

Appendix E Independent Science Panel Report Development Meeting Summaries and Discussion/ Responses to Sand Mining Management Questions

As detailed in Section 2.3 of this report, the Independent Science Panel (ISP) held discussions on the extent to which the scientific study findings answered the original sand mining management questions, including identification of areas of uncertainty and future study. The last attachment in this appendix is a compilation of ISP discussion on the sand mining management questions.

Note that not all scientific study deliverables were complete at the time the ISP first met to conduct this review, so the conclusions drawn in these summary documents represent an initial, then evolving evaluation by the ISP. The meeting summaries reflect the iterative, cumulative process of understanding individual study findings in the broader context. In reviewing these notes, the continuous, layered processing of information becomes apparent over time. The attachments in this appendix are superseded by the report itself.

All Meeting Summaries were prepared by the independent study coordinator and distributed to the ISP for timely review and comment.

Documents include:

- ISP Report Development Meeting 1 Summary: June 5, 2023
- ISP Report Development Meeting 2 Summary: July 24, 2023
- ISP Report Development Meeting 3 Summary: October 11, 2023
- ISP Report Development Meeting 4 Summary: March 4, 2024
- Responses to Sand Mining Management Questions

Sand Mining Studies ISP Report Development Meeting 1

Virtual Meeting (Zoom)
June 5, 2023, 9:00am – Noon

1

Discussion Highlights

2 **MEETING GOALS:**

- 3
- Confirm content for inclusion in the final report.
 - 4 • Refamiliarize the Independent Science Panel (ISP) with the sand mining management questions and identify what limitations may exist in the studies' ability to address the questions.
 - 5
 - 6 • Assess how the study findings collectively answer the management questions, including the degree of confidence in study findings, the sufficiency of the study findings to answer the larger
 - 7 management questions, and the identification of remaining questions or areas for additional study.
 - 8

9 **ACTION ITEMS:**

- 10
- The ISP is to advise whether any questions discussed during this first meeting would need to be revisited at a future meeting, due to the Sand Budget and Bedload Transport Report (SFEI) being released.
 - 11
 - 12
 - 13 • Erica Johnson to investigate whether the sand mining study teams can either review the draft report or participate in a meeting with the ISP to review the ISP's interpretation of study findings.
 - 14

15 **ATTENDANCE:**

16 **INDEPENDENT SCIENCE PANEL:**

David Schoellhamer, USGS Emeritus
Bob Battalio, ESA Consulting

John Largier, UC Davis
Craig Jones, Integral Consulting (joined at 9:30 a.m.)

17 **OBSERVERS:**

Bay Conservation and Development Commission (BCDC)	Brenda Goeden, Jaime Lopez, and Pascale Soumoy
Bay Keeper	Ian Wren
California Coastal Commission	Jeremy Smith
California Water Board	Jazzy Graham-Davis
NOAA Fisheries	Sara Azat
State Coastal Conservancy (SCC)	Erica Johnson, Marilyn Latta
State Lands Commission	Christopher Huitt
U.S. Army Corps of Engineers	Jayme Ohlhaber
Lehigh Hanson/ Martin Marietta	Mike Bishop, Erika Guerra
Lind Marine	Bill Butler
GHD (consultant to mining companies)	Nick Sadrpour

18 **STUDY COORDINATORS:**

19 Lisa Beutler, Jamil Ibrahim, and Marisa Perez-Reyes, Stantec

20 **SUPPORTING MATERIALS**

- 21
- Meeting chat (attached as Appendix A)
 - 22 • Session PowerPoint
 - 23 • Time-stamped meeting transcript
 - 24 • Meeting recording

1 **SUMMARY**

2 **1. Welcome and Agenda Review, Set Up Discussion, Introduce Report Product**

3 Erica Johnson welcomed attendees and explained the purpose of the meeting was to provide an opportunity
4 for the ISP to discuss the study findings that will seed the content for a report to the BCDC. Lisa Beutler,
5 session facilitator, elaborated on the meeting goals and confirmed the agenda and discussion approach with
6 ISP members. Brenda Goeden expressed appreciation to the ISP, Sand Studies Technical Advisory
7 Committee (STAC), and research teams for their years of work.

8 Marisa Perez-Reyes shared an overview of the draft outline for the report to BCDC summarizing ISP
9 discussion on study findings and noted the primary audience as being the BCDC members and regulators.
10 Brenda emphasized that this is the ISP's report and Stantec's role is to help them write it.

11 Members of the ISP provided input on the report outline. Bob Battalio shared that he views the report
12 development process as iterative, since the ISP will not only need to speak on the management questions,
13 but also conduct some technical synthesis. He expressed doubt that the ISP could definitively answer the
14 questions and highlighted an ancillary objective for their discussion which is to synthesize the work for the
15 benefit of the science community and projects. He suggested a potential synthesis section as either part of
16 the report or an appendix to it.

17 **2. Revisiting the Sand Mining Management Questions**

18 The ISP reviewed the original Sand Mining Management Questions developed by BCDC. For the purposes
19 of the day's deliberations, the facilitator explained the group would be reviewing the primary, overarching
20 questions (Tier 1) and then the subset of study questions (Tier 2) that had been designed to inform the Tier 1
21 questions. She then explained the ISP would consider the efficacy of the findings generated by the Tier 2
22 questions and reflect on the following:

- 23 • Are the study findings sufficient to answer the larger management questions?
- 24 • Did we learn anything we didn't expect to learn?
- 25 • One study aim was to provide the best available science for use by decision makers - to what extent
26 has this goal been met?
- 27 • What limitations might still exist?
- 28 • What future study might be required?

29 The ISP expressed concurrence with the questions and the discussion approach.

30 **3. Discussion on How Study Findings Address Management Question 2**

31 The ISP held discussion on each of the Tier 2 questions under Management Question 2: **What are the**
32 **anticipated physical effects of sand mining at permitted levels on sand transport and supply within**
33 **San Francisco Bay and the Outer Coast?** The Tier 2 questions were intended to build toward answering
34 the overarching question. Responses from the sand mining study reports were also included.

35 The group acknowledged that the Sand Budget and Bedload Transport Report (SFEI) and Final Stratigraphy
36 Report (UT Austin) had not yet been delivered. The ISP was instructed to report back on whether any
37 questions discussed during today's meeting would need to be revisited as a result of those new reports.

38 **TIER 1, QUESTION 2**

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

Question 2a) Is there regional uplift/subsidence or other factors that would confound evaluation of sand mining effects?
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41 **Sand Mining Study Team Response:**

1 The evaluation of uplift/subsidence was outside the scope of this study. However, sediment transport
2 modeling and analysis of bedforms (Elias and Roelvink 2022a) show that sand transport depends on the
3 environmental conditions. As such, changes to the physical forces influencing sand transport could confound
4 evaluating effects of sand mining. For example, changes through time to the relative proportion of wet versus
5 dry years could alter the decadal sand transport in the system and the supply of sand to the SF Bay.¹

6 **ISP Discussion**

7 The group acknowledged that, aside from the bathymetric change analysis developed by USGS as part of
8 the sand budget, uplift and subsidence were not addressed through the studies. Still, the ISP generally felt
9 that uplift and subsidence are not likely confounding factors in the evaluation of sand mining effects (it may
10 be closer to the tertiary level). Study teams have discussion sections in report that should identify other
11 factors, and those factors should be considered in ISP discussions.

