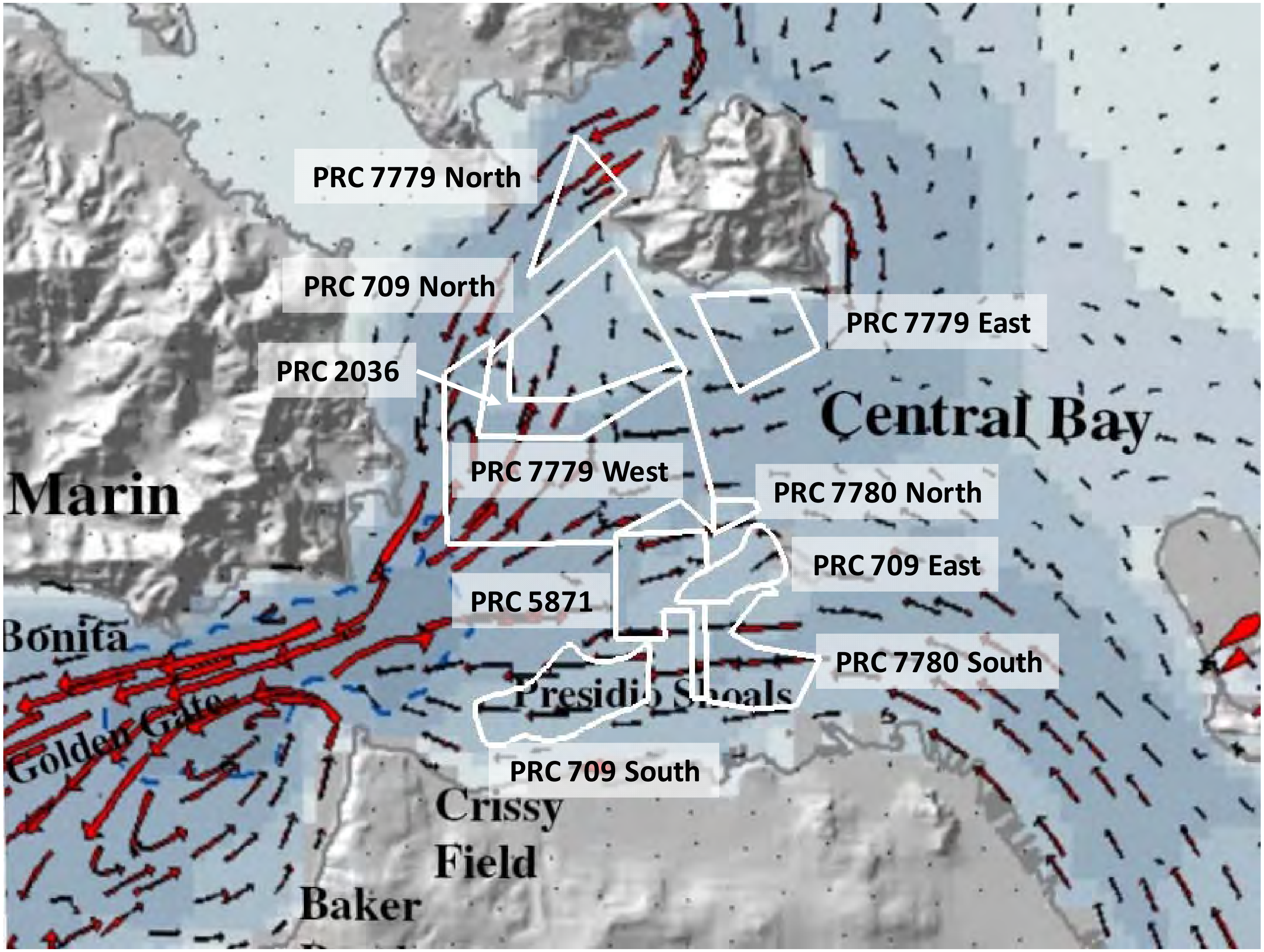

Figure 2. Results of modeled residual sediment transport in San Francisco Bay Coastal System (adapted from Barnard *et al.*, 2013a).

4.1.2 FEIR

The FEIR shows the results of a numerical modeling effort that identified the changes that the proposed ten years of sand mining may cause to sediment transport and bottom morphology. The numerical modeling effort also determined to what extent each particular lease area contributes sand to areas outside the Golden Gate, and the potential reduction in that contribution caused by the proposed sand mining in Central Bay. The sediment transport patterns in the San Francisco Bay Coastal System were modeled with a coupled hydrodynamic / sediment transport modeling system, including a three-dimensional (3D) hydrodynamic model, and a two-dimensional (2D) Lagrangian multi-fraction particle tracking sediment transport model. The numerical modeling used the extremely conservative assumption that all ten years of mining occurred instantaneously at once prior to the simulation. Within the lease areas of Central Bay and Suisun Bay, mining was digitally performed in areas that met the permitting requirements (250-ft minimum distance from the -4-ft MLLW contour). The numerical modeling included the effects of tidal and river currents on sediment transport patterns in the San Francisco Bay Coastal System. Results from this numerical modeling effort were analyzed to determine Central Bay and Suisun Bay bed changes due to the proposed lease areas sand mining, bed changes in areas outside the Golden Gate due to the proposed Central Bay lease areas sand mining, and sand transport linkages between Central Bay lease areas and the Bar / Ocean Beach system.

Central Bay and Suisun Bay Bed Changes

For both Central Bay and Suisun Bay, results of the sediment transport modeling indicate that the changes in transport patterns during both ebb and flood currents are limited to areas immediately adjacent to the lease areas. In addition, comparison of bed changes between existing conditions and after-mining conditions indicates that no measurable morphological impacts (erosion or accretion) are likely outside the vicinity of the mining areas.

Figure 3 (adapted from the FEIR) shows the net sand transport patterns and relative magnitudes after a full one-year simulation for existing conditions (no sand mining) in Central Bay. Net transport in areas not shown (San Pablo Bay, Suisun Bay) is ebb-directed, whereas Central Bay is more complicated since flows are not confined to a bidirectional channel.

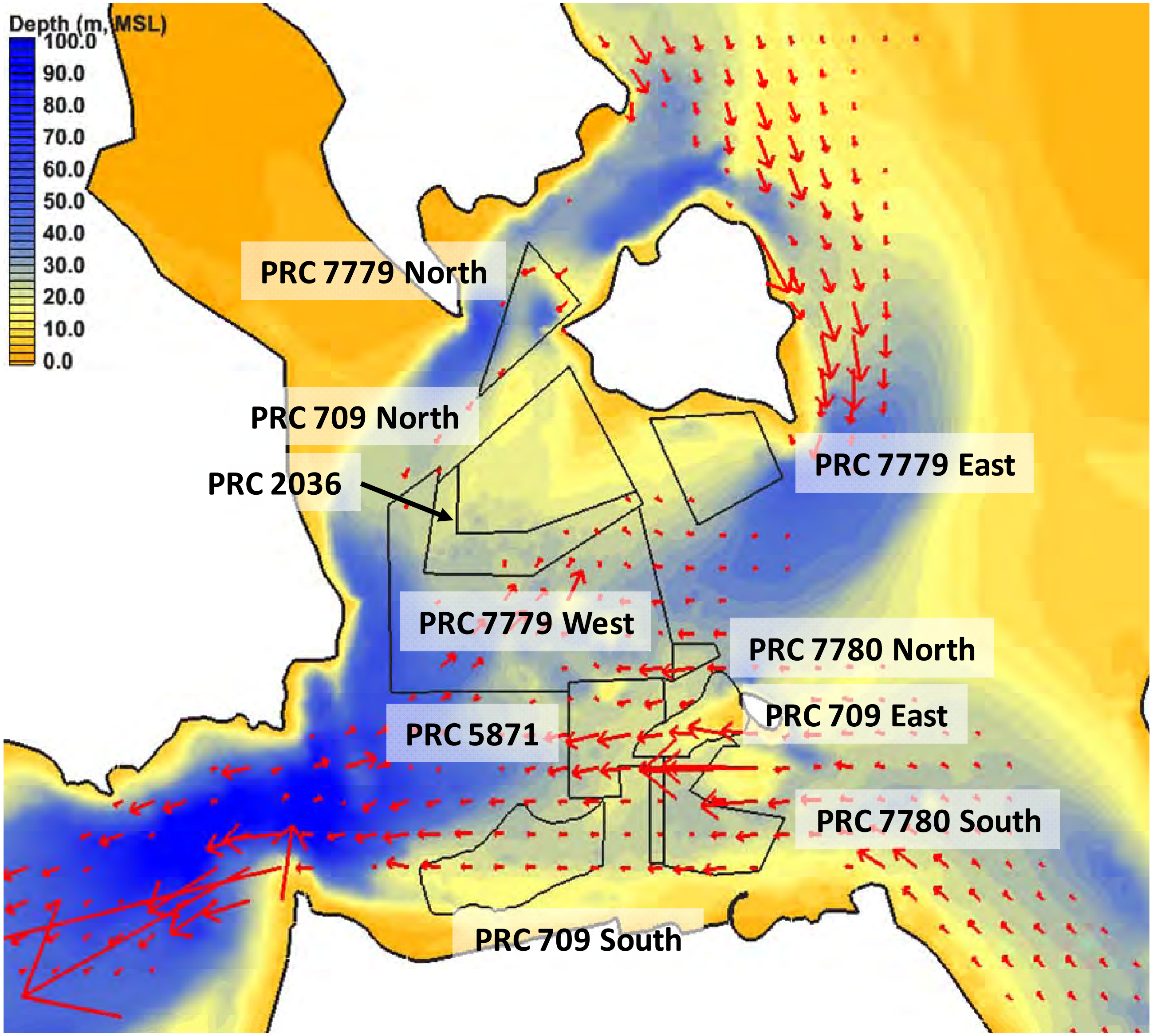

Figure 3. Net sediment transport from the one-year simulation for existing conditions in Central Bay (adapted from the FEIR)

The sediment transport patterns shown in Figure 3 are qualitatively similar to the patterns shown by Barnard *et al*. (2013a) study (Figure 2 of this Technical Report, above). Considering the differences in numerical modeling tools, boundary conditions, input assumptions, sediment sizes used, etc., the results are considered quite similar. Transport modeling was also used to measure how much sand would fill back into the mining holes in a typical year, with the extremely conservative assumption that all ten years of mining occurred instantaneously at once prior to the simulation. Results of the sediment transport modeling show that the (simulated) sand replenishment rate in the mining areas would vary, but overall only approximately 2% of the material proposed to be mined in the Central Bay lease areas was replaced by natural processes during the simulation. This replenishment is less than measured using bathymetry data, likely due in part to the limited number of sand grain sizes used in the modeling (only beach sand or larger)[12].

Bed Changes outside the Golden Gate

Figure 4 (adapted from the FEIR) shows modeled bed changes from instantaneous mining of the total volume proposed over ten years after the one-year simulation. Based on the modeling of this hypothetical mining scenario, erosion was predicted to occur outside the Golden Gate, but sand mining would only reduce the sediment supply to the Bar by a maximum of 6,000 CY annually. While these results indicate that a linkage exists between the mining areas and the offshore areas (including the Bar), the potential annual deficit of sand at the Bar is approximately 85 times less than the annual average Bar dredging volumes removed by the USACE from 1931 to present.

