

# San Francisco Bay Conservation and Development Commission

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April 30, 2021 (Revised May 14, 2021)

**TO:** Commissioners and Alternates

**FROM:** Lawrence J. Goldzband, Executive Director (415/352-3653; [larry.goldzband@bcdc.ca.gov](mailto:larry.goldzband@bcdc.ca.gov))  
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**SUBJECT: Sand Mining Workshop Report**  
(For Commission Workshop on May 6, 2021)

## Sand Mining Workshop Background

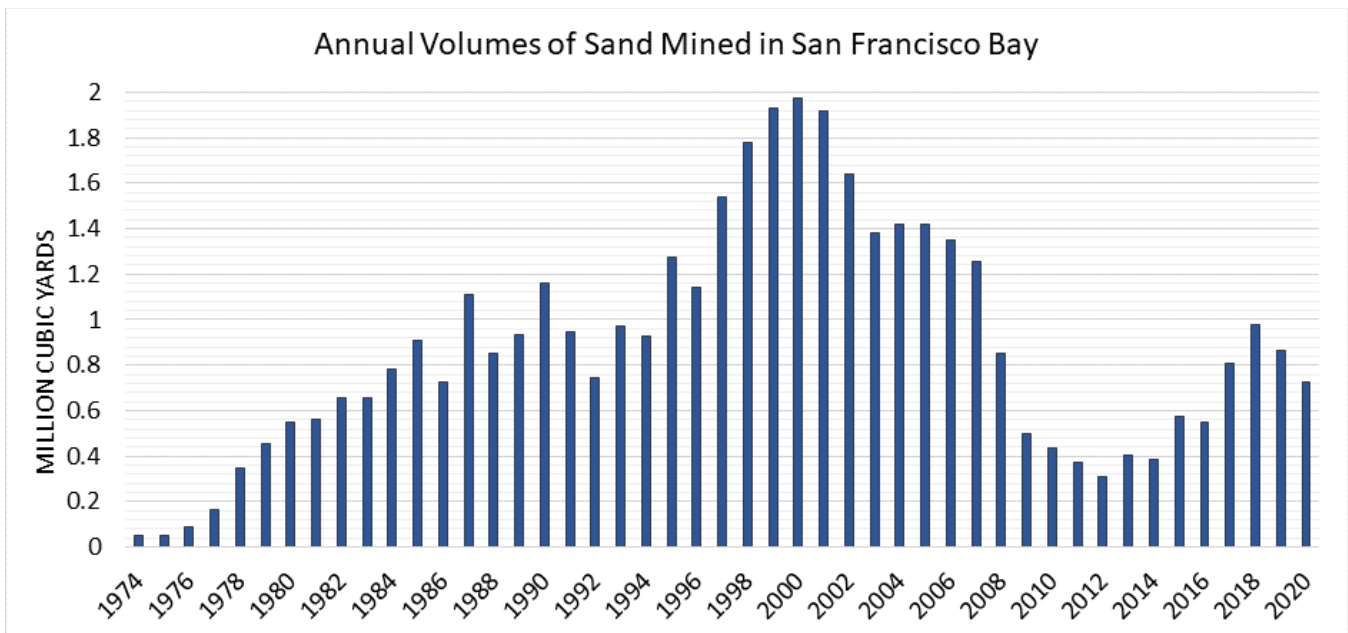
On May 6, 2021, the Commission will conduct a sand mining physical processes workshop. At that workshop, the Independent Science Panel will discuss three studies proposed and funded to help reduce knowledge gaps regarding the sand budget and transport system in San Francisco Bay (Bay) and the potential impacts of authorized sand mining activities. This document briefly describes the history of sand mining in the Bay, the mining companies and their practices, permitting, and studies that are being conducted on behalf of the Commission.

### Historic Mining

Aggregate companies have mined San Francisco Bay for sand since the 1930s, using it for concrete, asphalt, road-base and general construction fill. BCDC issued its first sand mining permit to a company named Tidewater Sand and Gravel in 1973. Since then Commission staff have worked with the aggregate miners to ensure that mining of this resource is consistent with the Commission's laws and policies, and done in an environmentally sensitive manner. Although aggregate mining has occurred in San Francisco Bay for nearly one hundred years, the actual volume of sand mined annually has only been recorded since the mid-1970s with the onset of permitting actions. As shown in Figure 1, over the past 50 years the amount of sand mined has both varied and increased due to demands for the material by the construction industry.