12 Regarding the question of whether other effects may be confounding the evaluation of sand mining effects
13 outside uplift/subsidence, Bob noted that there has not been an inventory of the littoral zone (shallow
14 subtidal, inter-tidal, and wave run-up), so it isn't known yet whether beaches in the SF Bay are growing or
15 shrinking.

16 **Areas for Future Study**

- 17 • Evaluation of sand erosion at beaches – volume of sand in SF Bay beaches and shoals and
18 evaluation of whether that volume has changed much over time.
- 19 • Unknown factors referenced in sand study reports

Question 2b) Is there a seasonality to sand transport?

20 **Sand Mining Study Team Response:**

21 Yes, there is a seasonality and interannual variability to sand transport in the SF Bay. Predicted sand fluxes
22 from 3D sediment transport modeling showed considerable seasonal variability in both the rate and direction
23 of sand transport in SF Bay. From Suisun Bay to the Golden Gate, sand fluxes were influenced by Delta
24 outflow, with that influence being greater in Suisun Bay and decreasing toward the Golden Gate. Variability
25 in sand transport over time is further supported by the analysis of bedforms, where Elias and Roelvink
26 (2022a) found that bedform migration direction at a location in eastern Suisun Bay switched 180 degrees
27 between 2014 and 2018 and again between 2018 and 2019.²

28 **ISP Discussion**

29 The ISP agreed that the studies have clarified the patterns and factors involved, but intra-annual and
30 seasonal variability is still uncertain. Seasonality may be different than previously thought. The ISP flagged
31 that this question may be addressed in the analyses that haven't yet been released.

32 The ISP discussed how the findings suggest that density-driven flow is occurring in high outflow years.
33 Results show more sand coming into SF Bay through the Golden Gate during wet periods, whereas previous
34 thoughts were rivers brought sand/sediment in during wet periods. It was previously assumed that high
35 outflows would result in net seaward transport of sand; however, the modeling shows that suspended, finer
36 sediments are moving out through Golden Gate in an upper layer while a lower layer of denser water is
37 transporting sand landward into SF Bay, resulting in a net sand transport into the Bay. John remarked that
38 the two-layer flow finding makes sense and pointed to examples from Tiburon and San Pablo Bay.

39 John and Bob spoke about the extent to which wave driven littoral transport is better understood as a result
40 of the studies. Bob reflected that modeling has adopted it as a piece of the picture, but it's still a data gap

¹ Sand Transport Modeling Report, Anchor QEA

² Sand Transport Modeling Report, Anchor QEA

1 that would be important to understand at some point. Bob estimated the volume could be between 50,000
2 and 100,000 cubic yards, which is significant but perhaps well-known enough to focus on other questions.

3 Craig highlighted what he felt to be a profound finding from the Stratigraphy Report, which is that the
4 substantial portion of sands in the Central Bay are sourced from the Outer Coast. Oceanic/coastal effects are
5 not well understood; relationship between SF Bay and Pacific Ocean are uncertain.

6 **Areas for Future Study**

- 7 • Density driven flows and sand transport
- 8 • Sand transport driven by oceanic forcing
- 9 • Flux due to wave-driven littoral transport, particularly addressing uncertainty along Marin Coast
- 10 • Sand transport at the Golden Gate

Question 2c) What is our current technical ability to model sand transport to and from the Bay?

11 **Sand Mining Study Team Response:**

12 The current technical ability to model sand transport to and from SF Bay is moderate because it is limited by
13 the lack of available data for model calibration and validation. Equations and models representing the
14 physics of sand transport are available, but there are little observational data available on sand transport
15 rates in the Bay and on the amount of sand supplied directly to SF Bay by local tributaries available for
16 model calibration and validation. Current hydrodynamic and watershed models can be used to evaluate
17 interannual and spatial variability in sand transport and supply for scenario comparisons to predict how
18 changes to the system may affect sand transport and for general order-of-magnitude estimates of sand
19 transport rates. Additional studies focused on measuring sand transport in SF Bay and sand directly supplied
20 to SF Bay by local tributaries, to and past head of tide, would provide valuable calibration and validation data
21 for model refinement. In-Bay studies could use repeated bathymetric surveys to track individual bedforms
22 and estimate bedload sand transport rates. In-Bay studies could also include sensors on bridge pilings that
23 measure grain size distributions as well as turbidity, collocated with the current turbidity/suspended sediment
24 concentration (SSC) measurements, to evaluate the amount of sand suspended into the water column and
25 transported as suspended load.³

26 **ISP Discussion**

27 The ISP remarked that the model is great for exploring short-term trends but cannot speak much to the long-
28 term questions under discussion. The ability of the model to predict transport to and from SF Bay is
29 constrained by the amount of data available to set boundary conditions. Boundary conditions limit the ability
30 to simulate transport to and from SF Bay (on long-term basis). Model analysis effectively simulated short-
31 term conditions but is inherently limited due to boundary condition limitations.

Question 2d) 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?

32 **Sand Mining Study Team Response:**

33 Key uncertainties in evaluating a relationship between sand mining in SF Bay and erosion of outer coast
34 beaches are the magnitude (rates) of sand transport and time lags between changes to sand transport or
35 supply and any associated responses. The studies designed to answer the management questions do not
36 directly reduce these uncertainties. Studies estimating sand transport rates based on observed data would
37 help reduce data-based and modeled uncertainties, even if the studies are focused on specific strategic
38 locations and are not Bay-wide studies. Some possible locations are near Bulls Head Shoal, Mallard Island,

³ Sand Transport Modeling Report, Anchor QEA

1 Central Bay between Alcatraz Island and Angel Island and near the mining areas, and near Point San
2 Pablo.⁴

3 **ISP Discussion**

4 The ISP reflected that while the studies did not yield a much better understanding of the relationship between
5 the outer coast beaches and sand mining in SF Bay, they do feel studies provided a good understanding of
6 how sand reaches the mining areas and that studies focused on the right things. Stratigraphy results
7 demonstrate that the Pacific Ocean is likely a larger source/supplying sand to SF Bay over longer term
8 period, and the ring formation/scale cascade analyses show highly localized impacts of sand mining that
9 rapidly diminish as you travel away from the mined area. The ring analysis study, however, is limited in that it
10 does not speak to the longer-term cumulative effects, so the ISP cannot make definitive conclusions. The
11 ISP also noted that it's not likely that outer coast beach erosion is sand mining source; however, due to
12 uncertainty about coastal analysis, studies focused on in-Bay effects. Studies of In-bay effects did not point
13 to any conclusions about long-term effects related to coastal beaches.

14 **Areas for Future Study**

- 15 • Evaluate mining areas separately and develop locally appropriate areas of focus
- 16 • Oceanic and wave processes informing transport at the Golden Gate zone
- 17 • Resolution of finer or coarser than medium sands in transport
- 18 • Reducing uncertainty around the finding that outer beaches are the primary source of sands in SF
19 Bay
- 20 • Analysis of long-term, cumulative effects of sand mining on SF Bay and outer coast beaches

Question 2e) 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?