[12] The analysis of measured bathymetry changes using USGS multi-beam bathymetries collected in 1997 and 2008 for Central Bay presented in Section 3.7.2 indicates that only approximately 5% of the material that was mined in Central Bay has been replaced by natural processes. The percentage of sand replenished by natural processes in Central Bay is slightly different if calculated using modeling results or historical bathymetric changes (2% vs. 5%). Considering the complexities of the natural system, the relative similarity of the two estimates, which were obtained using completely different analysis methods (including only simulating sand and gravel in the modeling), provides a high level of confidence regarding model predictions of the potential impacts of sand mining

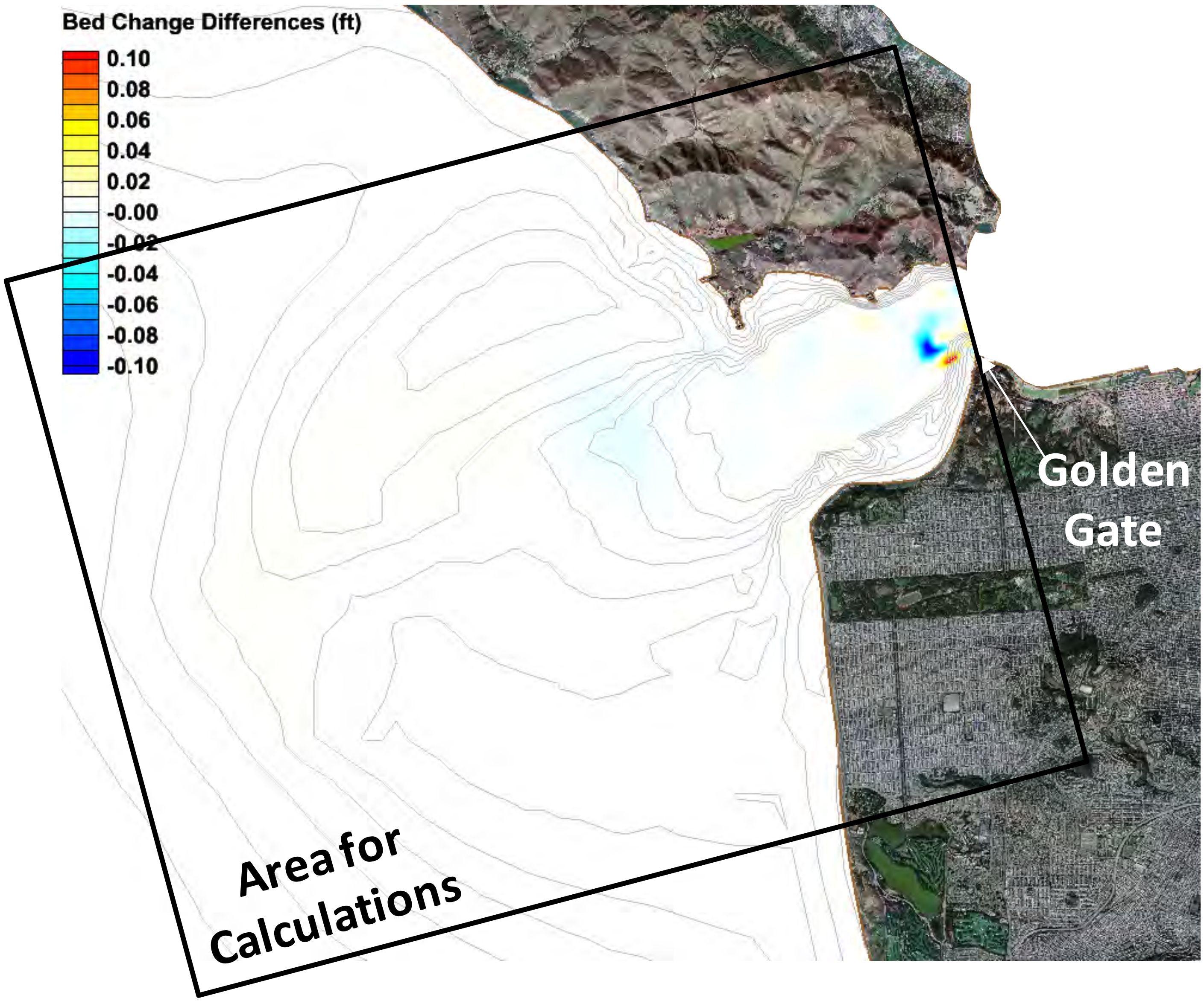

Figure 4. One-year bed changes caused by instantaneous ten-year mining. Blue colors indicate erosion, whereas red/yellow colors indicate accretion (adapted from the FEIR).

Sand Transport Linkages between Central Bay Lease Areas and the Bar / Ocean Beach

Results of the sediment transport modeling indicate that the total volume of sand transported from Central Bay lease areas out through the Golden Gate after one year is approximately 68,000 CY for existing conditions (no sand mining), and would be roughly 62,000 CY after instantaneous ten-year of mining in Central Bay lease areas (i.e., the conservative and hypothetical mining scenario used in the modeling). The results show that the lease areas in the southern part of Central Bay tend to contribute more sand to areas outside the Golden Gate. This is consistent with the flow and transport patterns in Central Bay predicted in Barnard *et al.* (2013a) as well as in the FEIR, which both show ebb-dominated flow/transport in the south part of Central Bay and flood-dominated flow/transport in the north part of Central Bay. USGS analysis indicates that in the period 1956 to 2005, the Bar was losing sediment at a rate of approximately 2.5 million CY (1.9 million m^3) per year (Barnard and Kvitek, 2010). Sediment transport modeling results in the FEIR indicate that sand mining in the Bay may reduce sediment supply to the Bar up to approximately 0.2% (or 6,000 CY over 2.5 million CY). Since the modeling uses the extremely conservative approach of mining all ten years of sand at once before the one-year simulation, the percentage of annual sediment deficit on the Bar that could be attributable to the proposed sand mining is more likely to be less.

Table 2. Potential annual contribution of sand mining activities to the measured sediment loss at the Bar after one year for each Central Bay lease area

Lease Area	%
PRC 709 South	0.05
PRC 5871	0.04
PRC 709 East	0.03
PRC 7780 South	0.03
PRC 7780 North	0.03
PRC 7779 West	0.04
PRC 2036	0.01
PRC 709 North	0.00
PRC 7779 East	0.00
PRC 7779 North	0.00
Total Central Bay	**0.23**

4.2 Summary of Conclusions Obtained from Numerical Modeling

Numerical modeling efforts presented in Barnard *et al.* (2013a) and in the FEIR conducted by independent experts show that the sediment transport processes in the San Francisco Bay Coastal System are complex. However, both Barnard *et al.* (2013a) and the FEIR indicate a transport pathway from the Delta towards Suisun Bay, Central Bay and seaward across the Golden Gate. Studies also indicate inward-directed net bedload transport in large areas of northern Central Bay.

Results from the particle tracking sediment transport numerical modeling presented in the FEIR show that the potential transport pathway from the Delta all the way to the Golden Gate is dormant during day-to-day river flows from the Sacramento River and the San Joaquin River. Within the one-year simulation (December 1996 – December 1997), there was one large river flow event lasting several days, and only during that large river flow the modeling showed that Bar-size sand particles moved all the way from the Delta through Suisun Bay, Central Bay and to areas outside the Golden Gate. Results of sediment transport / morphology numerical modeling indicate that the changes in instantaneous sediment transport patterns during both ebb and flood currents are limited to areas immediately adjacent to the lease areas. In addition, comparison of bed changes between existing conditions and after-mining conditions indicates that no measurable morphological impacts (erosion or accretion) are likely to occur outside the immediate vicinity of the mining areas. The modeling results do, however, indicate that some linkage exists between sand in the mining areas and the offshore areas, including the Bar. The modeling attempted to quantify this linkage by modeling a hypothetical, worst-case mining scenario where all ten years of mining would occur prior to the first year. Based on this conservative and hypothetical scenario, the modeling indicated that sand mining in the Bay could reduce sediment supply to the Bar by up to 0.2% of total losses of sediment each year. Again, actual reductions in sediment supply is expected to be less and, consistent with the FEIR's conclusions, immeasurable in terms of elevation changes at the Bar.

5. Summary of Recently Published Studies on Sediment Transport and Coastal Erosion

Since certification of the FEIR by the CSLC, several new studies have been published on the subject of sediment transport and morphology changes in the San Francisco Bay Coastal System, including several USGS-authored studies. Barnard et al (2013) represents the most significant work, incorporating many types of field data analysis, numerical modeling results and cross-correlation of those findings between methods to improve certainty regarding historical sand-sized transport pathways. As noted previously, the findings in these recent publications are in agreement with the findings in the FEIR in terms of transport pathways. Therefore the recent studies *do not* present any new information of substantial importance that shows either a new significant effect not previously discussed in the FEIR or showing that a previously examined significant effect will be substantially more severe under CEQA Guidelines 15162(a)(3)(A) and (B). These new studies restate prior conclusions, present new data and some new findings not present in previous publications, however the findings in the new analyses are consistent with those in the FEIR.

6. Conclusions

Both the CSLC's EIR and independent USGS studies agree that a historically dominant pathway for beach-sized sand material destined for the open coast west of the Golden Gate originates from the Delta, moves through Suisun Bay, San Pablo Bay, and Central Bay before leaving the Golden Gate. USGS studies suggest that since the net transport of beach sand is directed seaward, a direct linkage could be made between activities in the sand mining lease areas (in

Central Bay and Suisun Bay) and morphological changes outside the Golden Gate, including at the Bar and Ocean Beach. However, the USGS studies did not quantify this linkage.

Results shown in the FEIR are consistent with the above USGS conclusions. The FEIR quantitatively demonstrated through numerical modeling the linkage (although weak in magnitude) between the sand mining lease areas in Central Bay and areas outside the Golden Gate. ***The modeling conducted for the FEIR showed that the specific mining activity proposed for ten years in all lease areas—presuming it is all conducted instantaneously prior to the first year—could reduce sediment supply to the Bar up to a maximum of 0.2% of the observed annual deficit. USACE dredging from the Bar represents approximately 85 times greater sand deficit at the Bar than would be caused by the proposed sand mining.*** The FEIR analysis showed that while incremental contribution of sand mining to the observed sediment deficit at the Bar is essentially immeasurable, some mining areas have a stronger linkage to the offshore areas, such as those in southern Central Bay (709 South, 5871, 709 East and 7780 South, see Table 2) where net transport predicted by all available studies (including USGS and FEIR) is directed seaward, and beach sand material is most similar in size to sand at the Bar and Ocean Beach. However, it should be noted that littoral transport from outside the Golden Gate is well documented (Hanes *et al.* 2011) and contributes to accretion of sand along the San Francisco north shore peninsula. The FEIR, using direct analysis of USGS multi-beam bathymetry data, also showed that the mining holes in Central Bay did not significantly fill back in during the period 1997 – 2008. Since the vast majority of material (95%) removed from Central Bay in the period 1997 – 2008 is still absent from the lease areas, sand impoundment in the mining lease areas was minimal in that period. Therefore, ***the mining areas are not likely to capture sand and induce deficits in other areas (including the Bar and Ocean Beach) resulting in measurable erosion***. Since analysis of lease area bathymetry changes during the period 1997 – 2008 indicated that the Central Bay lease areas were not significantly replenished, Central Bay sand mining resources are mostly limited to sand already in place. Numerical modeling results described in the FEIR also indicate that sediment transport/morphology changes are limited to areas immediately adjacent to the lease areas.

The contribution of sand mining to the sediment transport dynamics in the San Francisco Bay Coastal System needs to be put in perspective, with respect to the processes that have governed the evolution of the system. Historically, high rates of sediment contribution to the Bay's watershed, including from hydraulic mining activities in the 1800s, may have contributed substantially to the formation and evolution of the Bar. The Bar has been documented to be contracting during the time of historic bathymetric surveys, which correlates temporally with a reduction in the San Francisco tidal prism and sediment supply from the Sierra Nevada and the rest of the rivers watershed (Barnard 2005, Barnard *et* al., 2013c). ***All studies by a variety of experts suggest that the Bar evolution and related coastal erosion (included erosion at South Ocean Beach) are controlled by much larger-scale and longer-term processes than sand mining***. The incremental contribution of sand mining is so small as to be immeasurable in terms of elevation changes at the Bar.

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APPENDIX A

Summary Table - List of Comments to the FEIR

NOTE: As of December 9, 2013, the "References in Text (Lines)" line numbers in this table still need to be updated.