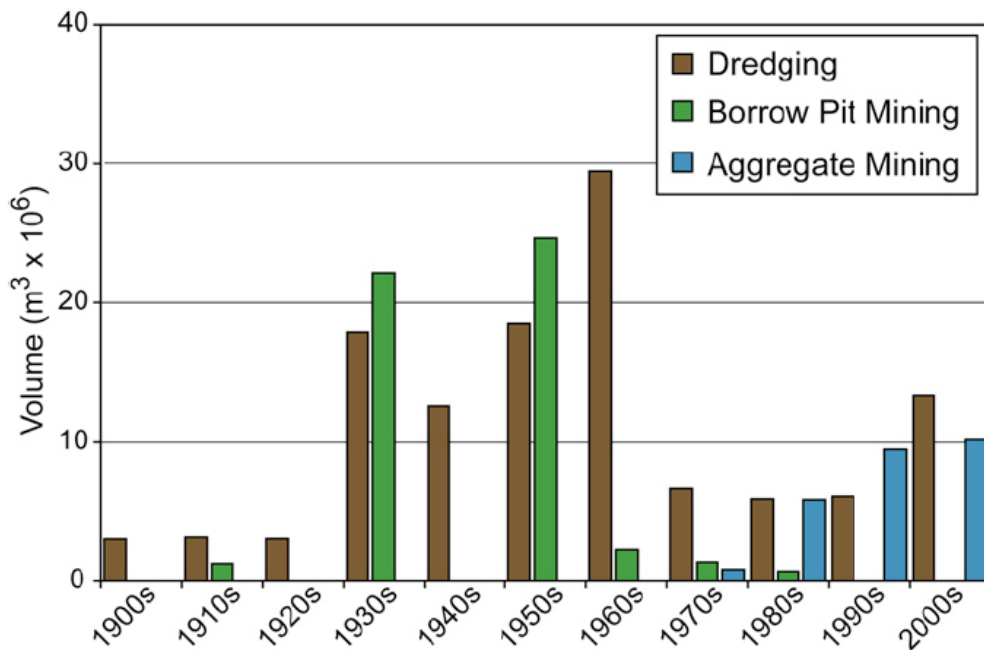
Prior to 2000 several different aggregate mining companies had permits to mine sand from the California State Lands Commission (SLC) lease areas in central San Francisco Bay and Suisun Bay and privately owned subtidal lands. Over time these leases changed hands to other mining companies operating in the area. Currently Lind Marine, Inc. (Lind), Hanson Marine Operations (Hanson) and Suisun Associates (a joint venture between Hanson and Lind) operate mining activities on the lease areas obtained from companies that no longer mine sand in the Bay.





**Figure 1. Annual reported volume of sand mined from San Francisco Bay. Reported volumes prior to the mid-2000s are likely higher due to unreported mining activity.**

Figure 2, while limited to the early 2000’s, shows a comparison between mining and other sediment extracted from the Bay, including navigation dredging and construction borrow. Shown as borrow pit mining, construction borrow extracted sediment for specific projects including Treasure Island in the 1930’s and the BART tunnel in the 1960’s. Currently, between 2 and 3 million cubic yards of sediment are dredged for navigation purposes annually. By and large, borrow pit mining projects have ceased in the region.



**Figure 2. Comparison of historic sediment extractions from San Francisco Bay.**

Source: Dallas, K., and Barnard, P. 2011

## Mining Companies

Hanson is a subsidiary of Lehigh Hanson, Inc. and is a part of the Heidelberg Cement Group, one of the largest building materials manufacturers in the world. Currently Hanson has four SLC leases in the Central Bay and is authorized to mine an average of 1.14 million cy annually. Lind is a family-owned and operated mining, dredging and marine construction company based in Petaluma. Lind leases the Middle Ground Shoal parcel from the Grossi family where they are authorized to mine an average of 100,000 cy of sand per year. Suisun Associates, a joint venture between Hanson and Lind is authorized to mine an average of 185,000 cy from the SLC lease in the Suisun Channel. The total amount mined annually is driven by the demand of the local construction industry.

## Location

The current mining leases are located in three main areas of the Bay where sand deposits exist. The lease areas are in the central San Francisco Bay between the Golden Gate Straits, Alcatraz Island and Angel Island, in Suisun Bay on a privately owned tidelands parcel known as Middle Ground Shoal, and in the Suisun Channel along the Chipps and Van Sickle islands of the Suisun Marsh as shown in Figure 3.