21 **Sand Mining Study Team Response:**

22 Reducing uncertainty in modeled sand transport rates would increase the confidence in quantitative findings
23 from sediment transport modeling that could evaluate a relationship between sand mining and erosion along
24 the outer coast. Monitoring of suspended grain size distribution, in addition to turbidity (and SSC), at in-Bay
25 locations would help reduce uncertainty in modeled suspended sand transport. Estimation of bedload sand
26 transport using observed data would help address uncertainty in modeled bedload sand transport. Bedload
27 transport could be estimated over relatively large spatial scales using frequent bathymetric surveys, tracking
28 bedform migration, and assuming bedload transport is the dominant contributor to bedform migration. Using
29 additional grain size data to quantitatively define transport pathways would be challenging because the
30 physical processes (e.g., currents and waves) acting to transport sand can also sort the sand. For example,
31 a mixed sand consisting of only two sediment sizes could result in two different uniform sands, each
32 comprising only one of the original grain sizes, at different locations along a transport pathway, depending on
33 how the currents and waves sort the sand.⁵

34 **ISP Discussion**

35 At first, members of the ISP remarked that the level of effort for monitoring and modeling required to reduce
36 uncertainty may not be warranted because the effort would not significantly reduce uncertainty. Bob shared
37 that the studies provided a better understanding sand fluxes at the Golden Gate, and that was the highest
38 priority. The question now for the ISP is determining the level of priority of studying sand transport beyond
39 the Golden Gate.

⁴ Sand Transport Modeling Report, Anchor QEA

⁵ Sand Transport Modeling Report, Anchor QEA

1 Bob also raised the question of whether the study findings do anything to combat the perception that mining
2 is resulting in erosion of outer beaches, to which he pointed to the Anchor QEA finding that sand flux out of
3 the Golden Gate may be reduced as a result of mining.

4 **Areas for Future Study**

- 5 • Fluxes at the Golden Gate
- 6 • Address Central Bay mining relative to conceptual framework

2f) Under currently permitted mining levels, would erosion be measurably influenced by 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?

7 **Sand Mining Study Team Response:**

8 No responses were available at the time of this meeting.

9 **ISP Discussion**

10 The ISP concluded that there is not enough information to definitively answer this question, particularly at the
11 30- and 50-year time horizons. Although the studies don't show that there is a definitive effect, they don't go
12 far enough to rule out the possibility or contradict the findings from the 2012 compilation. The ISP remarked
13 on the inertial scale of systems like this, which can be steady in an oscillating way, and it's not certain that
14 those effects could be discerned. The group also acknowledged the powerful and dynamic nature of the
15 system and the resulting degree of uncertainty in the data due to major events, time-scale processes, and
16 dredging.

17 Craig noted that because the littoral transport of sediments across Ocean Beach is of the same relative order
18 of magnitude as the sediments coming into SF Bay, the littoral fluxes warrant further study.

19 **Areas for Future Study**

- 20 • Ocean-estuary connection
- 21 • Longer-term littoral fluxes

22 The ISP concluded discussion on Sand Mining Management Question 2 with the culminating Tier 1 question:

Question 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?

23 **ISP Discussion**

24 The anticipated effects of mining on sand transport and supply depend on types of mining and locations. For
25 example, the studies indicated that little to no transport was occurring in Central and North Bay; so, in that
26 sense, mining has little to no effect. In flood shoals (the convergent zones between land and sea), sand is
27 suspended and dispersed widely across the system; so, on a short-term scale, mining also has little effect on
28 transport or supply. On the other hand, for transport pathways that bring sand to desired places like beaches,
29 there may be issues if mining reduces sand transport through the Golden Gate; it's a highly localized
30 question.

31 In light of the place-based nature of the answers, there was widespread agreement from the ISP to develop
32 robust monitoring protocols and adopt an adaptive-management approach. Some noted that good monitoring
33 could be more valuable and responsible than prolonged study. Monitoring could indicate whether mining is
34 approaching a tipping point in sand recovery or if it triggers different, undesired effects like pulling from other
35 areas.

1 Brenda requested the ISP weigh in on what monitoring they would recommend. John replied that smart,
2 strategic, and diagnostical measurements will take time to come up with, but it seems that smart, affordable
3 approaches exist. Bob offered several recommendations:

- 4 • Inventory the extent of SF Bay beaches, including the size of the beaches, how much sand they
5 contain, and the size of that sand.
- 6 • With that data set, use satellite imagery to track and estimate volume change.
- 7 • Develop a data sharing repository on beach geometry and grain size. Several projects are already
8 collecting cross-sectional data.
- 9 • Areas of priority could include: SF Bay beaches (not necessarily Ocean Beach—that is being
10 monitored by USGS currently and hopefully funding will continue), Central (Berkely, Richmond,
11 Rodeo), South Central Bay, North of Dumbarton (not just north of San Mateo beach), and Crissy
12 Field. He noted that far South may not be as important (though there is a project at San Lorenzo,
13 Long Beach).
- 14 • Additional sediment cores in SF Bay for texture and stratigraphy information.
- 15 • SF Bay wave data.

16 The ISP acknowledged the studies' limitations to answer this question on a longer timescale for cumulative
17 effects because the studies were more focused on shorter time scales. Short term effects do not seem
18 substantial, but long-term effects are not well understood. Sand mining is not only anthropogenic activity that
19 could affect sand transport/budget, so while the mining volume is significant relative to the fluxes, there are a
20 community of associated dynamics. Much more clarity in proximal space and time is needed, particularly at
21 specific, local areas. Additionally, the full implications of the stratigraphy report on this question aren't well
22 known. The ISP expressed interest in hearing the study teams' perspectives on their limitations and areas of
23 uncertainty (for example, Stratigraphy wanted deeper cores in SF Bay). The ISP stated that adaptive
24 management and monitoring would help address uncertainty, and suggested follow up to discuss/determine
25 appropriate monitoring.

26 There were several specific study findings that the ISP wanted to be further explored:

- 27 • One of the findings seemed strange and warranted further study. It's hard to believe that the amount
28 of sand traveling through the system in a bigger fluvial event (wet winter) would be seemingly non-
29 existent. Moreover, the tributary system didn't seem to be important in the overall sand budget to SF
30 Bay (the ISP flagged this as a question to explore once the SFEI report is in). If sand isn't traveling
31 through the system, where is the increased volume of sand that's appearing on beaches under
32 those circumstances coming from?
- 33 • Bob called attention to another study finding, which indicated that reduced sand mining could result
34 in less sand flux into SF Bay at the Golden Gate, which could result in reduced supply for beaches.
35 At a high level, there does seem to be potential effect, but the scale of uncertainty isn't clear.

36 **Areas for Future Study**

- 37 • Further verification of the finding that suggests the amount of sand traveling through the system in a
38 bigger fluvial event (wet winter) is seemingly non-existent.
- 39 • Origin of increased sand on beaches in wet years.
- 40 • Origin of sands accumulating in the northern Central Bay (Richmond, Berkley area).
- 41 • Assess the degree of uncertainty of the finding which indicates that reduced sand mining could result
42 in diminished supply for beaches as a result of reduced flux in at the Golden Gate.
- 43 • Clarity in proximal space and time of other associated anthropogenic dynamics.
- 44 • In-Bay studies could use repeated bathymetric surveys to track individual bedforms and estimate
45 bedload sand transport rates.
- 46 • In-Bay studies could also include sensors on bridge pilings that measure grain size distributions as
47 well as turbidity, collocated with the current turbidity/suspended sediment concentration
48 measurements, to evaluate the amount of sand suspended into the water column and transported as
49 suspended load.

1 **4. Break**

2 The group adjourned for a short break.

3 **5. Preview Management Question 1**

4 Marisa observed the ISP may or may not be able to definitively answer the Tier 2 questions under Sand
5 Mining Management Question 1, without access to the Sand Budget and Bedload Transport Report.