Category	Comment Set	Name of Commenter	Date of Comment	Comment ID	File Name	Reference in Text (Lines)
Federal Agency	A	Laurie Monarres, Chief North Branch, **U.S. Army Corps of Engineers**	8/2/2013	A-1	USACE Sand Mining PN Comment Response Request MARKED.pdf	44-51; 52-58; 198-204; 250-258; 322-335; 336-354; 361-377; 397-412; 413-430.
Organization	B	Carin High, **Citizens Committee to Complete the Refuge**	6/7/2013	B-1	2013 Sand Mining Public Notice Comments MARKED.pdf	44-51; 52-58; 198-204; 250-258; 322-335; 336-354; 361-377; 397-412; 413-430.
	B	Carin High, **Citizens Committee to Complete the Refuge**	6/7/2013	B-2	2013 Sand Mining Public Notice Comments MARKED.pdf	44-51; 52-58; 198-204; 250-258; 322-335; 336-354; 361-377; 397-412; 413-430.
	B	Carin High, **Citizens Committee to Complete the Refuge**	6/7/2013	B-3	2013 Sand Mining Public Notice Comments MARKED.pdf	58-61; 62-64; 196-204; 230-243; 255-258; 259-267; 303-321; 367-372; 407-412.
	B	Carin High, **Citizens Committee to Complete the Refuge**	6/7/2013	B-4	2013 Sand Mining Public Notice Comments MARKED.pdf	44-51; 52-58; 198-204; 250-258; 322-335; 336-354; 361-377; 397-412; 413-430.
	C	Jason Flanders, **San Francisco Baykeeper**	6/7/2013	C-1	2013 Sand Mining Public Notice Comments MARKED.pdf	44-51; 52-58; 198-204; 250-258; 322-335; 336-354; 361-377; 397-412; 413-430.
	C	Jason Flanders, Ian Wren, **San Francisco Baykeeper**	12/15/2011	C-2[13]	2013 Sand Mining Public Notice Comments MARKED.pdf	44-51; 52-58; 198-204; 250-258; 322-335; 336-354; 361-377; 397-412; 413-430.
	C	Jason Flanders, Ian Wren, **San Francisco Baykeeper**	12/15/2011	C-3[10]	2013 Sand Mining Public Notice Comments MARKED.pdf	62-64; 230-243; 255-258; 407-412.
	C	Jason Flanders, Ian Wren, **San Francisco Baykeeper**	12/15/2011	C-4[10]	2013 Sand Mining Public Notice Comments MARKED.pdf	62-64; 230-243; 255-258; 259-267; 407-412.
	C	Jason Flanders, Ian Wren, **San Francisco Baykeeper**	12/15/2011	C-5[10]	2013 Sand Mining Public Notice Comments MARKED.pdf	62-64; 230-243; 255-258; 407-412.
	C	Jason Flanders, Ian Wren, **San Francisco Baykeeper**	12/15/2011	C-6[10]	2013 Sand Mining Public Notice Comments MARKED.pdf	62-64; 230-243; 255-258; 407-412.
	C	Jason Flanders, Ian Wren, **San Francisco Baykeeper**	12/15/2011	C-7[10]	2013 Sand Mining Public Notice Comments MARKED.pdf	44-51; 52-58; 198-204; 250-258; 322-335; 336-354; 361-377; 397-412; 413-430.
	C	Jason Flanders, Ian Wren, **San**	12/15/2011	C-8[10]	2013 Sand Mining Public Notice	44-51; 52-58; 198-204; 250-

[13] Comments C-2 to C-9 were originally issued by Baykeeper as comments to RDEIR and have been included by Baykeeper as attachments to a new set of comments (to the FEIR), dated June 2013.

Category	Comment Set	Name of Commenter	Date of Comment	Comment ID	File Name	Reference in Text (Lines)
Organization		**Francisco Baykeeper**			Comments MARKED.pdf	258; 322-335; 336-354; 361-377; 397-412; 413-430.
	C	Jason Flanders, Ian Wren, **San Francisco Baykeeper**	12/15/2011	C-9[10]	2013 Sand Mining Public Notice Comments MARKED.pdf	44-51; 52-58; 198-204; 250-258; 322-335; 336-354; 361-377; 397-412; 413-430.
	C	Amanda Garcia, Ian Wren, **San Francisco Baykeeper**	10/17/2012	C-10	2013 Sand Mining Public Notice Comments MARKED.pdf	44-51; 52-58; 198-204; 250-258; 322-335; 336-354; 361-377; 397-412; 413-430.
	C	Amanda Garcia, Ian Wren, **San Francisco Baykeeper**	10/17/2012	C-11	2013 Sand Mining Public Notice Comments MARKED.pdf	44-51; 52-58; 198-204; 250-258; 322-335; 336-354; 361-377; 397-412; 413-430.
	C	Amanda Garcia, Ian Wren, **San Francisco Baykeeper**	10/17/2012	C-12	2013 Sand Mining Public Notice Comments MARKED.pdf	62-64; 230-243; 255-258; 407-412.
	C	Amanda Garcia, Ian Wren, **San Francisco Baykeeper**	10/17/2012	C-13	2013 Sand Mining Public Notice Comments MARKED.pdf	62-64; 230-243; 255-258; 407-412.
Individual	D	Peter Baye	5/22/2013	D-1	2013 Sand Mining Public Notice Comments MARKED.pdf	44-51; 52-58; 198-204; 250-258; 322-335; 336-354; 361-377; 397-412; 413-430.
Individual	D	Peter Baye	5/22/2013	D-2	2013 Sand Mining Public Notice Comments MARKED.pdf	44-51; 52-58; 198-204; 250-258; 322-335; 336-354; 361-377; 397-412; 413-430.
	D	Peter Baye	5/22/2013	D-3	2013 Sand Mining Public Notice Comments MARKED.pdf	44-51; 52-58; 198-204; 250-258; 322-335; 336-354; 361-377; 397-412; 413-430.
	D	Peter Baye	5/22/2013	D-4	2013 Sand Mining Public Notice Comments MARKED.pdf	44-51; 52-58; 198-204; 250-258; 322-335; 336-354; 361-377; 397-412; 413-430.
	D	Peter Baye	5/22/2013	D-5	2013 Sand Mining Public Notice Comments MARKED.pdf	44-51; 52-58; 62-64; 198-204; 230-243; 250-258; 259-267; 322-335; 336-354; 361-377; 397-412; 413-430.
	D	Peter Baye	5/22/2013	D-6	2013 Sand Mining Public Notice Comments MARKED.pdf	44-51; 52-58; 198-204; 250-258; 322-335; 336-354; 361-377; 397-412; 413-430.
	D	Peter Baye	5/9/2007	D-7	2013 Sand Mining Public Notice Comments MARKED.pdf	44-51; 52-58; 198-204; 250-258; 322-335; 336-354; 361-

Category	Comment Set	Name of Commenter	Date of Comment	Comment ID	File Name	Reference in Text (Lines)
						377; 397-412; 413-430.
	D	Peter Baye	5/9/2007	D-8	2013 Sand Mining Public Notice Comments MARKED.pdf	44-51; 52-58; 198-204; 250-258; 322-335; 336-354; 361-377; 397-412; 413-430.
	D	Peter Baye	5/9/2007	D-9	2013 Sand Mining Public Notice Comments MARKED.pdf	44-51; 52-58; 198-204; 250-258; 322-335; 336-354; 361-377; 397-412; 413-430.
	D	Peter Baye	5/9/2007	D-10	2013 Sand Mining Public Notice Comments MARKED.pdf	44-51; 52-58; 198-204; 250-258; 322-335; 336-354; 361-377; 397-412; 413-430.
	D	Peter Baye	5/9/2007	D-11	2013 Sand Mining Public Notice Comments MARKED.pdf	76-82.
	D	Peter Baye	1/3/2012	D-12	2013 Sand Mining Public Notice Comments MARKED.pdf	36-51; 44-51; 52-58; 65-73; 159-170; 172-177; 198-204; 211-217; 250-258; 322-335; 336-354; 356-360; 361-377; 392-395; 397-412; 413-430.
Individual	D	Peter Baye	1/3/2012	D-13	2013 Sand Mining Public Notice Comments MARKED.pdf	36-51; 44-51; 52-58; 65-73; 159-170; 172-177; 198-204; 211-217; 250-258; 322-335; 336-354; 356-360; 361-377; 392-395; 397-412; 413-430.
	D	Peter Baye	1/3/2012	D-14	2013 Sand Mining Public Notice Comments MARKED.pdf	36-51; 44-51; 52-58; 65-73; 159-170; 172-177; 198-204; 211-217; 250-258; 322-335; 336-354; 356-360; 361-377; 392-395; 397-412; 413-430.
	D	Peter Baye	9/27/2010	D-15	2013 Sand Mining Public Notice Comments MARKED.pdf	62-64; 230-243; 255-258; 407-412.
	D	Peter Baye	9/27/2010	D-16	2013 Sand Mining Public Notice Comments MARKED.pdf	36-51; 44-51; 52-58; 65-73; 159-170; 172-177; 198-204; 211-217; 250-258; 322-335; 336-354; 356-360; 361-377; 392-395; 397-412; 413-430.
	D	Peter Baye	9/27/2010	D-17	2013 Sand Mining Public Notice Comments MARKED.pdf	36-51; 44-51; 52-58; 65-73; 159-170; 172-177; 198-204; 211-217; 250-258; 322-335;

Category	Comment Set	Name of Commenter	Date of Comment	Comment ID	File Name	Reference in Text (Lines)
Individual						336-354; 356-360; 361-377; 392-395; 397-412; 413-430.
	D	Peter Baye	10/18/2012	D-18	2013 Sand Mining Public Notice Comments MARKED.pdf	36-51; 44-51; 52-58; 65-73; 159-170; 172-177; 198-204; 211-217; 250-258; 322-335; 336-354; 356-360; 361-377; 392-395; 397-412; 413-430.
	D	Peter Baye	10/18/2012	D-19	2013 Sand Mining Public Notice Comments MARKED.pdf	36-51; 44-51; 52-58; 65-73; 159-170; 172-177; 198-204; 211-217; 250-258; 322-335; 336-354; 356-360; 361-377; 392-395; 397-412; 413-430.
Individual	E	Libby Lucas	05/22/2013	E-1	2013 Sand Mining Public Notice Comments MARKED.pdf	205-209; 239-243; 259-267; 302-321.
	E	Libby Lucas	05/22/2013	E-2	2013 Sand Mining Public Notice Comments MARKED.pdf	44-51; 52-58; 198-204; 250-258; 322-335; 336-354; 361-377; 397-412; 413-430.
	E	Libby Lucas	05/22/2013	E-3	2013 Sand Mining Public Notice Comments MARKED.pdf	76-82.
	E	Libby Lucas	05/22/2013	E-4	2013 Sand Mining Public Notice Comments MARKED.pdf	76-82.
State Agency	F	Brenda Goeden, **Bay Conservation and Development Commission**	3/21/2013	F-1	2013.004.00HansonCBMining30Dltr MARKED.pdf	62-64; 230-239; 255-258; 407-412.
	F	Brenda Goeden, **Bay Conservation and Development Commission**	3/21/2013	F-2	2013.004.00HansonCBMining30Dltr MARKED.pdf	
	F	Brenda Goeden, **Bay Conservation and Development Commission**	3/21/2013	F-3	2013.004.00HansonCBMining30Dltr MARKED.pdf	
	F	Brenda Goeden, **Bay Conservation and Development Commission**	3/21/2013	F-4	2013.004.00HansonCBMining30Dltr MARKED.pdf	44-51; 52-58; 62-64; 198-204; 230-239; 250-258; 322-335; 336-354; 361-377; 397-412; 413-430.
	F	Brenda Goeden, **Bay Conservation and**	3/21/2013	F-5	2013.004.00HansonCBMining30Dltr MARKED.pdf	44-51; 52-58; 62-64; 198-204; 230-243; 250-258; 259-267; 322-335; 336-354; 361-377;

Category	Comment Set	Name of Commenter	Date of Comment	Comment ID	File Name	Reference in Text (Lines)
		Development Commission				397-412; 413-430.
	F	Brenda Goeden, **Bay Conservation and Development Commission**	3/21/2013	F-6	2015.005.00mdSuisunAssoc30DL032113 MARKED.pdf	242-243.
	F	Brenda Goeden, **Bay Conservation and Development Commission**	3/21/2013	F-7	2015.005.00mdSuisunAssoc30DL032113 MARKED.pdf	205-209; 239-243; 259-267; 302-308.
	F	Brenda Goeden, **Bay Conservation and Development Commission**	3/21/2013	F-8	2015.005.00mdSuisunAssoc30DL032113 MARKED.pdf	
	F	Brenda Goeden, **Bay Conservation and Development Commission**	3/21/2013	F-9	2015.005.00mdSuisunAssoc30DL032113 MARKED.pdf	205-209; 242-243; 259-267; 302-308; 361-377; 413-430.
	F	Brenda Goeden, **Bay Conservation and Development Commission**	3/21/2013	F-10	2015.005.00mdSuisunAssoc30DL032113 MARKED.pdf	52-58; 242-243; 259-267; 361-377; 397-412; 413-430.
State Agency	F	Brenda Goeden, **Bay Conservation and Development Commission**	3/21/2013	F-11	2010.006.00(m)HansonMiddleGround3,F.GG MARKED.pdf	205-209; 239-242.
	F	Brenda Goeden, **Bay Conservation and Development Commission**	3/21/2013	F-12	2010.006.00(m)HansonMiddleGround3,F.GG MARKED.pdf	205-209; 259-267; 302-308.
	F	Brenda Goeden, **Bay Conservation and Development Commission**	3/21/2013	F-13	2010.006.00(m)HansonMiddleGround3,F.GG MARKED.pdf	
	F	Brenda Goeden, **Bay Conservation and Development Commission**	3/21/2013	F-14	2010.006.00(m)HansonMiddleGround3,F.GG MARKED.pdf	205-209; 239-242; 259-267; 302-308; 361-377; 413-430.
	F	Brenda Goeden, **Bay Conservation and Development Commission**	3/21/2013	F-15	2010.006.00(m)HansonMiddleGround3,F.GG MARKED.pdf	52-58; 239-242; 259-267; 361-377; 397-412; 413-430.