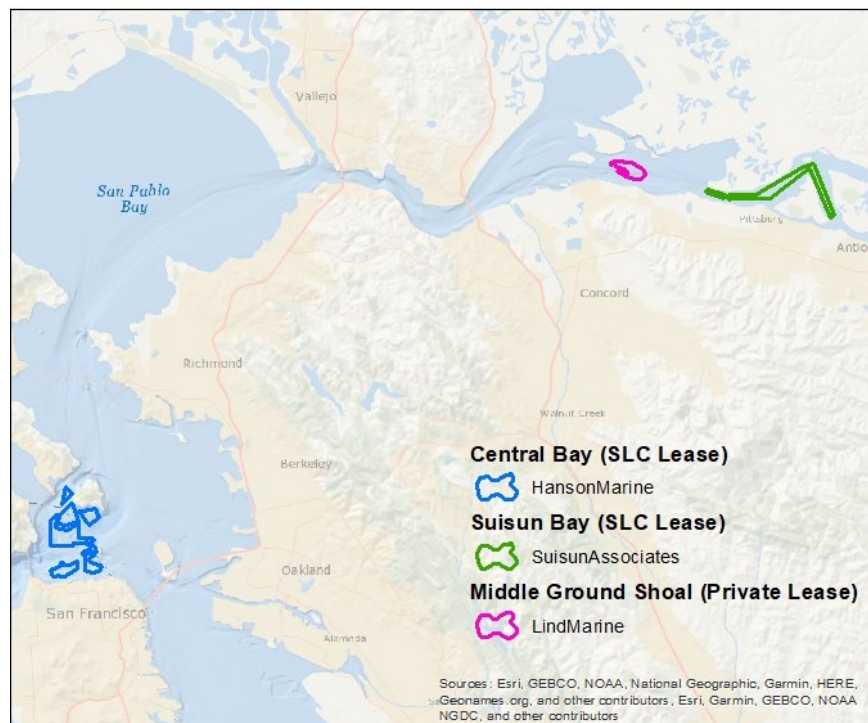
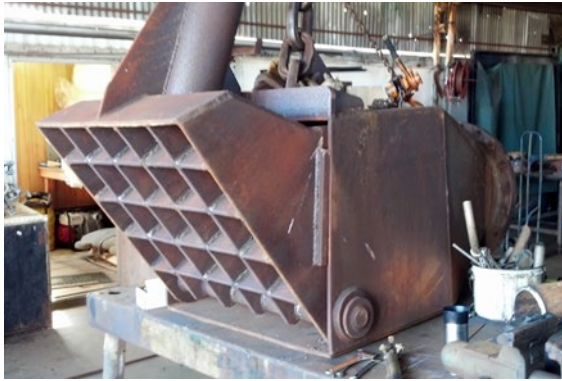


Figure 3. Currently permitted sand mining locations in San Francisco Bay.

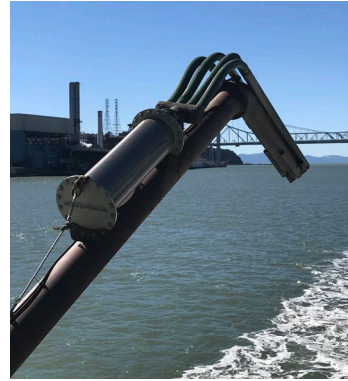
## Mining Process

Sand is mined two ways in San Francisco Bay, both hydraulically. Hanson mines sand through a draghead (left photograph) lowered from a barge to the sand shoal where it is slowly dragged across the sand much like a vacuum cleaner. In this case, the draghead is shallowly imbedded into the sand. The sand is slurried with Bay water drawn through a fish screen, and is pumped into the barge. The excess water, fine sediment, and aggregate too large to pass through the target sand size sieve is returned to the Bay. The majority of the sand mined is extracted from the Central Bay lease areas, an average of 751,150 cubic yards (cy) annually (Table 1). Lind uses a different hydraulic method, in which the mining head is more similar to a pipe (right photograph) inserted deeper into the sand shoal and held stationary while Bay water is drawn through the fish screen to slurry the sand that is then pumped

into the barge. Both methods employ a screen on their water intake pipes to reduce the entrainment of fish. The average mining volume in the Suisun region is 204,375 (cy) annually (Table 1). In either case, the mining barges hold approximately 2,000 cy of sand and are offloaded at the miners' landside facilities, where the sand is drained of Bay water. Hanson further processes the sand by washing with fresh water to remove salt. The sand is then loaded and trucked by customers to the location where it is used. The mined sand is used almost exclusively within the Greater Bay Area.



Hanson's Mining Draghead



Lind's Mining Head

### Permitting

The previous BCDC permits issued to Hanson and Lind expired in 2008 but were granted time extensions several times due to the availability of previously authorized volumes remaining on the permits. In addition, when the SLC leases expired, it was determined that a full California Environmental Policy Act (CEQA) review was necessary to assess the potential impacts of the proposed issuance of new ten year leases. As part of the CEQA review, a number of studies were required to inform the analysis and Environmental Impact Report (EIR). A list of those studies are provided in Table 3. The CEQA process was concluded in October 2012 when the SLC certified the EIR. The state permitting agencies relied on this document as part of their permit application review.



The US Army Corps of Engineers (USACE) conducted a review under the National Environmental Protection Act (NEPA) as part of its permitting process.

In 2013, Hanson, Lind, and Suisun Associates submitted applications to the Commission requesting new 10-year permits for a combined 2.04 million cy of sand annually. Working with the permitting agencies, the final combined annual authorized volume is 1.426 million cy, with mining reduced in areas identified as having potential impacts to sand transport to coastal beaches and Middle Ground Island's smelt spawning habitat. A complete list of the permits is provided in Table 2 at the end of this document.