6 BCDC provided information about the Commission's timeline for using the findings of the Sand Studies.
7 Applications from sand miners are anticipated at the end of 2023, beginning of 2024 so there is a desire to
8 convene the Commission work group in mid- to late fall.

9 The ISP agreed to proceed using the same discussion structure as had been used in the first part of the
10 meeting, acknowledging the limitations of proceeding without the benefit of all the studies.

11 **TIER 1, QUESTION 1**

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

Question 1a) Does sand mining influence sand transport through SF Bay? How does sand mining impact the volume or characteristics of sand supplies to the beaches (In-Bay and Outer Coast)?

14 **Sand Mining Study Team Response:**

15 Sand mining in Central Bay may be reducing the volume of sand in SF Bay sand transport cells (Figures 9-1
16 and 9-2) and thus reducing the volume of sand available to naturally nourish beaches. Sediment transport
17 modeling predicts sand mining in Central Bay reduces the sand transport out of the Golden Gate. The sand
18 transport out of the Golden Gate was predicted to decrease by 59% and 32% (4.11×10^7 kg and 5.01×10^7 kg)
19 as a result of sand mining during the high-outflow and low-outflow years, respectively, which was less than
20 the difference in predicted sand transport between the high-outflow and low-outflow years. Based on the
21 hypothesis that sand is transported out of the Golden Gate to the San Francisco Bar, toward Ocean Beach,
22 along the shoreline and back into SF Bay, a reduction in sand transport out of the Golden Gate would reduce
23 the sand supply to beaches. However, there may be considerable (decadal) time lags in this transport cell
24 (Battalio 2014), and the magnitudes of the sand transport rates in the transport cell are uncertain.⁶

25 **ISP Discussion**

26 The ISP agreed that it appears that sand mining does influence transport through SF Bay; however, the ISP
27 was not sure about effects on coastal beaches, if any. There was also less certainty about how effects are
28 manifesting in SF Bay. For example, the Suisun Bay mining area may or may not be affecting sand supplies
29 to the North/Central Bay, and there's a question about the significance of the effects of the mining in Central
30 Bay during the short term. Conceptually, the long-term effects are where you'd see the most impact. John
31 expressed that the studies didn't provide new insights as to whether mining affects supply to beaches.

Question 1a)ii) Does sand mining change the way sand moves from subtidal shoals to intertidal flats, marshes and beaches?

32 **Sand Mining Study Team Response:**

33 No responses were available at the time of this meeting.

34 **ISP Discussion**

35 The ISP felt that the studies did not speak to this question definitively, and it remains an important question
36 to keep on the table. Marsh-fringing beaches, though they make up a small portion of the sand budget, are
37 critical to protecting and preserving marshlands. Other recent work has revealed that there are significant

⁶ Modeling Sand Transport and the Effect of Sand Mining in San Francisco Bay, Anchor QEA, May 2023.

1 quantities of sand in intertidal flats and there are questions about how sand is transported to those flats. ISP
2 members believed that sand transport is from subtidal shoals to beaches, rather than to intertidal flats and
3 marshes. Bob knows of studies that show sand at flats and marshes, but didn't know where it came from.
4 Subtidal shoals were not studied, but BCDC may be able to learn from other current work on studying
5 beaches, estuaries, and enclosed bays.

6 **Contributions from Observers, provided via chat feature:**

7 Marilyn Latta: We've discussed briefly previously that nearshore subtidal/intertidal physical sediment and
8 bathymetry data are available from various living shoreline and other projects- benthic cores at Giant Marsh/
9 Pt Pinole and also at San Rafael, Tiburon Greenwood Beach and Brunini Beach, Pier 94, drone and survey
10 data via New Life for Living Shorelines Report, others. We can prepare a list more systematically of what
11 data is available or anticipated.

Question 1a(III) Does sand mining influence sand waves and their contributions in transport processes?

12 **Sand Mining Study Team Response:**

13 No responses were available at the time of this meeting.

14 **ISP Discussion**

15 The ISP expressed interest in meeting with the Deltares study team to gain additional clarity on how their
16 work responds to this question. To the extent that some members felt comfortable drawing conclusions, they
17 shared that it appears sand mining does influence sand waves in that it removes them, but the significance
18 and extent seemed uncertain. Regarding the second question, there are spatial resolution issues, and the
19 contractors did not provide an interpretation of physical change on the transport process. The ISP also
20 expressed interest in cross-referencing the USGS reports to identify divergent and convergent zones.

21 **6. Wrap Up, Next Steps**

22 The group postponed the upcoming meeting from June 15 to June 19 to accommodate anticipated delays in
23 the delivery of the Sand Budget and Bedload Transport Report (SFEI, Deltares, USGS) and the Final
24 Stratigraphy Report (UT Austin).

25 The ISP requested an additional layer of review occur with the sand study teams after the draft report is
26 prepared, to gauge whether they view the ISP's summary of their work to be accurate. A meeting would be
27 ideal, but even their comments on the draft report would be helpful.

28 The meeting adjourned at 12pm.

1 **Appendix A – Meeting Chat**

2 09:05:54 From Jaime Lopez|BCDC to Everyone: Welcome Nick!

3 09:06:07 From Nick Sadrpour (he/him), GHD to Everyone: Thank you and good morning all

4 09:08:45 From Brenda Goeden, BCDC (she/her) to Everyone: Hi All I am having computer problems in
5 that the screen and audio keeps freezing :(

6 09:20:35 From Brenda Goeden, BCDC (she/her) to Everyone: is there another page to the outline?

7 09:20:52 From Lisa Beutler to Everyone: yes

8 09:21:06 From Lisa Beutler to Everyone: But they are the same structure.

9 09:21:12 From Brenda Goeden, BCDC (she/her) to Everyone: maybe you should show it so that people
10 have a full view of the report

11 09:25:25 From Jazzy (they/them) Graham-Davis, Water Board to Everyone: Thanks Brenda and Bob. I
12 see use for a technical summary that Bob mentioned, for us scientists to dive into. But exec/commission
13 level summary will also be helpful for when we need to take it to the Water Board.

14 09:32:42 From Marisa Perez-Reyes to Everyone: Welcome, Craig!

15 09:41:51 From Brenda Goeden, BCDC (she/her) to Everyone: HI - still having trouble. am going to call in
16 to supplement

17 10:28:36 From Brenda Goeden, BCDC (she/her) to Everyone: the STAC wrote the questions - and they
18 are hard because those of us who have to write permits have these questions and want to understand
impacts

Sand Mining Studies ISP Report Development Meeting 2

Virtual Meeting (Zoom)
July 24, 2023, 2:30 – 5:00 PM

1

Discussion Highlights

2 **MEETING GOALS:**

- 3
- 4 • Assess how the study findings collectively answer the management questions, including the degree
 - 5 of confidence in study findings, the sufficiency of the study findings to answer the larger
 - 6 management questions, and the identification of remaining questions or areas for additional study.
 - Confirm content for inclusion in the final report.

7 **ACTION ITEMS:**

- 8
- 9 • Members of the ISP to exchange thoughts on Management Question 3 with one another via email
 - 10 chain. It was also suggested that the ISP develop a conceptual model to help one another process
 - 11 the information.
 - 12 • Erica to coordinate with study teams to explore whether they can prepare bullet-point summaries of
 - 13 conclusions from the various final reports.
 - Erica to compile all final reports in one place on the OneDrive.