APPENDIX B

Original Comments to the FEIR

Appendix E

Downey Brand LLP Letter re Baykeeper Comments,

March 17, 2015

DOWNEY BRAND
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March 17, 2015

VIA E-MAIL AND U.S. MAIL

Honorable Members of the Commission
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Re: Response to San Francisco Baykeeper Letter dated December 16, 2014

Dear Mr. Goldzband and Commissioners:

We are writing in response to the letter dated December 16, 2014, submitted by San Francisco Baykeeper, Inc. ("Baykeeper") to your Commission concerning the pending applications of Hanson Marine Operations ("Hanson") and Lind Marine, Inc. ("Lind"). Hanson and Lind are seeking renewal of 10-year permits to continue harvesting construction-grade sand in parts of San Francisco Bay, Suisun Bay, and the western Delta. As explained in greater detail below, the Baykeeper letter contains factual and legal misstatements about the four pending applications. In this letter we correct those misstatements.

RESPONSE

Baykeeper opposes sand mining, claiming that this Project would have irreversible effects on the San Francisco Bay and coastline. Baykeeper's position is directly at odds with the findings of the California State Lands Commission ("SLC") and its Environmental Impact Report ("EIR"), certified after six-years of environmental review. Baykeeper's position is also directly at odds with the findings of the San Francisco County Superior Court, rendered after the Court had a full opportunity to view the record evidence and arguments of Baykeeper's legal counsel. The EIR that Baykeeper sought unsuccessfully to overturn analyzed the Project's potential impacts on a wide range of resources, including benthic habitats, sediment transport, and bathymetry within the San Francisco Bay. In conducting its analysis, the SLC engaged independent experts, among them Applied Marine Sciences and Coast & Harbor Engineering ("CHE"), and evaluated numerous articles co-authored by Patrick Barnard and others. The SLC and CHE even met and consulted directly with Barnard and BCDC staff to evaluate the possible connection between sand mining and Bay and coastal processes.

After completing its extensive evaluation of sediment transport, sediment supply, and coastal erosion, the SLC found that sand mining at full volumes (2,040,000 cubic yards ("cy") per year):

- "is not expected in itself, or in combination with other projects, to result in a substantial alteration of sediment transport patterns or the morphology of the seabed outside of the vicinity of the lease areas," and

- "is not expected to result in a substantial decrease in the supply of sediment to the San Francisco Bar and Ocean Beach." (FEIR, p. 4.3-42.)

Specifically, the Final EIR concluded that continued sand mining in Central and Suisun Bays "is not likely to cause measurable sediment depletion" and "would not affect sediment transport outside of the immediate vicinity of the mining lease areas." (FEIR, pp. 4.3-30, -31, II-4.)

Baykeeper attempts to claim that "recent" studies support its position that sand mining has led to far-reaching and irreversible effects on San Francisco's coastline. The Barnard articles published after the SLC certified its EIR in 2012 do not present any new data that contradicts the prior analysis conducted by the SLC and its engineering consultant CHE. Instead, these studies largely echo the prior research by verifying pathways and sediment provenance. Unlike the SLC EIR, none of those studies have attempted to quantify or otherwise evaluate the contribution of this Project to the overall sediment supply to the Offshore Bar or coastal beaches.

I. BAYKEEPER MISCHARACTERIZES HISTORICAL VOLUMES AND IS WRONG ON MARKET PROJECTIONS AND PUBLIC BENEFITS

A. Permitted Mining Volumes. Baykeeper repeatedly states that the Applicants are seeking to significantly increase commercial sand extraction in the Bay. These statements ignore the practical realities of the market and the actual volumes permitted and mined in the last 10-year permit term (1998-2007).

Actual volumes can vary significantly in any given year due to fluctuations in market demand. For this reason, permitted volumes have historically been described as annual and 10-year maximums. That does not mean, however, that future mining will occur at those maximum levels, and certainly not in every year. For example, during the previous 10-year permit term (1998–2007), Hanson and Lind averaged 1,478,131 cy annually and reached a peak of approximately 1,980,000 cy. Further, the volumes authorized by the SLC in 2012 actually represented a *decrease* in overall permitted volumes, from 2,240,000 to 2,040,000 cubic yards ("cy") per year—a reduction of 200,000 cy per year (or 9%).

Despite the lack of clear evidence of harm to beneficial uses,[1] the San Francisco Bay Regional Water Quality Control Board ("RWQCB") in January 2015 further reduced

[1] The RWQCB Executive Officer, in response to questions from Board Members at the public hearing on January 21, 2015, acknowledged that there was no clear evidence of harm to beneficial uses and that, due to surrounding

permitted mining volumes. For the first time, average annual sand mining volumes cannot exceed 1,613,000 cy over the 10-year permit term (with annual peak volumes limited to 1,950,000 cy). This new limit marks a *substantial decrease* in permitted volumes (from 2,240,000, a decrease of 28%). Hanson and Lind do not expect to achieve maximum volumes every year; however, maintaining flexibility to peak at the higher level is crucial to respond to fluctuations in market demands and the relatively fixed costs and marginal returns afforded sand mining over a 10-year permitting cycle.

B. Projecting Future Market Trends. Baykeeper recommends that BCDC limit sand mining volumes to the average volumes mined in the last 10 years (2005–2014) because, as Baykeeper posits, those rates "capture[] likely conditions over the next permit cycle." This statement ignores the realities of the market for Bay sands and is simply wrong as to its projections of future conditions:

- First, Hanson and Lind have been operating under short-term permit extensions since 2008—including from BCDC—and therefore have been unable to capture full permitted volumes over the last 7 years. These short-term permit extensions generally limited mining to holdover volumes—that is, volumes remaining from the last permitting cycle. Without any certainty of when all outstanding permits would be issued, Hanson and Lind have purposely restricted the amount of sand mined to ensure that adequate holdover volumes would be available to provide sand to customers that rely on the material for their daily production.

- Second, the last 6 years of sand mining *are not* representative of expected market conditions over the next 10-year permit cycle. Beginning in 2008, California entered the greatest recession since the Great Depression. Despite recent activity in infrastructure and commercial real estate development, the market for Bay sands is more closely tied to housing and has only just begun to return.[2] Based on projections by the Association of Bay Area Governments ("ABAG"), housing demand in the Bay Area is expected to grow by 660,000 units between 2010 and 2040, which equates to 22,000 units per year. This expected demand dwarfs the actual demand in 2010, which was less than 5,000 units annually (a 132-fold increase). At 22,000 units per year, the demand for sand is expected to increase to approximately 5,570,000 cy for residential construction on an annual basis—well more than the amounts requested by Hanson and Lind.

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uncertainties, staff had recommended lowering mining volumes in line with the "precautionary principle." The precautionary principle counsels that conservative decisions be made to protect a resource whenever there is scientific uncertainty (i.e., when there is an *absence* of evidence). In making determinations under the Bay Plan, however, BCDC staff have acknowledged that any decision to further limit sand mining must be supported by substantial evidence.

[2] Memorandum from Edward Sullivan, Economic & Planning Systems, Inc., to Christian Marsh, *Past as Prologue – Identifying the Appropriate Basis for Projecting Future Demand for Bay Sand and other locally-Mined Construction Sand in the San Francisco Bay Region* (Dec. 30, 2014).

- Third, Hanson has recently adopted changes in its processing, which has rendered Bay sands suitable for a wider variety of uses. This change will allow Hanson to meet a greater share of the demand for construction-grade sands.

- Fourth, in anticipation of long-term permit approvals and improving market conditions, Lind in 2014 removed its sand mining equipment from service for major repairs and maintenance for approximately four months, artificially reducing volumes during this period.

In sum, due to severe market and other limits on both the production and demand for Bay sands over the last several years, volumes have been artificially depressed and do not represent historical or future conditions. Again, maintaining flexibility in annual peaks and longer-term averages is crucial to address the relatively fixed costs and marginal returns afforded sand mining over a 10-year permitting cycle.

C. Substantial Public Benefits. Baykeeper claims, without legal authority, that the phrase "substantial public benefit" (presumably as applied in the Bay Plan) should be interpreted "traditionally" to support only projects with a "truly public purpose" such as "restoration" or "aids to navigation." What constitutes a public benefit has never in the history of the State been so narrowly restricted as Baykeeper would have it.

Public benefits served by the common law public trust doctrine have traditionally been defined broadly in terms of navigation, fisheries (including commercial fisheries operated for profit), and "commerce," and not limited to restoration as Baykeeper contends. (*Borax Consolidated, Ltd. v. Los Angeles* (1935) 296 U.S. 10, 15-16; *City of Berkeley v. Superior Court* (1980) 26 Cal.3d 515, 521.) "Commerce," in turn, includes oil development from public tide and submerged lands (*Boone v. Kingsbury* (1928) 206 Cal. 148, 181). As for mining, the Legislature has declared that:

> extraction of minerals is *essential* to the continued economic well-being of the state and to the needs of the society . . . [and] the production and development of *local mineral resources* . . . are *vital* to reducing transportation emissions that result from the distribution of hundreds of millions of tons of construction aggregates that are used annually in building and maintaining the state.

(Pub. Resources Code, §§ 2711(a), (d) [emphasis added].)

Private sand mining is necessary to realize the substantial public benefits of Bay sands, which form an important part of the regional economy. First, public agencies are not in the business of sand mining. Second, Bay sands provide a substantial public benefit as an important resource for public and private construction projects (including public roads and other infrastructure). Bay sands generate significant revenues to the State and local agencies, and contribute to employment and the regional economy. Sand mining, as the

SLC has stressed, has occurred in the San Francisco Bay and Delta for more than 70 years, "providing jobs and supplying high quality sand to the Bay Area construction industry." (SLC Findings, p. D-34.)

Last, Bay sands provide direct and indirect benefits to the environment by reducing emissions of air pollutants and greenhouse gases and lessening regional traffic from heavy-haul trucks. As provided in the EIR, there is a "clear and substantial benefit to maintaining a local source of construction material" in the Bay Area, including a substantial reduction of greenhouse gases. (FEIR, p. 4.7-27.) If Bay sand volumes are further restricted and regional demand must be served by local surface quarries or imports from British Columbia, air and greenhouse emissions are expected to increase dramatically (as much as 44 times for some pollutants). (FEIR, p. 4.5-27; ENVIRON Air Quality Technical Appendix, pp. 29, 31.) As a further illustration, the table below displays the increase in emissions by pollutant expected for any replacement of Bay sand volumes from alternative sources.

Table 1. Ratio of Total Alternative Supplier Emissions to Total Project Emissions

Emission	2015	2024
ROG	2.2x	2.1x
CO	1.7x	1.0x
NOx	3.8x	5.1x
SOx	44x	44x
PM10	3.5x	7.7x
PM2.5	2.0x	4.2x
CO2e	2.4x	2.3x

An updated summary of the air quality and greenhouse gas impacts of forcing the region to rely on alternative sources of sand is attached as **Exhibit 1**.