**Table 1.** Averaged Volume Mined and Permitted Annual and Peak Volumes

Location/Lease No.	Lease Annual Volumes Averaged from 2000 - 2020	Current BCDC Authorized Volumes <sup>A</sup>	
		Annual Volume (cy)	Peak Year Volume (cy)
Suisun Bay/Western Delta (Suisun Associates)	81,630	185,000	235,000
Grossi Middle Ground (Lind)	122,750	100,000	120,000
<b><i>Suisun Bay Leases Total: Suisun Bay/Delta and Middle Ground Shoal</i></b>	<b>204,380</b>	<b>285,000</b>	<b>355,000</b>
Central Bay Leases (Hanson)	751,170	1,141,000	1,395,000
<b>Total Volume</b>	<b>955,550</b>	<b>1,426,000</b>	<b>1,750,000</b>

Notes: A. Although other regulatory agencies authorized greater volumes, BCDC authorized the lowest annual and peak volumes, which are presented in this table. In addition, the average volumes are rounded to the nearest tenth.

Hanson, Lind, and Suisun Associates also obtained mining permits from the following regulatory and resources agencies:

- San Francisco Bay Regional Water Quality Control Board
- U.S. Army Corps of Engineers
- California Department of Fish and Wildlife
- U.S. Fish and Wildlife Service
- National Marine Fisheries Service

These authorizations included minimization measure protective of fish and fish habitat implemented during mining activities as well as monitoring and mitigation requirements. The required mitigation included the purchase of mitigation credits at Liberty Island, a mitigation bank benefitting threatened and endangered salmonids and smelt. In addition, to mitigate for impacts to essential fish habitat, the companies removed marine debris at the former Crockett Marina. These mitigation requirements have been completed. In addition, the Commission required studies to address data and knowledge gaps associated with potential impacts from mining activities.

### Required Studies

As part of the Commission's permits, two primary knowledge gaps – impacts to bottom dwelling organisms and the sand budget and transport system were identified. To address these gaps, the Commission required a study of the impacts to the benthic community and \$1.2 million of funding towards new scientific studies on the San Francisco Bay sand resource and transport. The Commission required that a Sand Studies Technical Advisory Committee (STAC) made up of regulatory and resource agencies, the miners and stakeholders develop management questions (Attachment A); an Independent Science Panel (ISP) to develop studies to address the management questions; and a Study Coordinator

to help coordinate these efforts. Over the course of two years management questions were identified, recommendations for studies were developed, and a request for proposals was developed and issued. Three studies and study teams were selected in 2020 to further the understanding of sand transport mechanisms in order to better assess the impacts of sand mining on the Bay’s sediment supply and will provide data addressing the management questions. Attachment B provides high level summaries of the proposed studies, which will be described and discussed with the Commission at the sand mining workshop in greater detail. The Commission workshop and these studies specifically address the potential impacts to the Bay’s sand budget and transport system. Additional studies were conducted as part of the CEQA process and requirements from other agencies. They are listed in Table 3 at the end of this document.

Historically the sand has been transported from the Delta by the Sacramento and San Joaquin Rivers into Suisun Bay where tidal currents carry it through San Pablo Bay into Central San Francisco Bay and out through the Golden Gate to the outer coast. The current understanding to the transport system is illustrated in this diagram created from several studies conducted by the US Geological Survey.