14 **ATTENDANCE:**

15 **INDEPENDENT SCIENCE PANEL:**

David Schoellhamer, USGS Emeritus
Bob Battalio, ESA Consulting
Paul Work, USGS

John Largier, UC Davis
Craig Jones, Integral Consulting

16 **OBSERVERS:**

Bay Conservation and Development Commission (BCDC)	Brenda Goeden, Jaime Lopez, and Pascale Soumoy
California Coastal Commission	Jeremy Smith
California Water Board	Jazzy Graham-Davis
NOAA Fisheries	Sara Azat
State Coastal Conservancy (SCC)	Erica Johnson
Lehigh Hanson/ Martin Marietta	Mike Bishop
Lind Marine	Bill Butler
GHD (consultant to mining companies)	Aaron Holloway, Nick Sadrpour
Other consultant to miners	Christine Boudreau

17 **STUDY COORDINATORS:**

18 Lisa Beutler, Jamil Ibrahim, and Marisa Perez-Reyes, Stantec

19 **SUPPORTING MATERIALS**

- 20
- 21 • Meeting chat (attached as Appendix A)
 - 22 • Session PowerPoint
 - 23 • Time-stamped meeting transcript
 - Meeting recording

1 **SUMMARY**

2 **1. Welcome and Agenda Review, Set Up Discussion, Introduce Report Product**

3 Erica Johnson welcomed attendees and Lisa Beutler, session facilitator, reviewed the meeting goals and
4 agenda. Lisa then invited the members of the ISP to comment on the summary of the first report
5 development meeting on June 5. The ISP confirmed the summary approach. She then invited ISP members
6 to weigh in on whether new or revised reports released since the June 5 meeting (which include the second
7 draft of the UT Austin Stratigraphy Report and the first draft of the SFEI Sand Budget and Transport Report),
8 would change their responses to the sand mining management questions discussed at that time.

9 The ISP reflected that until all the reports are in, different lines of evidence and insight from different
10 perspectives will cause the answers to shift. Bob Battalio remarked that the sand budget now has net
11 sediment flux at Golden Gate Bridge going out to ocean, when it had at one point suggested the opposite.
12 He said the ISP's previous discussion may hold, but it may also change. David Schoellhamer commented
13 that although the overall tenor of their previous discussion conveys uncertainty, he does believe the studies
14 have increased their knowledge a lot about how sand transport works and the impacts of sand mining. David
15 observed that the meeting summary includes many caveats, and recommended the report developers make
16 that take-home message clearer.

17 Note: Under the next discussion item, one member also remarked that the updated version of the UT Austin
18 report would change the tenor of their previous discussion.

19 **2. Overview of Process and Timeline for Report Development**

20 Marisa Perez-Reyes shared an update about the report development process and timeline, as follows:

- 21 • Monday July 5 – Report Development Meeting 1
- 22 • Wednesday, June 21 – Meeting 1 Summary out for review
- 23 • Friday, July 28 – Meeting 1 Summary comments from ISP due
- 24 • Monday July 24 – Report Development Meeting 2
- 25 • Tuesday August 8 – Meeting 2 Summary out for review
- 26 • Tuesday August 22 – Meeting 2 Summary comments from ISP due
- 27 • TBD – Draft Report out for review
- 28 • TBD in September – Draft Report comments from ISP due
- 29 • Friday September 22 – Report Development Meeting 3: ISP and STAC comments on Draft Report
- 30 • Monday, October 9 – Meeting 3 Summary out for review
- 31 • Monday, October 23 – Meeting 3 Summary comments from ISP due
- 32 • Wednesday, October 11 – Report Development Meeting 4: researchers' comments
- 33 • Thursday, October 26 – Meeting 4 Summary out for review
- 34 • Thursday, November 9 – Meeting 4 Summary comments from ISP due
- 35 • TBD November – Final Report

36 Members of the ISP generally remarked that the schedule is problematic and challenging, in part because
37 not all study findings are summarized in one place. Several also felt that their thoughts on the new reports
38 had not settled sufficiently to jump into the planned discussion as presented in the session agenda for the
39 day.

40 Members of the STAC shared details about why the timeline is too compressed. Brenda Goeden said she
41 does not envision putting the report before the BCDC Commission until early December. Bill Butler added
42 that the sand miners' permits go through May 2025 and expressed that the sand miners' priority is ensuring
43 the compressed nature of the timeline doesn't impede the report from best reflecting the science.

44 No revisions to the schedule were offered.

45 **3. Discussion on How Study Findings Address Management Questions and the Application of the** 46 **Findings**

47 Given the previous discussion, Lisa restated the original premise that the management questions were used
48 to inform the study designs and the resulting study findings would lead to answers that could be used in

1 applying the best available science to decision making. She then noted that the management Tier 2
2 questions were designed to inform the answers to the primary management questions.

3 She explained that the agenda for this meeting was developed to extract the ISP view of the study findings
4 as they relate to the Management Questions so that this could be extrapolated to the final ISP report on best
5 available science. The intended use of the ISP report is to inform decision making.

6 Lisa then asked the ISP to discuss their level of comfort in proceeding with the day's agenda.

7 Paul Work reflected that the ISP had predicted at the start of the sand mining study effort that the reports
8 would not likely answer management question 3. Craig Jones and Brenda echoed Paul's comment, that
9 none of the reports dive into question 3.

10 With the caveats provided related to management question 3, the group proceeded with the agenda as
11 presented.

12 **4. Discussion on How Study Findings Address Management Question 1**

13 The ISP held discussion on each of the Tier 2 questions under Management Question 1: **Is sand mining at
14 existing lease areas, at permitted levels, having a measurable or demonstrable impact on sediment
15 transport and supply within San Francisco Bay?**

16 **TIER 1, QUESTION 1**

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

Question 1a.iv) Has sand mining altered the grain size distribution of in-bay or outer coast sand resources?

19 **ISP Discussion**

20 The ISP felt that the degree to which the studies focused on grain size was not sufficient to answer this
21 question, though they did think it would be possible to tease out several conclusions from the newer reports.
22 The ISP also remarked that the Sand Budget Report's as-yet unwritten conclusion section, combined with
23 UT Austin's stratigraphy findings, may provide insights for this question.

24 David suggested the question could be addressed through evaluation of grain size in the Bay before and
25 after sand mining, but noted that if a change were detected, it may be due to other factors aside from sand
26 mining. Craig Jones expressed doubt that a before and after approach would be sufficient to answer the
27 question due to the short and long term natural dynamics of surface grain sizes.

28 **Areas for Future Study**

- 29
- Greater distinction between coarser and finer sands
 - 30 • Deeper study on the capacity for different grain sizes to move in suspension
 - 31 • How different grain sizes move via bedload transport
 - 32 • Grain size distribution at the Bay's boundaries (in and out flows)

Question 1a.v) Does sand mining result in sand sinks and resultant changes in flux to the Outer Coast?

33 **ISP Discussion**

34 Yes, the study reports do point to sand mining leading to sand sinks and resultant changes in flux to the
35 Outer Coast, however, the relationship of the findings to one another are not entirely clear yet. Paul said he'd
36 need to refer back to the studies' assumptions to answer this question. John thinks the models do show an
37 influence and provided comments about density driven flow. Craig specifically called attention to the need for
38 discussion on how the results of the sand budget and provenance studies agree or disagree with one
39 another.