II. THE APPLICANTS AND REGULATORY AGENCIES HAVE ALREADY ADDED MINIMIZATION MEASURES AND OTHER CONDITIONS TO ADDRESS THE AREAS OF BAYKEEPER'S CONCERN

Baykeeper asks that BCDC add four conditions to the Project: (1) reductions in volumes; (2) bathymetric studies every 5 years; (3) a tracer study to track the transport of sand to the outer coast; and (4) a reduction in the permit term to 5 years. Baykeeper neglects to acknowledge the numerous conditions added to the Project's regulatory approvals that further avoid, minimize, and mitigate resources impacts in line with the San Francisco Bay Plan.

A. Reductions in Volumes. On January 21, 2015, the RWQCB imposed new reductions in permitted volumes, which have minimized volumes substantially:

Table 2. Reductions From Proposed Volumes

Lease Area	Applicant's Proposed Volume	RWQCB Permitted (January 21, 2015)	
		Annual Average Volume	Annual Peak Volume
Hanson - Central Bay			
Total All Leases	1,540,000 cy	1,203,000 cy	1,450,000 cy
PRC 709.1	340,000 cy	232,000 cy	290,000 cy
PRC 2036.1	450,000 cy	360,000 cy	450,000 cy
PRC 7779.1	550,000 cy	484,000 cy	550,000 cy
PRC 7780.1	200,000 cy	127,000 cy	160,000 cy
Hanson - Middle Ground	50,000 cy	40,000 cy	50,000 cy
Lind - Middle Ground	150,000 cy	125,000 cy	150,000 cy
Suisun Associates – Suisun Channel	300,000 cy	245,000 cy	300,000 cy
Totals:	2,040,000 cy	1,613,000 cy	1,950,000 cy

Hanson, Lind, and Suisun Associates accepted these new limits but stated for the record their belief that the evidence to date is insufficient to justify the reduced volumes.

B. Bathymetric Studies: Hanson and Lind are already required to conduct multi-beam bathymetric surveys and analysis at five-year intervals, with the next survey scheduled for 2019.

C. Tracer Study: Tracer studies can provide information on the fate of sediments transported from a particular distribution point. A tracer study, if done correctly, would be enormously expensive and take years to complete. Even if done correctly, there is a strong likelihood it would be inconclusive or present anomalous results unrepresentative of the entire system.

Barnard's work, which formed the basis of his analysis and the modeling conducted by CHE, identified pathways for sediment transport throughout the Bay system. There appears to be little disagreement among the scientific community about the accuracy of Barnard's pathways, and his work is likely a more accurate predictor than any individual tracer study (which would, at best, serve only to confirm discrete pathways). And to the extent mined sands are relic deposits and not involved in the active sediment transport system, a tracer study would not provide any data to help advance the scientific knowledge surrounding the role of sand mining in the overall system. Nevertheless, the Applicants are in discussions with BCDC staff about the possibility of forming a Technical Advisory Committee ("TAC") to address key scientific questions with regards to sediment transport, and a tracer study will be considered among competing priorities for research and data collection.

D. Five-Year Permit Term: Baykeeper contends that a 5-year permit term should be imposed in order to allow BCDC to revise the permits depending on the results of the tracer and bathymetric studies recommended above. But BCDC already has the ability, through existing permit conditions, to alter permitted volumes and suspend or revoke the permit if the Executive Director, at any time, determines through monitoring, studies, or new information that the sandy deep water habitat is not being conserved and/or significant adverse impacts cannot be mitigated or avoided.

Moreover, as outlined above, a tracer study is unlikely to provide useful, system-wide information, especially in this short timeframe. 5 years is simply too short to measure real change in Bay bathymetry and trends. Further, a 5-year permit term, particularly at reduced volumes, is entirely untenable from the Applicants' perspective. Hanson and Lind have expended 10 years and millions in environmental review and its efforts to secure permits and entitlements. A 5-year permit term is therefore unreasonable and impracticable and needlessly exposes BCDC to litigation from Baykeeper and others.

E. Added Mitigation Measures. Unmentioned by Baykeeper are the multitude of measures that have been added or proposed as conditions to the Project by the Applicants and other regulatory agencies since the SLC's certification of the EIR.

1. **Monitoring and Verification Studies:**

    a. Mining Location Tracking. Applicants will track mining locations and provide detailed reports to all regulatory agencies to ensure mining avoids sensitive subtidal areas;

    b. Water Quality Study. To ensure adequate water quality and protection of beneficial uses, Applicants will conduct an updated study to evaluate receiving water quality during mining events[3];

    c. Benthic Habitat Study. As conditioned by the National Marine Fisheries Service ("NMFS"), a TAC comprised of key biologists and regulatory

[3] The last water quality study concluded that there would be no impairment of water quality and beneficial uses.

agencies will develop a work plan to identify and address key questions pertaining to potential effects of sand mining on benthic habitats;

d. Multi-Beam Bathymetric Studies. To support ongoing assessment of impacts to Bay floor and sediment supply system, Applicants will conduct multi-beam bathymetric studies of all lease areas every 5 years; and

e. Biological Monitoring. A designated biologist must conduct monthly compliance inspections.

2. Avoidance and Minimization Measures:

a. Fish Screens. As conditioned by fish and wildlife agencies, Applicants have installed positive barrier fish screens that prevent entrainment of fish;

b. Operational Restrictions. As conditioned by fish and wildlife agencies, Applicants employ specific techniques for operation of mining equipment (e.g., limits on pump priming and height of drag head off bottom) to reduce disturbance and prevent entrainment of fish;

c. Depth and Lease Area Limits. Several conditions have been added to limit mining in shallow water, including specific seasonal limits and distance requirements, to avoid sensitive shallow-water habitats and species; and

d. Seasonal Volume Restrictions. Strict limits on seasonal volumes have been added to the Middle Ground and Suisun Bay operations during sensitive months (December 1 through June 30) to minimize entrainment and other effects on early-stage special-status species.

3. Compensatory Mitigation:

a. Purchase of Habitat Credits. To address any potential "take" of listed species, the Applicants have purchases credits from the Liberty Island Mitigation Bank to provide permanent protection and perpetual management of habitats for sensitive fish species; and

b. Sandy Bottom Habitat Restoration. To address possible adverse effects on Essential Fish Habitat ("EFH"), the Applicants have agreed to contribute to Cal Rycle's Estuary Cleanup Project that will restore benthic habitats.

In addition to the above measures, the Applicants and BCDC staff have discussed the formation of a second TAC to develop a study plan focused on key scientific questions concerning sand mining and its role in the sediment transport system.

III. THE EIR EVALUATED THE BEST SCIENTIFIC EVIDENCE AVAILABLE AND CONCLUDED THAT SAND MINING'S IMPACTS ON SEDIMENT SUPPLIES ARE LIMITED TO THE IMMEDIATE LEASE AREAS

Baykeeper misinterprets geologic information and exaggerates the impacts of sand mining, which are not substantiated by science. Sediment transport and coastal erosion are two complex areas of coastal morphology that are influenced by natural and anthropogenic influences—influences far more complicated than Baykeeper acknowledges.

A. **Sediment Loss to the Bay System.** Historically, high rates of sediment contribution to the estuary's watershed may have contributed substantially to the formation and evolution of the San Francisco Bar. Indeed, during the second half of the 19th century, hydraulic mining activities in the Sierra foothills alone discharged an estimated 850 million cubic meters of sediment *into the Bay*—over four times the volume estimated to have been removed from the Bay through dredging, aggregate mining, and borrow pit mining combined over the last century.[4] Thus, as it was reported by Barnard, the Bar may be shrinking over time simply due to a dramatic reduction in the supply of sediment from the Central Valley.

B. **Changes in Bay Bathymetry.** Baykeeper states that an analysis by the U.S. Geological Survey ("USGS") showed that Central Bay experienced net accretion between 2008 and 2014, suggesting that sand extraction during this period more closely approximated sand replenishment in the area. Baykeeper attempts to contrast this general period of accretion with the erosional period that coincided with higher levels of sand mining (1997-2008). Baykeeper reads too much into the 2014 bathymetric survey, and this period is too short to provide meaningful results. First, the perceived change in bathymetry between 2008 and 2014 was so small that it is within the standard for error. Second, the survey could simply mean that this time period experienced natural accretion that exceeded earlier time periods regardless of the level of mining. Although Baykeeper attempts to draw further conclusions from the data, nothing more is suggested by the survey results.

   It is important to note that sand mining occurs within relatively small areas of the Bay floor, and thus is not expected to disturb significant portions of the Bay or even individual lease areas. For example, the lease areas comprise 3,825 acres of the roughly 12,800 acres of sandy deep water habitat within the Bay. In its highest historical production year for Central Bay (2005), Hanson only disturbed about 283 acres (or 2.2% of available sandy habitat). For that same year, Lind only disturbed between 9.4 to 18.4 acres (or 0.1% of available sandy habitat). Thus contrary to Baykeeper's intimation otherwise, sand mining results in temporary disturbance of relatively small areas—at most, 2.2% of sandy deep water habitat within the Bay.

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[4] Barnard, Patrick L. et. al. (2012) *Synthesis Study of an Erosion Hot Spot, Ocean Beach, CA*, Journal of Coastal Research, 28(4), p. 914.

C. Sediment Supplies to the Offshore Bar and Ocean Beach. Baykeeper in its description of the linkage between sand mining and the Offshore Bar and Ocean Beach presents an incomplete and misleading interpretation of the sedimentation situation. Baykeeper glaringly omits the fact that the Bar and southern Ocean Beach have been shrinking since the late 1800's,[5] and that there are several natural and anthropogenic factors that may be involved.[6]

As noted in the EIR and in recent independent studies, there are many "plausible causes" of erosion of the Bar and outer coastal beaches, including increases in wave height and wave focusing, beach topography, stronger winter storms, changes in the tidal prism of the Bay, and overall decreases in sediment supplies. (FEIR, p. 4.3-38—39.) While some studies suggest that the Bar supplies sand-sized sediment to nearby beaches, the role of the Bar in supplying sediment to open coast beaches remains uncertain and un-quantified. (FEIR, p. 4.3-38.) A "direct or empirical causal link between commercial sand extraction from the Bay and erosion of the San Francisco Bar has not been established." (FEIR, p. 4.3-7—8.) These statements were confirmed during the BCDC science advisory panel assembled by BCDC staff in January of 2014, where the moderator Jessie Lacy summarized the panelists' statements that:

> [T]here seems to be a general evidence that there's connectivity between the lease sites and . . . beaches within San Francisco Bay, but also the outer bar and the coast, but that the timescale of that is really not known, and the strength of that connection is also not known—there's really a big unknown and an important unknown at this point.

Indeed, during the science panel, Barnard himself stated:

> Southern Ocean Beach in particular, there are other aggravating factors. Among them is the fact that the shoreline was built out during the great highway construction in the 1920's. *So it doesn't want to be where it is right now.* Secondly, there is an outflow pipe immediately adjacent to the erosion, the erosional hotspot. The whole area is eroding, and that's *in the background.*

But while southern Ocean Beach is eroding, northern Ocean Beach and several in-Bay beaches such as Crissy Field have been "stable or experience[ing] net accretion since the late 1800s."[7] Significant amounts of accretion are also present offshore and south of the

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[5] *Id.*, p. 905; *see also* Dallas, Kate L. and Barnard, Patrick L. (2011) *Anthropogenic influences on shoreline and nearshore evolution in the San Francisco Bay coastal system*, Estuarine, Coastal and Shelf Science, 92(1), p. 202.

[6] Barnard, Patrick L. et. al. (2012) *Synthesis Study of an Erosion Hot Spot, Ocean Beach, CA*, Journal of Coastal Research, 28(4), p. 913.

[7] *Id.* at p. 911.

longitudinal bar west of Ocean Beach.[8] All of these facts highlight the complexity of sediment transport system and coastal morphology—a complexity Baykeeper conveniently ignores. The SLC's EIR and its expert modeling and analysis—the only study to date to attempt to quantify the contribution of sand mining to the sediment system—concluded that the Project is not expected to result in a significant decrease in the supply of sediment to the Bar or Ocean Beach, and thus "would have no discernible effect on the Bar." (FEIR, p. II-14.)