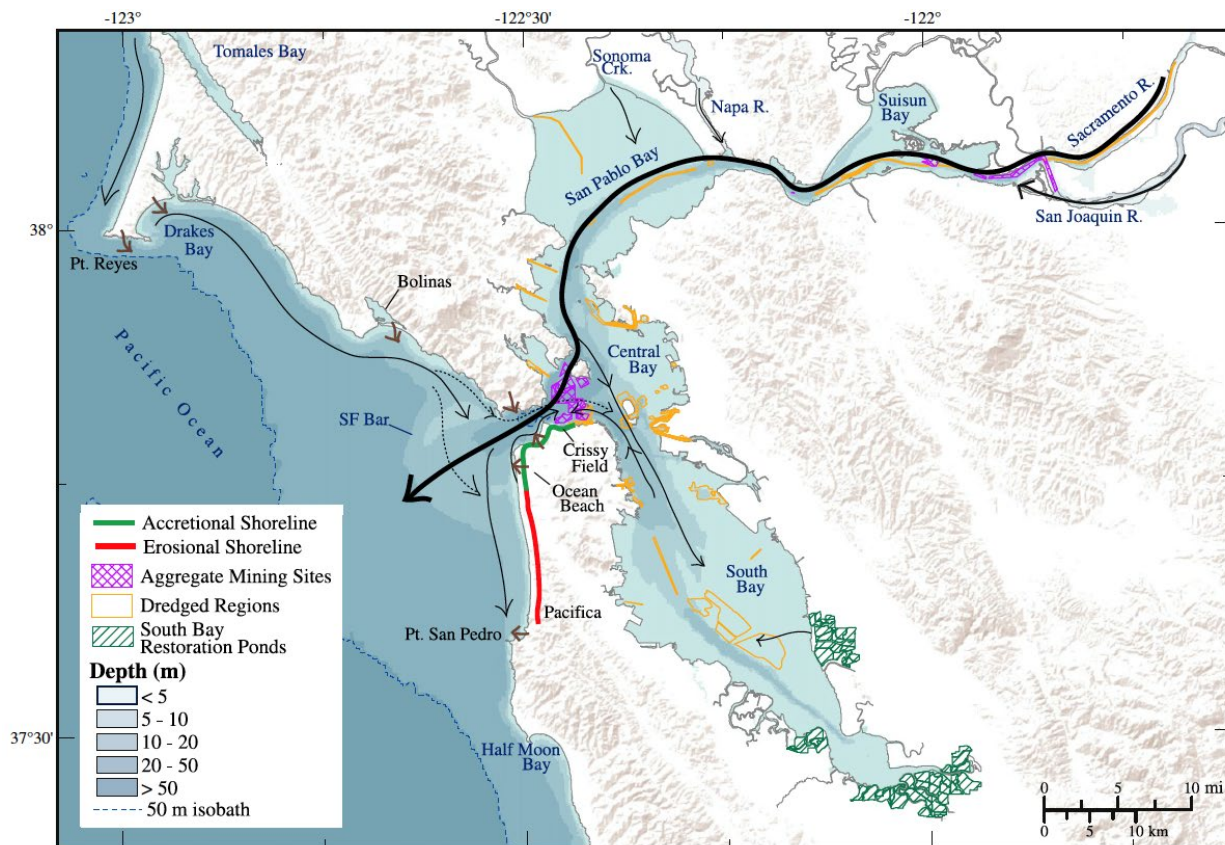


Figure 4. Sand transport pathways as identified through multiple USGS studies. Source: Barnard, P. 2013<sup>1</sup>

<sup>1</sup> “Final conceptual model of the primary beach-sized sand transport pathways in the San Francisco Bay Coastal System, based on the integration of the provenance techniques”

The key management questions these studies will focus on include:

1. Is sand mining at the existing lease areas, at the permitted levels, having a measurable or demonstrable impact on sediment transport and supply within San Francisco Bay or the outer coast?
2. What are the anticipated physical effects of sand mining at the permitted levels on the sand transport and supply to San Francisco Bay and the outer coast?
3. Are there other feasible sand mining approaches to consider in the San Francisco Bay?

The kick off meeting for the studies occurred in April and the studies are scheduled to be completed by the end of 2022. An executive summary of the studies is included as Attachment B. The studies and teams are:

- a. San Francisco Sand Budget, Information Collection and Synthesis: Led by San Francisco Estuary Institute, supported by USGS and Deltares
- b. Stratigraphy and Sand Resource Availability: Led by researchers from Stanford and University of Texas
- c. Sand Transport Study: Led by AnchorQEA in collaboration with the San Francisco Estuary Institute

**Table 2.** Permits Associated with Lease Sites

Agency	Central Bay Permits <sup>1</sup>			
	Presidio Shoals	Point Knox South	Point Knox Shoals	Alcatraz South Shoal
CSLC All leases expire 12/31/2022	709.1	2036.1	7779.1	7780.1
USACE	24305S	2441N	24997N	23573S
	All USACE permits and the associated Biological Opinions from NMFS and USFWS expire June 1, 2025			
BCDC	2013.004.00 expires April 29, 2025			
RWQCB	Order No. R2-2015-0008 (applies to all Hanson's mining leases) expires January 21, 2025			
CDFW	ITP #2081-2013-047-03 expires December 31, 2023 for all Hanson's sand mining lease			
Agency	Middle Ground Permits <sup>1</sup>			
USACE	24996N and 25653N and associated NMFS and USFWS Biological Opinions expires June 1, 2025			
BCDC	2013.003.00md expires April 29, 2025			
RWQCB	Order No. R2-2015-0009 (applies to Lind's mining lease) expires January 21, 2025			
CDFW	ITP #2081-2012-012-03 expires December 31, 2023 for all Lind's sand mining leases			
Agency	Suisun Channel Permits <sup>1</sup>			
CSLC	7781.1 expires December 31, 2022			
USACE	2013-00130S and the associated Biological Opinions from NMFS and USFWS expires June 1, 2025			
BCDC	2013.005.00md expires April 29, 2025			
RWQCB	Order No. R2-2015-0010 expires January 21, 2025			

Note: 1 The California State Mining and Geology Board has approval authority over the reclamation plans prepared pursuant to SMARA for the sand mining sites. SMGB adopted resolution 2005-02 in February 2005, approving the reclamation plans for sand mining leases in the Central Bay, Suisun Bay and the western Delta. The SMGB considers the reclamation plans valid and current.