40 Bob described the studies' findings by geographic area, including:

- 1 • Anchor QEA's model predicts that sand mining reduces transport in and around the Central Bay.
- 2 • The ring analysis indicates that the southern lease area (Presidio Shoals) is recovering whereas the
- 3 northern area (Point Knox Shoal) is not (i.e., the depressions left by mining tend to remain).
- 4 • In the northern Central Bay area, it appears that coarser, relic sands are diminishing, but it's not
- 5 entirely clear that those sands aren't being replenished.
- 6 • In Suisun Bay, contrary to what they'd previously thought, the model shows more sand moving
- 7 upstream than downstream (between the San Pablo Bay and the Delta), yet sand does appear to be
- 8 moving from San Pablo to Central Bay.
- 9 • We don't have resolution of the sand transport pathways to the subembayments.

Question 1b) What is the source of mined sand in the lease areas? Is it "relic" sand, or "new" sand transported into the system?

10 **ISP Discussion**

11 The ISP expressed a high degree of confidence in the report findings which conclude that the mined sand in
12 the lease areas is relic, in the sense that it was delivered between 15 and 20 thousand years ago. The sand
13 source could be connoted as "new" to the system in the sense that it is moving into and around the Bay. Bob
14 elaborated that he thinks the relic medium and fine grain sands are moving, but he isn't sure that the coarser
15 sands are moving.
16

Question 1b.i) What is the ratio of relic sand to new sand found in mined sand?

17 **ISP Discussion**

18 The ISP built on their response to the previous question to state that the Stratigraphy Report's findings
19 clearly suggest the vast majority of mined sands are relic.
20

Question 1b.ii) How much of what's available is being mined?

21 **ISP Discussion**

22 In response to the ISP's request for clarification on how "available" is defined, Brenda shared that permitting
23 decisions typically define "available" as the amount minable to a depth of 90 feet because that's the range
24 most modern mining equipment available in the Bay can reach. Note that the baseline to which that 90 feet is
25 relative to (i.e., depth below water surface, sediment surface, or other datum) was not specified. Bill Butler
26 confirmed Brenda's response and noted that the baseline is arbitrary and there is certainly some equipment
27 that could go deeper. David noted that the answer to the question changes depending on whether it's
28 defined relative to equipment reach or down to bedrock, or whether shoals outside the permitted areas are
29 considered.

30 Without data on the volume or depth of sand in the shoals, the ISP found this question difficult to answer,
31 though they did note that the volume of mined sand is on the same order of magnitude as other flows within
32 the system (like dredging). Bob expressed doubt that anyone has an estimate of the Central Bay deposit's
33 base level. Craig later added that a mapping of depth to bedrock throughout Central Bay (perhaps from
34 previous USGS subbottom or other survey work) would be needed. Some members of the ISP felt that the
35 reports addressed the question but that they would need to investigate them further.

36 *The group adjourned for a short break, then discussed the next questions.*
37

Question 1b.iii) Is it better for the physical environment to mine "relic" sand or "new" sand?

38 **ISP Discussion**

39 The ISP's response to this question was mixed.

1 Bob observed that sands coming into the Bay along Crissy Field Shore, depositing in the San Francisco
2 Marina, are considered by some to be a nuisance and that littoral transport may currently be in excess of
3 what is needed. In that sense, there is a possibility that sand mining could be considered sustainable and
4 extracted without causing direct erosion. If, however, sand was to be removed from a littoral cell that would
5 have otherwise been delivered to the San Francisco Bar and beaches, then there are potential impacts
6 which would be difficult to trace, given the possible 30-year lag time. Further, Bob pointed to potential future
7 needs for building shorelines to keep pace with sea level rise and indicated that the question of whether
8 mining is sustainable touches on public trust issues. Bob also mentioned the possibility for sand being taken
9 out of the flood control channels, but there are practical differences associated with that approach and opted
10 not to comment much further.

11 Craig shared that this question represents a disconnection for him. He said the budget shows one thing, and
12 the ring analysis also says something. The UT study seems to confirm that the mined sand is relic. He
13 reflected that if a massive amount of that sand is coming in from offshore, then perhaps the mining is
14 sustainable, but he has further questions about how large that quantity is and what they are contending with.

15 John critiqued the choice to use “better” in the management question because it implies a value judgement.
16 He unpacked some of the implied assumptions that frame the question, noting that it appears to be set in the
17 geologic timeframe of one century, over a certain spatial area. He said considerations differ for a huge
18 reservoir (sand deposit) versus a small reservoir. He noted a potential problem with mining relic sand, which
19 is that it changes morphology, which then changes hydrodynamics and affects plankton and other
20 ecosystems. He remarked that if a value judgement were to be made, then mining relic seems like the less
21 good alternative. On the other hand, John spoke about the difficulties of defining what is “new,” and whether
22 one beach or littoral cell may be conceived of as connected to one another. He proposed thinking about sand
23 as “sloshing” between the Bay and Outer Coast, drawing a line around that dynamic process.

24 David suggested that a helpful way to reframe the question would be to answer whether it is better to mine in
25 areas that experience a higher degree of transport as opposed to areas that are relatively stationary. Building
26 on John’s characterization of the Golden Gate, for example, sand “sloshes” in and out of the Bay, generating
27 a tremendous amount of exchange, whereas there is little transport in the northern part of the Bay. The ISP
28 felt that the conceptualizing of sand in littoral cells could help guide considerations of whether removing sand
29 from a cell would have downstream impacts.

30 Paul concurred with David’s proposal to characterize areas as more or less dynamic vs stationary.
31

Question 1c) What is the relationship between bathymetric change trends and sand mining intensity trends, recognizing the possible lag between stimulus and response? Do we have the appropriate information for this evaluation?

32 ISP Discussion

33 Generally, the ISP did not feel that this question could be definitively answered based on the available
34 information; however, they did feel that the study findings held relevant insights on tipping points to monitor
35 and adaptively manage for. The following considerations were shared:

- 36 • There are other anthropogenic influences aside from sand mining that are contributing to bathymetric
37 change trends, including hydraulic mining. For this reason, establishing cause and effect for sand
38 mining specifically would be difficult.
- 39 • David remarked that the bathymetric change trend for the past 150 years has been largely dictated
40 by hydraulic mining, not sand mining. David made mention of erosion in other subembayments
41 where sand mining isn’t occurring.
- 42 • Craig felt that the data to-date do not show “massive” long term changes in bathymetry due to sand
43 mining, though there do appear to be “scarring” effects that persist for multiple years as a result of
44 sand mining in the Central Bay (this is where decadal data would be useful).
- 45 • The bathymetric change trends do offer good information on what metrics could be monitored to
46 avoid reaching a tipping point, where conditions would then become irrecoverable. Members of the

- 1 ISP echoed their earlier statements about pulling information from across the study to inform an
 2 adaptive management monitoring strategy.
- 3 • To John's earlier point, there may be other tipping point effects associated with deepening the Bay
 4 besides sand transport, such as saltwater intrusion and effects on plankton.
 - 5 • The mining areas' recovery rates differ greatly.
 - 6 • Bob remarked that earlier scientific thought supposed that river sediment supplies were being
 7 disrupted by sand mining, and these new studies suggest that that is not happening.
 - 8 • The sediment budget and bed change totals were not correlated in time series with dredging and
 9 mining, though the scales are on the same order. Members of the ISP differed on whether they
 10 thought this correlation could be conducted or not, given the number of other confounding factors
 11 that could also contribute to any observed trends. John suggested that the best shot at
 12 understanding those effects would be found at the ring analysis scale.
 - 13 • Bob estimates that sand transport in the Golden Gate littoral cell, between the Central Bay and the
 14 offshore shoals, has a 30-year time lag between an event and its observable effects. He noted, also,
 15 that the effects don't occur in a stationary system: sea level has been steady, but the San Francisco
 16 Bar has been shrinking and rotating at a slow pace.