Finally, Baykeeper argues that the SLC improperly utilized a "ratio comparison" because it attempted to quantify, through numerical modeling, the Project's potential reduction of sediment transported to the Bar (conservatively calculated as, at most, 5,000-7,000 cy annually). Baykeeper's assertion is factually and legally unsupported. CHE's modeling, consistent with that of USGS, shows that any impact of sand mining to the shrinkage of Offshore Bar is negligible. Baykeeper's argument was also rejected by the San Francisco Superior Court, which expressly found that the SLC's "determination that the Project would have less-than-significant cumulative impacts on sediment transport and coastal erosion is supported by substantial evidence."[9]

D. Recent Studies Do Not Alter The EIR's Analysis. Baykeeper in its letter and attached as Appendix 2 lists a series of "findings" from recent studies to support its claim that "[m]ore recent science" has established a new "'causal link' between sand removal in the Bay and 'both the widespread erosion of the ebb tidal delta and extensive erosion of the adjacent south coast shoreline.'" (Letter, pp. 4, 7-8; Appx. 2.) Baykeeper is incorrect.

First, the studies and the underlying data are not necessarily new. Eleven of the fifteen studies cited by Baykeeper were either cited in the SLC's EIR or available prior to certification of the EIR. With regard to the four studies published after certification of the EIR, those studies do not alter the previous conclusions reached by the SLC and its consultant CHE. Instead, these studies largely reaffirm prior research. For example:

- Barnard, P.L. et al., 2012b: This study notes that "the sediment transport pattern in Central Bay and the Golden Gate is very similar to that inferred by Rubin and McCulloch (1979) . . . and Barnard et al. (2012a)," clarifying that the current study simply validates the pathways and increases spatial coverage and resolution from earlier work. (Barnard 2012b, p. 88.) The sediment transport map developed in this study is almost identical to that produced for the EIR and does not alter any of the EIR's conclusions.

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[8] *Id.* at p. 911.

[9] *San Francisco Baykeeper, Inc. v. California State Lands Commission*, Order Denying Petition for Writ of Mandate , San Fran. Sup. Ct. Case No. CPF-12-512620 (April 28, 2014), p. 2:10-12.)

- <u>Barnard, P.L. et al., 2013</u>: This paper contains a review of previous work on sediment transport and provenance (all pre-EIR) and synthesizes existing data with new methods to develop the sand-sized transport pathway map. The new map, however, does not differ from the transport pathways described in the EIR and CHE's modeling results.

- <u>Barnard, P.L., Schoellhamer, D.H., Jaffe, B.E. & McKee, L.J., 2013</u>: This paper was the "introductory paper" of the 2013 Marine Geology issue, and simply "describe[s] prior research that forms the basis of our understanding of the fundamental processes that shape this complex coastal-estuarine system, and to clearly identify the data gaps that are addressed in this special issue." (p. 3.)

- <u>Hein, J.R., Mizell, K & Barnard, P.L., 2013</u>: This study emphasizes that its findings regarding transport pathways are "consistent with prior work" by Barnard and Dallas (2009 and 2011) and Barnard (2012). (p. 163.) The prior work of Dallas and Barnard was analyzed in the EIR. (FEIR, pp. II-22, II-105—107, 4.3-28, 4.3-38, 9-12—16.) This study looked at mineralogy to determine transport pathways, with a transport pathway map that is virtually identical to previous work by Barnard that was evaluated in the EIR.

Second, none of the more recent studies attempted to quantify sediment transport rates or analyze the effects that additional mining may have on sediment transport and coastal morphology. Instead, the studies evaluated generally the reduction in sediment deposited at the Bar and transport pathways in and out of the San Francisco Bay. Consistent with prior studies, the 2012 studies postulated that mining in the Bay is one of many factors that "could" or "may" reduce coastal sediment supplies. These sediment transport pathways, however, are entirely consistent with the analysis and modeling already conducted by CHE for the SLC's EIR. Baykeeper is essentially asking this Commission to adopt a finding that directly contradicts the evidentiary findings of the SLC.

IV. SAND MINING AND RECENT CONDITIONS IMPOSED ON THE PROJECT SATISFY THE McATEER PETRIS ACT AND BCDC's BAY PLAN POLICIES

Baykeeper asserts that the proposed sand mining permit volumes "must be reduced to achieve any semblance of consistency with the Bay Plan." (Letter, p. 4.) Specifically, Baykeeper references the Bay Plan's Tidal, Subtidal, and Climate Change policies. The RWQCB has already reduced permitted volumes to an annual average of 1,613,000 cy—a 627,000 cy *reduction* from previously permitted levels. Combined with the measures identified in Section II.E above and the EIR's Mitigation, Monitoring and Recovery Plan ("MMRP"), this project is consistent with the Bay Plan policies.

A. **The Bay Plan's Tidal Lands Policies Do Not Apply.** The Bay Plan's Tidal Marshes and Tidal Flats policies are being presented entirely out of context. These policies seek to protect tidal marshes and mud flats for habitat and shoreline resiliency. Tidal flats occur from the elevation of the lowest tides to approximately Mean Sea level and include mudflats, sandflats and shell flats. Mudflats comprise the largest area of tidal flat areas. Sand mining, however, does not impact tidal flats or tidal marshes because the lease areas are clearly defined and mining is strictly prohibited in shallower depths.

More importantly, there is absolutely no scientific evidence linking sand removal from Central Bay or other lease areas with the health of tidal marshes and tidal flats around the Bay. Tidal flats and marshes are almost entirely comprised of Bay mud and fine sediment in the silt and clay size range as classified by geologists. Fine sediments are transported as suspended sediment throughout the water column, and a reduction in the amount of such material has been documented in recent years. When this reduction is combined with projected sea level rise, the future of tidal flats in the San Francisco Bay estuarine system indeed appears precarious. The medium to coarse sand that is mined from the Bay (to the extent it is not comprised of relic sands), is transported by a different process. Medium and course sands are transported as bedload due to strong tidal currents, with the material moving by saltation ("jumping" of grains) or very local, near-bottom suspension that is unrelated to tidal flats. Sand mining therefor has no impact whatsoever on tidal flats.

Ironically, Bay sands, once mined, are available for beach replenishment and shoreline resiliency projects (e.g., Crown Beach and Alameda Cove), and can form a base layer for tidelands restoration projects (with muds and finer silts layered on top). If mining volumes are reduced further as Baykeeper advocates, less sand will be available for these important projects.

B. The Project Is Consistent With The Bay Plan Subtidal Policies. Baykeeper recites Subtidal Policies 1, 2 and 5 to urge the Commission to decrease the intensity of sand mining and require further study to increase scientific knowledge of Bay sandy habitats. (Letter, p. 7.) As outlined in Section II, above, the intensity of sand mining has already been reduced substantially and several conditions have been or are being added to increase scientific knowledge of Bay sandy habitats (e.g., water quality, benthic habitats, bay bathymetry, and sediment transport). Further, the Project as revised is consistent with Subtidal Policies 1, 2, and 5.[10]

Pertinent here, Subtidal Policy 1 states that projects in subtidal areas should be designed to "minimize and, if feasible, avoid any harmful effects." Subtidal Policy 2 states generally that sandy deep water areas should be conserved. Baykeeper suggests that sand mining is unsustainable and that the intensity of sand mining should be decreased to

[10] Subtidal Policies 1, 2, and 5 are addressed in detail in the SLC EIR and the transmittal letter and accompanying March 17, 2015 *Feasibility Analysis of Minimization Measures and Project Alternatives to Support BCDC's Application of Bay Plan Subtidal Policies* (submitted concurrently). The analysis is not repeated here for the sake of efficiency.

"begin to achieve consistency with this policy." While the volume of sand reserves has decreased slightly relative to the total amount of unconsolidated sediment in the system, the acreage of "sandy deep water" habitat has not been decreased by sand mining. The same type of bottom and quality of sand is present after mining as was there before and would be available to existing or migratory organisms with a preference for sandy habitat. Thus, the habitat area is not, in fact, decreased by sand mining. In that manner, it is conserved.

Similarly, even if there may be harm to the sandy deep water areas, the Project has already been minimized to reduce and avoid harm. For example, consistent with the reduced peak and average volumes approved by the RWQCB and summarized in Table 2, above, the U.S. Army Corps of Engineers ("USACE") recently emphasized that this change in volumes will be sufficient to minimize the Project's impacts on Bay bathymetry and sediment transport:

> In the Marine Geology paper, 'Sediment transport patterns in the San Francisco Bay Coastal System from cross validation of bedform asymmetry and modeled residual flux,' Barnard et al. (2012) note that while some sand mining lease areas show distinct seaward-directed transport pathways (PRC 709S (Presidio Shoal) and PRC 7780S (Alcatraz South), others show bayward-transportation (PRC 709N (Point Knox Shoal) and PRC 7779W (Point Knox Shoal) and little to no depth change. The Corps proposes to authorize lower volumes on the seaward-directed transport leases, such as Presidio Shoal and Alcatraz South Shoal, and additional volume on the bayward- transport- Point Knox Shoal leases to minimize impacts from sand mining to increased water depth and net bottom erosion.[11]

At least with regard to sediment transport and bay bathymetry, which appear to be Baykeeper's chief concern, none of the federal or state agencies are, at this point, imposing blanket volume reductions indiscriminately across all lease areas.

C. **The Project Supports The Bay Plan's Climate Change Policies.** Baykeeper questions this Project's consistency with the Bay Plan's Climate Policies. As outlined above, there is no connection between sand mining and any erosion that may be occurring at some in-Bay beaches or other tidal areas. Further, sand mining is not expected to result in any measurable changes at Ocean Beach. Consequently, this Project will not increase shoreline vulnerabilities to sea level rise.

Conversely, it is indisputable that shifting sand supplies from the Bay to domestic or

[11] Letter from Jane M. Hicks, U.S. Army Corps of Engineers, to William W. Stelle, Jr., Acting Regional Administrator, National Marine Fisheries Service (Feb. 15, 2015).

foreign surface resources would lead to substantial increases in greenhouse gas emissions. Indeed, for every 100,000 cy that must come from alternative sources as opposed to Bay supplies, greenhouse gas emissions are expected to increase by as much as 240%. The SLC expressly found that the reduced-volume alternative was "infeasible" because, among other things, it would conflict with the State's overriding policies—embodied in AB 32—calling for reductions in greenhouse gas emissions in an effort to slow global climate change. Indeed, the Governor in his inaugural address emphasized the paramount importance of reducing greenhouse gas emissions:

> [N]either California nor indeed the world itself can ignore the growing assault on the very systems of nature on which human beings and other forms of life depend.... 'The evidence for climate warming, with industrial pollution as the principal cause, is now overwhelming.' .... We must also reduce the relentless release of methane, black carbon and other potent pollutants across industries.[12]

Forcing the region to shift its sand supplies from local to foreign or domestic surface resources will more than double greenhouse gas emissions of producing and transporting sand and only impede the State's climate goals to 2020 and beyond. It is entirely incongruous for Baykeeper to condemn the process of global climate change only to impose on Hanson and Lind an alternative that would exacerbate the problem.

V. CEQA LIMITS BCDC's AUTHORITY TO ADOPT FINDINGS THAT CONTRADICT THOSE OF THE EIR AND STATE LANDS COMMISSION

Baykeeper incorrectly asserts that Hanson and Lind have argued that the Commission may not "require any minimization or avoidance measures in approving the approved sand mining permits." (Letter, p. 9.) This is false. In previous correspondence from Hanson and Lind to BCDC in May and September of 2014, we emphasized that if BCDC disagreed with the significant conclusions of the SLC in its EIR (for instance, that the Project's impacts to benthic habitat or sediment supplies are insignificant), BCDC was required to challenge the EIR or waive an objection to the finding.[13] Thus, if BCDC were to adopt contradictory findings as part of its approval of the sand mining permits, it would directly conflict with the EIR and CEQA. The legal authority cited by Baykeeper confirms this. Indeed, while "a responsible agency with permit authority . . . reach[es] its own conclusions as to whether and how to approve the project .

[12] Governor Edmund G. Brown Jr., Inaugural Address, Jan. 5, 2015.

[13] *CEQA Guidelines*, §§ 15096(e), 15321(a).