**Table 3.** Analysis of Potential Impacts from Sand Mining

<b>Supplemental Investigations in Support of the Certified 2012 EIR and SLC Leases</b>	<b>Year Completed</b>
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” by Hanson Environmental Inc. for Hanson Aggregates Mid-Pacific, Inc. RMC Pacific Materials, Inc. Jerico Products, Inc./Morris Tug & Barge.	2004
Bathymetric multi-beam surveys of lease areas	2008
Assessment and Evaluation of Fish and Invertebrate Entrainment Effects from Commercial Aggregate Sand Mining in San Francisco Estuary prepared by AMS for SLC (Appendix E of EIR)	2009
Benthic Survey of Commercial Aggregate Mining Leases in Central San Francisco Bay and Western Delta prepared by AMS for SLC (Appendix F of the EIR)	2009
Air Emissions Evaluations (Appendix D of EIR) and Human Health Risk Assessment (Appendix C of EIR)	2009
Sand Mining Resource Evaluation & Impacts Analysis: Sediment transport modeling analysis by CHE for SLC (Appendix G of EIR)	2009
EIR State Clearinghouse No. 2007072036 CSLC EIR NO. 742 San Francisco Bay and Delta Sand Mining Project 2	2012
<b>Additional Studies to Support Permitting/Permit Conditions</b>	<b>Year Completed</b>
Biological Assessments for Federal Endangered Species and Essential Fish Habitat submitted to USFWS & NMFS subsequent Biological Opinions	2013 -2015
Incidental Take Permit Application for State Endangered Species submitted to CDFW, permit issued in 2014	2013 -2014
NEPA Support for the USACE –Assessment of Economic Impacts Associated with Sand Mining in San Francisco Bay Prepared by Economic & Planning Systems Inc. BCDC requested revisions to this Economic Analysis to Support their Policy Consistency Determinations: response in Central Bay Sand Mining Activity - BCDC Permit Application No. 2013.004.00 3rd Response letter for additional information to BCDC from Hanson January 27, 2014	2013 – 2014
NEPA support for the USACE - 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 by Environ	2013
<b>Analysis of Potential Impacts from Sand Mining (continued)</b>	<b>Year Completed</b>
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 by Scott Fenical	2013
2014 multi-beam bathymetric surveys of all lease areas	2014
BCDC hosted Science Panel to discuss Benthic Habitat and Sediment Transport Potential Impacts	2014
2018 multi-beam survey of lease areas. Bathymetric Trend Analysis: 2008, 2014, and 2018 multi-beam surveys change analysis by ETrac Engineering	2018
Benthic Assessment of Sand Mining in Central San Francisco and Suisun Bays: Sampling Analysis Plan, Data Report and Supplemental Data Report Prepared by Newfields	2015- 2018
Water Quality Monitoring: Hanson Marine Operations & Lind Marine Inc Sand Mining Water Quality Monitoring Program Results Report Final by Newfields	2015- 2018
Sediment TAC, ISP and Study coordinator formed and meetings conducted	2019-2021
Three studies 1) Information Collection and Synthesis of bathymetric data; 2) Stratigraphy and Sand Resource Availability; and 3) Sand Transport Study	Pending

<sup>2</sup> The First District Court of Appeal reviewed the 2012 San Francisco Bay and Delta Sand Mining Project EIR and 2016 lease re-approvals by the SLC, ultimately upholding the SLC’s finding that the project “would not have a significant project specific or cumulative impact on sediment transport or coastal erosion.” (*San Francisco Baykeeper, Inc. v. State Lands Commission* (2015) 242 Cal.App.4th 202; see also *San Francisco Baykeeper, Inc. v. State Lands Commission* (2018) 29 Cal.App.5th 562.)



## ATTACHMENT A

### MEMORANDUM

**From:** San Francisco Bay Sand Mining Technical Advisory Committee (SFB Sand Mining TAC)  
**Date:** July 17, 2018  
**Subject:** Final Draft Management Questions from the Sand Mining TAC

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The following questions regarding sand mining activities and their potential impacts to San Francisco Bay and Outer Coast sand transport were developed by the Physical Process Technical Advisory Committee (STAC). They are intended to guide the Independent Science Panel in recommending appropriate studies or research that would inform future management of mining activities. The STAC recognizes that this is not an exhaustive list of questions, nor can all of the questions included here be researched or addressed with the current funding or time available, and that prioritization and leveraging of studies will be necessary.

#### TIER 1 MANAGEMENT QUESTIONS:

- 1) Is sand mining at existing lease areas, at permitted levels, having a measurable or demonstrable impact on sediment transport and supply within San Francisco Bay or the outer Coast?
- 2) What are the anticipated physical effects of sand mining at permitted levels on sand transport and supply to San Francisco Bay and the outer coast?
- 3) Are there other feasible sand mining approaches to consider in San Francisco Bay?