17 Areas for Future Study

- 18 • Development of metrics to monitor (of which, tipping point metrics are just one type) in an adaptive
 19 management strategy or plan.
- 20 • Additional analysis on correlating the sand budget (perhaps Central Bay, specifically) with the sand
 21 mining time series (though there was some disagreement among ISP members on the efficacy of
 22 this).

Question 1d) Does sand mining alter the geomorphology of the Bay floor beyond the mining location such that sand transport/supply are significantly impacted?

24 ISP Discussion

25 The ISP affirmed the significance of this question and indicated that they learned some things from the
 26 studies, namely that the ring analysis does not show short-term impacts of sand mining to areas surrounding
 27 the localized areas. Most of the ISP, however, expressed interest in better understanding longer-term
 28 implications for areas that appear to recover more slowly, since it is possible that there could be significant
 29 impacts.

- 30 • The ring analysis generally found that impacts are localized and don't echo outward. David said that
 31 at the scale of the lease area, they can say with some confidence that observable impacts subside
 32 within length scale of the mining areas.
- 33 • Craig said that just because tipping points haven't been reached yet doesn't preclude the eventual
 34 possibility for continued digging in areas of low recovery to result in changes to geomorphic and
 35 hydrodynamic feedback. He again highlighted the importance of understanding what it would take to
 36 reach that threshold, and that understanding can be developed or addressed through monitoring and
 37 adaptive management.
- 38 • John offered that slow replenishment suggests a lag response. He said the model could estimate the
 39 rate of that response, but it could be 20-years down the road.
- 40 • Paul reflected that the ring analysis is helpful for answering questions on a small time and spatial
 41 scale and it would be difficult to project their findings forward to answer whether mining will
 42 significantly alter geomorphology moving forward. At the scale of the ring analysis, Paul agreed it
 43 doesn't appear that mining alters geomorphology at a significant scale.
- 44 • Bob also concurred that there doesn't appear to be clear, discernable evidence of geomorphic
 45 effects beyond local mining areas. He noted, though, that given the intensity of currents and waves
 46 which weren't included in the study, diffusion and dispersal would make it hard to track even large
 47 sand removals in a system like the Bay. He concluded that although they don't see effects, they
 48 cannot conclude that those effects won't occur.

49 Other points of discussion included:

- 50 • Changes in the size of the San Francisco Bar as well as sea level rise have unknown implications for
 51 sand supply and transport, which make it difficult to definitively answer this and other questions.

- 1 • Bob expressed puzzlement around why Point Knox Shoals haven't recovered and what that could
 2 mean for sand transport. It seemed that there were sand waves on the bed that were part of a
 3 dynamic equilibrium sand transport process. After sand mining, those sand waves did not reform and
 4 the reason for that is unclear. Does it take more sand? More power? Or less? And does the sand
 5 transport through the system increase or decrease? He suggested this is something that Edwin from
 6 SFEI might be able to formulate thoughts on. Craig recalled that report being useful, but did not have
 7 specific details to share.

8 **Areas for Future Study**

- 9 • Long-term effects of sand mining on Bay floor geomorphology beyond the mining locations need to
 10 be better understood.
 11

Question 1e) 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?

12 **ISP Discussion**

13 The mining areas do not have the same effects on sand transport pathways and associated impacts. The
 14 two areas should be examined separately. David added that part of the reason for this is the Central Bay
 15 mining area's proximity to the Pacific Ocean relative to the Suisun Bay mining area.

16 **Areas for Future Study**

- 17 • The origin of sands in the East Bay shoals (near Richmond) is still a mystery, though perhaps some
 18 illumination can be obtained through a deeper dive into some of the study findings from UT Austin,
 19 SFEI, and Deltares. Some sand movements haven't been explained yet, particularly the sand that
 20 makes its way through the Carquinez Strait to San Pablo Bay and is then dispersed.

21 The ISP concluded discussion on Sand Mining Management Question 1 with the culminating Tier 1 question.

Question 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?

22 **ISP Discussion**

23 The ISP confirmed they asked the right Tier 2 questions to get at this culminating question, and they have
 24 learned a great deal from the study findings. The majority of the ISP did not feel, however, that the studies
 25 were sufficient to answer the question with a high degree of confidence. David thought the studies showed
 26 sand mining to have a measurable and demonstrable impact on sediment transport but could not necessarily
 27 say the same for supply.

28 When prompted to advise on considerations for the BCDC, the ISP observed that they can draw conclusions
 29 about useful data points to monitor in an adaptive management framework.

30 Overall, the ISP emphasized that they are much better prepared to answer the management questions now
 31 than they were at the start of the studies because uncertainty has been reduced. Craig proposed a way
 32 forward, including rolling up findings, identifying questions with key uncertainties, and developing an adaptive
 33 management/monitoring plan to monitor metrics associated with those uncertainties.

34 **Areas for Future Study**

- 35 • Transport of fine sands.
 36 • Contribution of waves to sediment transport, particularly at the Golden Gate, and the ability for huge
 37 oceanic surges to propagate.
 38 • Deep core for stratigraphy analysis.

39

40 **5. Discussion on How Study Findings Address Management Question 3**

41 The ISP did not have time to discuss the third management question:

- 1 • Question 3: Are there other feasible sand mining approaches to consider in San Francisco Bay?
- 2 • Question 3a) Are there areas within the current leases or other potential areas in the Bay where
- 3 sand mining could feasibly occur that would minimize or avoid impacts to sand transported supply,
- 4 as compared to existing mined areas?
- 5 • Question 3b) Is there a “better” time period to mine sand so that the impacts to the physical
- 6 processes are minimized while balancing economic realities, market demands and job impacts?
- 7 • Question 3c) What scenarios should we model to judge the likely impacts associated with
- 8 management actions (e.g. increase/reducing in mining intensity, rotation of lease areas,
- 9 establishment of new lease areas)?

10 Due to the lack of available time, ISP members weighed in on their preferred method for providing input.
11 Several members indicated a preference for exchanging thoughts via email chain. David suggested they
12 develop a conceptual model to help one another process the information. Craig requested bullet-point
13 summaries of conclusions from the various final reports and asked that all final reports be provided together
14 in the OneDrive. Bob emphasized the ISP’s need for more time with the documents and to talk with one
15 another.

16 **6. Revisit Any Questions from Previous Meeting**

17 This item was covered under Agenda Item 1.

18 **7. Wrap Up, Next Steps**

19 The group adjourned at 5pm.

1 **Appendix A – Meeting Chat**

2 01:07:35 Sara Azat (NOAA Fisheries): I remember that too, Brenda - we were not sure we would get to
3 question 3.

4 01:24:52 Brenda Goeden, BCDC (she/her): The one study that talks a bit about grain size is the Barnard
5 study that did collect samples from Pt Reyes to Pacific and all over the Bay. I don't believe there is any more
6 comprehensive grain size work beyond that paper. There is one more study that USGS did on grain size that
7 went up into the tributaries - might have been references in Bruce and Teresa's paper

8 02:06:17 John Largier: Still here - saving you from watching me eat!