. . [it] must, as a general rule, use the EIR prepared by the lead agency, even if [the responsible agency] believe[s] it to be inadequate."[14]

For example, BCDC staff have concurred that the term "infeasible" has the same meaning under CEQA and the Bay Plan's Subtidal Policies 1 and 2.[15] In approving the sand mining leases, the SLC expressly rejected the reduced-volume alternative advocated by Baykeeper (1.346 million cubic yards annually) on the basis that such a reduction would be "infeasible." The reduced-volume alternative was deemed infeasible because, among other grounds, it conflicted with AB 32 and important State policies favoring significant reductions in greenhouse gas emissions. The SLC's findings in this regard were never challenged and its determinations have since been upheld by the San Francisco Superior Court. Consequently, the SLC's finding of infeasibility with regard to the reduced-project alternative now controls and Baykeeper is asking BCDC to directly contradict the SLC's findings by adopting an alternative that the lead agency had already determined to be infeasible.

The Applicants do not dispute that the Commission's consideration of the Project is influenced by policies enumerated in the San Francisco Bay Plan, such as Subtidal Policy No. 1's mandate that the proposed Project be "designed to minimize, and if feasible, avoid any harmful effects." The SLC, in its environmental review of the Project pursuant to the California Environmental Quality Act ("CEQA"), was likewise required to adopt all "feasible alternatives or feasible mitigation measures available" that would "substantially lessen the significant environmental effects" of the proposed Project.[16] In the context of the mandates of the Bay Plan, CEQA, and other state and federal environmental laws applicable to the Project, Hanson and Lind have worked diligently with the BCDC, the SLC, and a host of other regulatory agencies (USACE, RWQCB, U.S. Fish & Wildlife Service ("USFWS"), National Marine Fish Service ("NMFS"), and the Bay Area Air Quality Management District) to include avoidance, minimization, and mitigation measures as either design elements or conditions of the proposed Project. Baykeeper has failed to mention any of these measures, which are outlined above.

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[14] *See Central Delta Water Agency v. State Water Resources Control Bd.* (2004) 124 Cal.App.4th 245, 274; *City of El Cajon v. County of San Diego Local Agency Formation Commission* (2010) WL3158906 (in making its own annexation/reorganization decision, LAFCO was prohibited from making findings that directly contradicted the city's EIR without first complying with the special procedural rules under CEQA for challenging them); *Ogden Environmental Services v. San Diego* (S.D. Cal. 1988) 687 F.Supp. 1436, 1451 (once the lead agency has issued its environmental document, "a responsible agency that believes [it] is inadequate must take the necessary steps to challenge the lead agency's findings or otherwise be deemed to have waived any objection").)

[15] In a case challenging BCDC's own interpretation of the term "infeasible," the First Appellate District emphasized that an alternative can be rejected as infeasible for noneconomic reasons such as a failure to achieve project "goals." (*SPRAWLDEF v. San Francisco Bay Conservation and Development Commission* (2014) 226 Cal.App.4th 905.)

[16] Pub. Resources Code, § 21002.

VI. SLASHING SAND MINING VOLUMES WOULD EFFECT AN UNCONSTITUTIONAL TAKING

The Takings Clause of the Fifth Amendment to the U.S. Constitution, which the Fourteenth Amendment makes enforceable against California and its agencies, prohibits the taking of private property for public use "without just compensation." The California Constitution, Article I, Section 19(a), is in accord. A lease issued to a private party to conduct commercial operations on public lands is a private property to which the Takings Clause applies. (*Alamo Land & Cattle Co. v. Arizona* (1976) 424 U.S. 295, 303.) BCDC thus may not take the Applicants' SLC leases unless BCDC pays the Applicants just compensation.

So what is a taking? Baykeeper's letter addresses two types of takings: (i) where there has been a "physical invasion" of the private property, and (ii) where regulation denies "all economically beneficial" use of the private property. Yet there is also a third type of taking that occurs where a regulation seeks to mitigate an impact that a project will not cause, or imposes mitigation that is disproportionate to a project's impacts. That is precisely what Baykeeper is proposing that BCDC do here.

The *Nollan* case illustrates this third type of taking. In *Nollan*, the California Coastal Commission refused to permit the redevelopment of a home unless its owners agreed to dedicate the beach in their front yard to the public, even though the new house would cause no new adverse impacts to public access to the coast. (*Nollan v. Cal. Coastal Comm'n* (1987) 483 U.S. 825, 829.) The U.S. Supreme Court ruled against the Coastal Commission, holding that, because there were no public-access impacts related to the redevelopment, the public-access condition did not "substantial[ly] advanc[e]" any legitimate governmental interest and was thus an unconstitutional taking. (*Id.*, at 841, quotation marks and citation omitted.) Subsequent Supreme Court cases have expanded *Nollan* to hold that, even if a project will cause impacts, mitigation conditions are a taking unless there is an "individualized determination" that there is "rough proportionality" between the impact and the condition. (*Dolan v. City of Tigard* (1994) 512 U.S. 374, 391.)

Here, the lead agency (SLC) has certified an exhaustive EIR that concludes that the Project will cause no significant impacts, including no significant impacts to benthic habits or to coastal beaches. Because BCDC did not challenge these findings, BCDC is bound by them. (*See* Section V, above.) And because BCDC is bound by the EIR's conclusions that the Project will cause no discernable impacts, the Takings Clause prohibits BCDC from imposing a condition that would slash mining volumes to mitigate impacts that do not exist.[17] Nor does the mere invocation of the precautionary principle do away with the constitutional requirement that BCDC make an individualized determination that a condition to slash mining volumes is roughly proportionate to an impact the project is actually likely to have. (*See Dolan.*) Any condition

[17] *See Nollan*; *CEQA Guidelines*, § 15041(a); *see also* Pub. Resources Code § 66632(f) (Commission's terms and conditions must be "reasonable").)

slashing mining volumes, without proposing to pay just compensation, would violate the Takings Clause.

The courts likely would review any decision by BCDC to slash mining volumes with great skepticism. Although courts review many BCDC decisions under the deferential "substantial evidence" standard, a different standard applies in Takings-Clause challenges. In those cases, the California Supreme Court has held that courts are to review the evidence independently: "[b]ecause a taking of property is alleged, the court must accord the owner de novo review of the evidence before the agency in ruling on the taking claim." (*Hensler v. City of Glendale* (1994) 8 Cal.4th 1, 16; *see also Goat Hill Tavern v. City of Costa Mesa* (1992) 6 Cal.App.4th 1519, 1529 (courts apply independent judgment when agencies apply new laws that "interfere[] with the right to continue an established business"); *The Termo Co. v. Luther* (2008) 169 Cal.App.4th 394, 407 (independent-judgment test applies to agency decision not to allow longstanding oil well to operate).) A court applying its own independent review of the evidence will likely conclude that any condition slashing mining volumes is unjustified and unconstitutional.

CONCLUSION

Consistent with Bay Plan Policies, sand mining has received intense scrutiny, including over six years of environmental review by the SLC and subsequent review and analysis by multiple regulatory agencies (CDFW, USFWS, RWQCB, and USACE). Since the Project was approved by the SLC in 2012, allowable volumes have been reduced substantially and conditions have been added that address directly the concerns and recommendations of Baykeeper. This process has and will continue to add to our knowledge of the Bay, and will undoubtedly inform any subsequent review for future permitting applications. In the meantime, the amended permit applications satisfy the letter and spirit of the Bay Plan and should be allowed to move forward when the project is presented to you for approval in April.

Sincerely,

DOWNEY BRAND LLP

Christian L. Marsh

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Appendix F

Downey Brand LLP Letter re Coastal Commission Staff Comments, March 17, 2015

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March 17, 2015

VIA E-MAIL AND U.S. MAIL

Honorable Members of the Commission
Mr. Larry Goldzband, Executive Director
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Re: Response to California Coastal Commission Letter dated January 23, 2015

Dear Commissioners and Mr. Goldzband:

We are responding to the January 23, 2015 letter from California Coastal Commission staff members Mark Delaplaine and Dr. Lesley Ewing concerning the pending applications of Hanson Marine Operations ("Hanson") and Lind Marine, Inc. ("Lind"). As explained in greater detail below, the staff letter contains three primary recommendations which are undermined by factual misstatements in the letter and the extensive scientific record developed in evaluation of the four pending applications. More importantly, however, Hanson and Lind are already committed to undertaking each of the three recommendations:

1. The San Francisco Bay Regional Water Quality Control Board ("Regional Board"), just two days before the Coastal Commission letter, substantially reduced overall sand mining volumes to an annual average of 1,613,000 cubic yards ("cy") (with the ability to peak at 1,950,000);

2. The Regional Board has further restricted sand mining volumes in average and peak years within the two lease areas in Southern Central Bay that are associated with ocean-ward sediment transport pathways; and

3. Ongoing multi-beam bathymetry surveys and a proposed Technical Advisory Committee ("TAC") and workplan to improve scientific understanding of possible effects of sand mining on coastal resources.

RESPONSE

At heart, Delaplaine and Ewing's letter raises a "concern" about the "potential" for sand mining to contribute to erosion outside the Bay, but acknowledges that the "dynamics" of the system are "complex," assessing the contribution of mining is "difficult," and scientific "uncertainties remain." These opinions of staff are just the sort of equivocal statements that the courts have found insubstantial.[1]

As the authors note, their position is at odds with the findings of the California State Lands Commission ("SLC") and its Environmental Impact Report ("EIR"), certified after six-years of environmental review. That EIR analyzed the Project's potential impacts on a wide range of resources, including sediment transport to the coast. After completing its evaluation, the SLC found that continued sand mining in Central and Suisun Bays "is not likely to cause measurable sediment depletion" and "would not affect sediment transport outside of the immediate vicinity of the mining leases areas." (FEIR, pp. 4.3-30, -31, II-4.) The staff letter fails to present any new data that contradicts the prior analysis conducted by the SLC and its engineering consultant CHE.

I. THE STAFF LETTER MAKES STATEMENTS AND RECOMMENDATIONS THAT ARE UNSUPPORTED AND UNREASONABLE

The Coastal Commission staff letter makes several statements that warrant clarification and correction:

A. EIR Modeling of Small Watersheds and In-Bay Transport (Staff Letter, p. 5, ¶ 4). The letter states that the EIR's modeling and analysis did not take into consideration sediments entering the system from the surrounding small watersheds or in-bay transport of sediment from Ocean Beach. The letter then makes the unsupported claim that this omission "likely" means that the EIR underestimated the difference between sediment losses and losses from mining activity.

The relative contribution of surrounding small watersheds of suspended fine sediment has been interpreted to have increased in recent years. The SLC EIR modeling did not include the wave-driven longshore transport mechanism that has been documented to carry significant amounts of sand from north Ocean Beach to the Crissy Beach/Marina area. Those areas are stable or accreting, however, and thus the key analysis from an impact perspective focused on sediment transport *to* the Offshore Bar and southern Ocean Beach. Whether the flood tide transport mechanism from Golden Gate to Point Knox Shoal is actively contributing to deposition, which remains an open geologic question, the

[1] *See Rominger v. County of Colusa* (2014) 229 Cal.App.4th 690, 723 [air quality expert's opinion too vague to show increased project odor impacts]; *Apartment Association of Greater Los Angeles v. City of Los Angeles* (2001) 90 Cal.App.4th 1162, 1176 [opinion raising "generalized concerns" or "which says nothing more than 'it is reasonable to assume' that something 'potentially . . . may occur'" is not substantial evidence].

strong currents *were* included in the modeling as shown in the SLC EIR and in USGS documents.

B. **Modeling of the Offshore Bar (Staff Letter, p. 5, ¶ 5).** The letter states that the model used to determine that mining will have minimal impacts on the sediment supply to the Offshore Bar has not been tested to replicate the changes to the Bar that have been observed recently. But the modeled analyzed the contribution of sand mining to the Bar and affirmed that any diminution would not be measurable at the Bar. Again, from an impacts perspective, the key analysis involved the contribution of sand mining areas to the Offshore Bar, which modeling and analysis affirmed would not be measurable at the Bar. Ongoing modeling by USGS has included the outer coast area, and there is no data or other evidence generated since certification of the EIR to alter its conclusions.