#### TIER 2 SCIENCE AND MANAGEMENT QUESTIONS:

- 1) **Is sand mining at existing lease areas, at permitted levels, having a measurable or demonstrable impact on sediment transport and supply within San Francisco Bay or the Outer Coast?**
  - a) Does sand mining influence sand transport through SF Bay?
    - i) How does sand mining impact the volume or characteristics of sand supplies to the beaches (In-Bay and Outer Coast)?
    - ii) Does sand mining change the way sand moves from subtidal shoals to intertidal flats, marshes and beaches?
    - iii) Does sand mining influence sand waves and their contributions in transport processes?
    - iv) Has sand mining altered the grain size distribution of in-bay or outer coast sand resources?
    - v) Does sand mining result in sand sinks and resultant changes in flux to the Outer Coast?
  - b) What is the source of mined sand in the lease areas? Is it “relic” sand, or “new” sand transported into the system?
    - i) What is the ratio of relic to new sand found in mined sand?
    - ii) How much of what’s available is being mined?
    - iii) Is it better for the physical environment to mine “relic” sand or “new” sand?

- c) What is the relationship between bathymetric change trends and sand mining intensity trends, recognizing the possible lag between stimulus and response?<sup>1</sup> Do we have the appropriate information for this evaluation?
  - d) Does sand mining alter the geomorphology of the Bay floor beyond the mining location such that sand transport/supply are significantly impacted?
  - e) Do both mining areas (Central Bay and Suisun) have the same effects on sand transport pathways and associated impacts? Should these areas be examined separately?
- 2) What are the anticipated physical effects of sand mining at permitted levels on sand transport and supply within San Francisco Bay and the Outer Coast?**
- a) Is there regional uplift/subsidence or other factors that would confound evaluation of sand mining effects?
  - b) Is there a seasonality to sand transport?
  - c) What is our current technical ability to model sand transport to and from the Bay?
  - d) What are the key uncertainties associated with measuring and modeling the relationship between sand mining in SF Bay and erosion of outer coast beaches? To what extent do the studies designed to answer the management questions presented here contribute towards reducing this uncertainty?
  - e) What monitoring and modeling efforts are required to significantly reduce uncertainty associated with quantitatively defining the relationship between sand mining in SF Bay and erosion along the outer coast?
  - f) Under currently permitted mining levels, would erosion be measurably influence sand transport to Ocean Beach or north of the Gate over a 10, 20, 30 and 50-year time horizon? By how much? What would quantitatively or qualitatively be the long-term effects ?
- 3) Are there other feasible sand mining approaches to consider in San Francisco Bay?**
- a) Are there areas within the current leases or other potential areas in the Bay where sand mining could feasibly occur that would minimize or avoid impacts to sand transported supply, as compared to existing mined areas?
  - b) Is there a “better” time period to mine sand so that the impacts to the physical processes are minimized while balancing economic realities, market demands and job impacts?
  - c) What scenarios should we model to judge the likely impacts associated with management actions (e.g. increase/reducing in mining intensity, rotation of lease areas, establishment of new lease areas)?

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<sup>1</sup> Bathymetric surveys and change analysis are permit requirements that will be addressed by sand miners, and this data/information will be provided to the ISP.

## ATTACHMENT B

### Executive Summary of Physical Process Studies

The following are short summaries of the studies selected to investigate the San Francisco Bay sand resources and budget, transport, and potential impacts of authorized mining activities through 2025.

#### 1. Literature Review and Sand Budget

**Research Team:** San Francisco Estuary Institute, U.S. Geological Survey, Pacific and Coastal Marine Science Center, and Deltares (Netherlands)

**Methodology.** This research will synthesize best available information on sand transport and update the sand budget describing and documenting sand sources and sinks, where the sand comes from, where it is deposited, and its destination. First, the researchers will compile historical literature and data into a database that includes relevant research through 2020.

With input from the Independent Science Panel and Sand Technical Advisory Committee, research regarding sand transport within San Francisco Bay, the major tributaries and the outer coast (with the focus on the mined areas and their linkages) will be compiled. The science of sand resources in San Francisco Bay has evolved in the past five years providing opportunities to vastly improve the information to support future management and policy decisions. There are new datasets and models available that will be used to formulate the sand budget. In addition, SFEI has developed a new watershed model that improves our knowledge of how sediment moves from the watershed to the Bay. New information includes five additional years of monitoring data on sediment input of the Delta and local Bay Area tributaries, seven years of data on sediment removal from flood control channels, new bathymetric data, and various models that can be used to look at sediment pathways and exchange. Any relevant datasets such as suspended sand at Mallard Island and stream gage data will be refined to provide a revised annual estimate of sand supply from the Delta to the Bay for the period of 1995 through 2019. Similarly, a refined and updated dataset of sand contributions from the local tributaries for the period of 1995 through 2019 will also be completed.

This team will also be working with and providing information on the sand transport model below.

#### **Management Questions Addressed**

*How does sand mining impact the volume or characteristics of sand supplies to the beaches (In-Bay and Outer Coast)?*

*Does sand mining change the way sand moves from subtidal shoals to intertidal flats, marshes and beaches?*

*Does sand mining result in sand sinks and resultant changes in flux to the Outer Coast?*

*Are there areas within the current leases or other potential areas in the Bay where sand mining could feasibly occur that would minimize or avoid impacts to sand transported supply, as compared to existing mined areas?*

## ATTACHMENT B

### 2. Stratigraphy and Sand Resource Availability in San Francisco Bay

**Research Team:** University of Texas at Austin, University of Texas Institute for Geophysics, and U.S. Geological Survey, Pacific and Coastal Marine Science Center

Stratigraphy is the science of rock strata and their relationship to geological time. The goal of this research is to determine the thickness and geologic origin of the sand underlying the sand mining lease areas. The main objectives are to quantify the amount of sand available, the age of the sand deposits, and whether the sand is relic or sand in transport.

**Methodology** This research will utilize existing sediment cores to compare the sand native origin's (provenance) signature of pre-1840's sand deposits to sand deposited post human activities to define "signals" useful in tracking sand transport. A variety of techniques will be applied to existing shallow cores to provide an explanation of sand transport patterns, reworking, and replenishment. The USGS has collected more than 300 gravity cores in San Francisco Bay that will be used in this study. A bathychronology (historical sedimentation) tool (<https://pubs.usgs.gov/of/2005/1273/>) will first be used to identify a subset of the USGS's cores that contain sediment deposited during the periods of interest including periods prior to European settlement, post-hydraulic gold mining, early sand mining, and recent sand mining. The tool will show where sand has been mobilizing and accumulating over time so that cores with the targeted provenance signal can be selected for sampling.

The best core locations will be those that indicate continuous deposition of sand between the 1850's and the near present. Samples will be taken from each selected core to capture key time horizons (e.g., pre-hydraulic gold mining, post-hydraulic gold mining, pre sanding mining, and post sand mining). One example of how provenance signatures reveal information about sand supply to the outer coast is if provenance signatures in older Ocean Beach sands show a strong Sacramento-San Joaquin signature but younger (post-mining) sand shows a marked decreased in the Sacramento-San Joaquin signature. That information can be interpreted to determine if sand mining may be significantly decreasing natural sand output through the Golden Gate Strait.

#### **Management Questions Addressed**

*Is sand mining at existing lease areas, at permitted levels, having a measurable or demonstrable impact on sediment transport and supply within San Francisco Bay or the outer Coast?*

*What is the source of mined sand in the lease areas? Is it "relic" sand or "new" sand transported into the system?*

*Is it better for the physical environment to mine "relic" sand or "new" sand?*

*Is there regional uplift/subsidence or other factors that would confound evaluation of sand mining effects?*

*What are the anticipated physical effects of sand mining at permitted levels on sand transport and supply within San Francisco Bay and the Outer Coast?*

## ATTACHMENT B

### 3. Sediment Transport Modeling

**Research Team:** Anchor QEA and the San Francisco Estuary Institute

Anchor QEA and San Francisco Estuary Institute (SFEI) will be conducting a Sediment Transport Modeling Study: (1) modeling of the sediment transport, (2) reporting the findings, and (3) team coordination and sediment flux analysis, the results of which will be combined to provide data on the volume, source and destination of sand in the San Francisco Bay sand mining lease areas.

**Methodology** Using the UnTRIM Bay-Delta model, Anchor QEA and SFEI will coordinate data development and transfer to create two scenarios: a historic, no-mining bathymetric conditions and historic bathymetric conditions with mined sand. In addition, they will model the hydrodynamics, waves and sediment transport for four scenarios for wet and dry years over a one-year span in order to capture seasonal changes in winds, waves, tides, and Delta outflow. Then, using two scenarios, historic environment without mining, and with mining, they will model the bedload (sand moving along the Bay bed) and suspended load (sand moving through the water) sand transport will be simulated and evaluated separately to predict their transport rates, directions and total transport. Maps showing these results as well as the predicted effects of sand mining on transport and deposition/erosion will be developed. Further collaboration between Anchor QEA and SFEI will allow comparison of the USGS flux data (sand moving in and out) collected at the Golden Gate with the modeled Golden Gate fluxes during both wet and dry years.

A detailed review of previous research on the Bay's sand transport will be conducted and the modeling findings will be evaluated in the context of this research for a more comprehensive understanding of transport. Easily interpretable conceptual models and graphics addressing the Management Questions will be developed based on the review. These maps, graphics and the sand transport modeling results will be synthesized into a report, as well as recommendations for future data collection and further analyses.

#### **Management Questions Addressed**

*Does sand mining influence sand transport through San Francisco Bay?*

*What is the relationship between bathymetric change trends and sand mining intensity trends, recognizing the possible lag between stimulus and response?<sup>1</sup> Do we have the appropriate information for this evaluation?*

*Does sand mining alter the geomorphology of the Bay floor beyond the mining location such that sand transport/supply are significantly impacted?*

*Do both mining areas (Central Bay and Suisun) have the same effects on sand transport pathways and associated impacts? Should these areas be examined separately?*

*Is there a seasonality to sand transport?*

*What is our current technical ability to model sand transport to and from the Bay?*

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<sup>1</sup> Bathymetric surveys and change analysis are permit requirements that will be addressed by sand miners, and this data/information will be provided to the ISP.