C. **Limits of Numerical Modeling (Staff Letter, p. 5, ¶ 6).** The staff letter argues that numerical modeling "may not" adequately reflect long-term and extremely complex dynamics of the sediment system, and urges that physical studies (such as tracer studies) be conducted to confirm or refine the numerical models. In the same paragraph, however, the staff letter then suggests that even if physical studies could confirm the numerical models, long terms trends in sediment inputs, grain sizes, coastal erosion, and sea level rise would likely render them "meaningless."

Computer models are approximations, based on the best data available and can never be expected to be perfectly accurate. This does not render numerical modeling efforts "meaningless." In fact, a major benefit of models is to understand the overall physical process, which can help identify the types of data that will be most important to future modeling efforts.

Tracer studies can provide information on the fate of sediments transported from a particular distribution point. If done correctly, however, a tracer study would be enormously expensive and take years to complete. Even if done correctly, there is a strong likelihood it would be inconclusive or present anomalous results unrepresentative of the entire system. Barnard's work, which formed the basis of his analysis and the modeling conducted by CHE, identified pathways for sediment transport throughout the Bay system. There appears to be little disagreement among the scientific community about the accuracy of Barnard's pathways, and his work is likely a more accurate predictor of how the system operates than any individual tracer study (which would, at best, serve only to confirm a few discrete pathways).

To the extent mined sands are relic deposits and not involved in the active sediment transport system, a tracer study would not advance the scientific knowledge surrounding the role of sand mining in the overall system. Nevertheless, the Applicants are in discussions with BCDC staff about the possibility of forming a Technical Advisory Committee ("TAC") to address key scientific questions with regards to sediment transport, and physical studies will be considered among competing priorities for research and data collection.

D. Sand Mining Should Shift From Southern Central Bay Lease Areas (Staff Letter, p. 7, ¶ 1). The letter quotes language from a Barnard Study and posits that, from a sediment supply perspective, sand mining should be focused on areas where it would have a more delayed effect on transport to the open ocean.

The quoted study suggests shifting mining from Presidio Shoal (PRC 709.1 and PRC 7780.1) to Point Knox Shoal based on the transport directional indicators. This recommendation was overly simplistic, as recharge rates at PRC 709.1 South were historically greater than at the Point Knox Shoal lease areas (1997-2008). Nevertheless, the average and peak mining volumes have already been reduced substantially in the two southern Central Bay lease areas more closely associated with ocean-ward pathways for sediment transport:

Lease Area	Applicant's Proposed Volume	RWQCB Permitted (January 21, 2015)	
		Annual Average Volume	Annual Peak Volume
Hanson - Central Bay			
Total All Leases	1,540,000 cy	1,203,000 cy	1,450,000 cy
PRC 709.1	340,000 cy	232,000 cy	290,000 cy
PRC 2036.1	450,000 cy	360,000 cy	450,000 cy
PRC 7779.1	550,000 cy	484,000 cy	550,000 cy
PRC 7780.1	200,000 cy	127,000 cy	160,000 cy
Hanson - Middle Ground	50,000 cy	40,000 cy	50,000 cy
Lind - Middle Ground	150,000 cy	125,000 cy	150,000 cy
Suisun Associates – Suisun Channel	300,000 cy	245,000 cy	300,000 cy
Totals:	2,040,000 cy	1,613,000 cy	1,950,000 cy

In this respect, the staff letter's recommendation has already been incorporated in the amended applications.

E. Monitoring Program and Expert Panel (Staff Letter, p. 7, ¶¶ 2-4). Without regard for technical feasibility or cost, the staff letter sets forth a list of wished-for physical studies, monitoring, and an expert review panel, some of which are physically impossible or entirely unnecessary to accurately evaluate the effects of sand mining on the sediment system. For example, there is no scientific justification for conducting bathymetric surveys annually and the usefulness of doing so is questionable particularly due to the small changes that occur in Bay bathymetry year to year.

To support ongoing scientific understanding of the Bay bathymetry and the sediment supply system, Hanson and Lind are already required to conduct multi-beam bathymetric studies of all lease areas every 5 years. Hanson and Lind have also proposed a Technical Advisory Committee to address key scientific questions with regards to sediment transport, and a tracer study will be considered among competing priorities for research and data collection.

II. THE EIR EVALUATED THE BEST SCIENTIFIC EVIDENCE AVAILABLE AND CONCLUDED THAT SAND MINING'S IMPACTS ON SEDIMENT SUPPLIES ARE LIMITED TO THE IMMEDIATE LEASE AREAS

The staff letter misinterprets geologic information and exaggerates the impacts of sand mining, which are not substantiated by science. Sediment transport and coastal erosion are two complex areas of coastal morphology that are influenced by natural and anthropogenic influences—influences far more complicated than the staff letter acknowledges. Delaplaine and Ewing fail to note, that, aside from the SLC EIR, no other study has attempted to quantify or otherwise evaluate the contribution of this Project to the overall sediment supply to the Offshore Bar or coastal beaches.

A. Sediment Loss to the Bay System. Historically, high rates of sediment contribution to the estuary's watershed may have contributed substantially to the formation and evolution of the San Francisco Bar. Indeed, during the second half of the 19th century, hydraulic mining activities in the Sierra foothills alone discharged an estimated 850 million cubic meters of sediment *into the Bay*—over four times the volume estimated to have been removed from the Bay through dredging, aggregate mining, and borrow pit mining combined over the last century.[2] Thus, as it was reported by Barnard, the Bar may be shrinking over time simply due to a dramatic reduction in the supply of sediment from the Central Valley.

B. Temporary Disturbance of the Bay Floor. Sand mining occurs within relatively small areas of the Bay floor, and thus is not expected to disturb significant portions of the Bay or even individual lease areas. For example, the lease areas comprise 3,825 acres of the roughly 12,800 acres of sandy deep water habitat within the Bay. In its highest historical production year for Central Bay (2005), Hanson only disturbed about 283 acres (or 2.2% of available sandy habitat). For that same year, Lind only disturbed between 9.4 to 18.4 acres (or 0.1% of available sandy habitat). Sand mining results in temporary disturbance of relatively small areas—at most, 2.2% of sandy deep water habitat within the Bay. Consequently, from a

[2] Barnard, Patrick L. et. al. (2012) *Synthesis Study of an Erosion Hot Spot, Ocean Beach, CA*, Journal of Coastal Research, 28(4), p. 914.

function and value standpoint, sand mining's effects on the Bay floor remain less than significant.

C. Sediment Supplies to the Offshore Bar and Ocean Beach. The staff letter omits the fact that the Bar and southern Ocean Beach have been shrinking since the late 1800's,[3] and that there are several natural and anthropogenic factors that may be involved.[4]

As noted in the EIR and in recent independent studies, there are many "plausible causes" of erosion of the Bar and outer coastal beaches, including increases in wave height and wave focusing, beach topography, stronger winter storms, changes in the tidal prism of the Bay, and overall decreases in sediment supplies. (FEIR, p. 4.3-38—39.) While some studies suggest that the Bar supplies sand-sized sediment to nearby beaches, the role of the Bar in supplying sediment to open coast beaches remains uncertain and un-quantified. (FEIR, p. 4.3-38.) A "direct or empirical causal link between commercial sand extraction from the Bay and erosion of the San Francisco Bar has not been established." (FEIR, p. 4.3-7—8.) These statements were confirmed during the BCDC science advisory panel assembled by BCDC staff in January of 2014, where the moderator Jessie Lacy summarized the panelists' statements that:

> [T]here seems to be a general evidence that there's connectivity between the lease sites and . . . beaches within San Francisco Bay, but also the outer bar and the coast, but that the timescale of that is really not known, and the strength of that connection is also not known—there's really a big unknown and an important unknown at this point.

Indeed, during the science panel, Barnard himself stated:

> Southern Ocean Beach in particular, there are other aggravating factors. Among them is the fact that the shoreline was built out during the great highway construction in the 1920's. *So it doesn't want to be where it is right now*. Secondly, there is an outflow pipe immediately adjacent to the erosion, the erosional hotspot. The whole area is eroding, and that's *in the background*.

But while southern Ocean Beach is eroding, northern Ocean Beach and several in-Bay beaches such as Crissy Field have been "stable or experience[ing] net accretion since the late 1800s."[5] Significant amounts of accretion are also present offshore and south of the longitudinal bar west of Ocean Beach.[6] In addition, the shrinkage of the Bar was noted a hundred years ago, prior to

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[3] *Id.*, p. 905; *see also* Dallas, Kate L. and Barnard, Patrick L. (2011) *Anthropogenic influences on shoreline and nearshore evolution in the San Francisco Bay coastal system*, Estuarine, Coastal and Shelf Science, 92(1), p. 202.

[4] Barnard, Patrick L. et. al. (2012) *Synthesis Study of an Erosion Hot Spot, Ocean Beach, CA*, Journal of Coastal Research, 28(4), p. 913.

[5] *Id.* at p. 911.

[6] *Id.* at p. 911.

sand mining activities, and, in recent decades, losses to the Bar have included direct sediment removal by USACE to maintain the shipping channel. Thus, according to the best current understanding, sand mining is not a significant contributor to erosion at south Ocean Beach, and there are no "mining levels" that would alter this situation.

All of these facts highlight the complexity of the sediment transport system and coastal morphology—a complexity the staff letter conveniently ignores. The SLC's EIR and its expert modeling and analysis—the only study to date to attempt to quantify the contribution of sand mining to the sediment system—concluded that the Project is not expected to result in a significant decrease in the supply of sediment to the Bar or Ocean Beach, and thus "would have no discernible effect on the Bar." (FEIR, p. II-14.) Additionally, CHE's modeling, consistent with that of USGS, shows that any impact of sand mining to the shrinkage of Offshore Bar is negligible.

III. THE STAFF LETTER IS WRONG ON PUBLIC BENEFITS

The staff letter recommends limiting permitted mining volumes "to 15% of historic mining levels (the upper estimate of the replenishment value)" on the unrealistic assumption that an extractive industry should be "limited to sustainable levels." First, mining of any mineral is an inherently extractive activity, and it is no way realistic to expect this important activity for the economy of the Bay Area to result in the maintenance of pre-existing bathymetry. However, the amount of material proposed to be extracted is much smaller, many orders of magnitude smaller, than the amount of unconsolidated sediment that underlies the Bay floor. After mining is completed the Bay floor will remain "sandy bottom habitat," so, in this sense, the environment will have been sustained.

Next, the staff letter mischaracterizes public policy authorizing sand mining as a "public policy decision that maximizes private industry profits in the face of extensive public expenditures to grapple with the outer coast erosion issues." As discussed above, the SLC's EIR concluded that the Project is not expected to result in a significant decrease in the supply of sediment to Ocean Beach. BCDC's permit process definitely does not "attempt to maximize private industry profits." In fact, the lease owner of the sand mining leases is the State of California, administered by SLC, so a significant part of sand mining revenues accrue to the coffers of the State.

Furthermore, as described in the SLC's EIR, there are significant environmental benefits associated with the reduction in emissions achieved with local marine sand mining as compared with importing aggregate, including issues of air quality and sea level rise. Insofar as the imported sources are not leased by the SLC, limiting local marine sand mining could actually increase "private industry" revenues, while decreasing revenues to the State of California. As for the State's policy with respect to mining, the Legislature has declared that:

> extraction of minerals is *essential* to the continued economic well-being of the state and to the needs of the society . . . [and] the production and development of

> *local mineral resources* . . . are *vital* to reducing transportation emissions that result from the distribution of hundreds of millions of tons of construction aggregates that are used annually in building and maintaining the state.[7]

Private sand mining is necessary to realize the substantial public benefits of Bay sands, which form an important part of the regional economy.

CONCLUSION

Sand mining has received intense scrutiny, including over six years of environmental review by the SLC and over two years of subsequent review and analysis by multiple regulatory agencies (CDFW, USFWS, RWQCB, and USACE). Since the Project was approved by the SLC in 2012, allowable volumes have been reduced substantially and conditions have been added that address directly the concerns and recommendations of the staff letter. This process has and will continue to add to our knowledge of the Bay, and will undoubtedly inform any subsequent review for future permitting applications. In the meantime, the amended permit applications satisfy the letter and spirit of the Bay Plan, and should be allowed to move forward when the project is presented to you for approval in April.

Sincerely,

DOWNEY BRAND LLP

Christian L. Marsh

cc: Michael Roth, Vice President Region West, Lehigh Hanson, Inc.
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[7] Pub. Resources Code, §§ 2711(a), (d).