9 02:34:39 Lisa Beutler: Discussion on How Study Findings Address Management Question 1

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

12 • Is sand mining at existing lease areas, at permitted levels, having a measurable or demonstrable
13 impact on sediment transport and supply within San Francisco Bay?

14 02:36:06 Erica Johnson: Hi Bob, no problem for the ISP to reach out to the research teams if they are willing
15 to chat. If you can circle back the information to the rest of the ISP and STAC that would be great

16 02:59:35 Bob Battalio: thank you!

Sand Mining Studies ISP Report Development Meeting 3

Virtual Meeting (Zoom)

October 11, 2023, 1:00 – 4:00 PM

1

2

Discussion Highlights

3 **MEETING GOALS:**

- 4 • Assess If study findings collectively answer the original management questions.
- 5 • Confirm the ISP's degree of confidence in study findings.
- 6 • Consider the sufficiency of the study findings to answer the larger management questions.
- 7 • Articulate the remaining questions or areas for additional study.
- 8 • Confirm content for inclusion in the final report.

9 **ATTENDANCE:**

10 **INDEPENDENT SCIENCE PANEL:**

David Schoellhamer, USGS Emeritus

Bob Battalio, ESA Consulting

John Largier, UC Davis

Craig Jones, Integral Consulting

11 **OBSERVERS:**

Bay Conservation and Development Commission (BCDC)	Jaime Lopez and Pascale Soumoy
California Coastal Commission	Jeremy Smith
California State Lands Commission	Chris Huitt
California Water Board	Jazzy Graham-Davis
NOAA Fisheries	Sara Azat
State Coastal Conservancy (SCC)	Erica Johnson, Marilyn Latta
Lehigh Hanson/ Martin Marietta	Erika Guerra, Mike Bishop
Lind Marine	Bill Butler
GHD (consultant to mining companies)	Aaron Holloway, Nick Sadrpour
Boudreau LLC (consultant to mining companies)	Christine Boudreau

12 **STUDY COORDINATORS:**

13 Lisa Beutler, Jamil Ibrahim, and Marisa Perez-Reyes, Stantec

14 **SUPPORTING MATERIALS**

- 15 • Meeting chat (attached as Appendix A)
- 16 • Session PowerPoint
- 17 • Time-stamped meeting transcript
- 18 • Meeting recording

1 **SUMMARY**

2 **1. Recap of Process**

3 Members of the ISP provided an update on the status of their administrative draft, synthesis document (not
4 yet available for review by external parties at the time of the meeting). The synthesis document provides a
5 succinct summary of what the ISP believes the studies can reasonably conclude. Prior to the meeting, Dave
6 Schoellhamer, Bob Battalio, and Craig Jones had contributed to the document. John Largier expressed
7 concurrence with the document's overall tone and message, saying he would provide minor comments. One
8 comment he wanted to add to this meeting was his desire to see more emphasis on the issues of equilibrium
9 between the Outer Coast and Bay sand supplies. He noted that there is less of a dump of sediment from the
10 mountains to the sea and more exchange between the Outer Coast and Bay reservoirs.

11 Bob added that the references in the administrative draft summary should be made internally consistent. He
12 suggested adding figures from the studies to visually demonstrate the lease areas in relationship to the
13 geographic areas of study.

14 **2. Review and Workshop Report Outline**

15 Members of the ISP reviewed the updated report outline and provided input on the structure and content.
16 The report reorganizes the content around study findings that may be useful in regulatory discussions. For
17 example, study findings regarding Susian Bay differed from findings for other locations. The report now
18 includes a section that groups findings by location.

19 The group provided input on how to best organize the findings section. They also discussed where and how
20 study limitations should be addressed in the report, either as part of the methodology section or at the end of
21 the report in the future work section. Bob remarked that the ISP outlined the study scopes based on priorities
22 influenced by key questions (e.g., sand flux at the Golden Gate, sand sources), where sand mining effects
23 are most apparent (the local "ring analysis"), and to use available tools and study contractor experience
24 (sediment budget and circulation modeling). Extending the study to the Pacific Coast was not included
25 because it was deemed too big a task for the available resources; among their greatest limitations was the
26 fact that they did not think it would be possible, given the available budget for the sand studies and the
27 capacity of the study contractors. Further, coastal processes are characterized by many different factors that
28 make the system "noisy" and hence more difficult to correlate sand mining actions with shore changes.

29 Members of the ISP recommended building out the sand mining study and research approach section by
30 listing the study objectives that were included as part of the Request for Proposals (RFP) for the studies.

31 **3. Discussion on Remaining Sand Mining Management Questions**

32 The ISP held discussion on a remaining Tier 2 question under Management Question 1: **Is sand mining at
33 existing lease areas, at permitted levels, having a measurable or demonstrable impact on sediment
34 transport and supply within San Francisco Bay?**

35 Question 1a asks whether sand mining influences sand transport through SF Bay. For their discussion, the
36 ISP focused on Question 1a.i.

Question 1a.i) How does sand mining impact the volume or characteristics of sand supplies to the beaches (In-Bay and Outer Coast)?

37
38 Members of the ISP agreed that the studies indicate sand mining does have an impact on the volume or
39 characteristics of sand supplies to beaches; however, there is not enough information to surmise the extent
40 of the effect. One of the ISP's draft synthesis findings reads: "exchange of sand between Central Bay and
41 the Ocean (Anchor QEA) creates a common pool of relic sand (UT Austin). Sand mining reduces the size of
42 that pool (Sand Budget). How big the pool is and thus the significance of that reduction is unknown."

43 Effects on beaches were not addressed by the studies due to capacity limitations. One could spatially scope
44 a study, but defining the boundary conditions would be very complex. Bob agreed, but noted that several

1 prior studies have addressed these boundary conditions, and this is the next logical step in understanding
2 the potential effects of sand mining.¹ There is no evidence that In-Bay beaches, in particular, would be
3 impacted, but they didn't study it. The lack of an inventory of beach sands is a known data gap. John
4 suggested there is little to support the expectation that the beaches would be impacted. Bob disagreed and
5 said that the mined sand at Presidio Shoals appears to be replenished from somewhere.

6 Craig emphasized that ISP's agreement that one can expect sand mining in one area to cause a deficit
7 elsewhere or reduce the supply to the Outer Coast. However, it would be extremely difficult to see the signal
8 from that, and he doubts there is any way to track specific effects at a given location with any reasonable
9 degree of certainty. Bob noted that he's authored two papers that address shore changes and their causes,
10 and link changes at Ocean Beach and Crissy Field. The study contractors ISP could not address the effect of
11 sand mining on beaches in this phase of the work.

12 **Areas for Future Study**

13 Bob recommended further study priorities in the following areas:

- 14 • Inventory of San Francisco Bay beaches, including details on sand and sediment characteristics,
15 spatial extents, and volumes. This information can be used to improve the sand budget study.
- 16 • Extend the stratigraphy study to include sand deposition areas, and perhaps the shoals and
17 offshore, Bay floor, and include the Richmond and Brooks Island area. The inventory plus the
18 stratigraphy analysis would help in understanding sand transport pathways. The sand transport
19 pathways can then inform an update to the sand budget. (Currently, the sand budget (SFEI)
20 indicates that sands from local tributaries are conveyed to the Golden Gate whereas the model
21 (Anchor QEA) indicates this sand isn't transported that far.)
- 22 • Extend the study to include the offshore, ocean-side areas. Despite the challenges, he thinks it
23 would be worthwhile.

24 All the members of the ISP concurred with Bob's recommendations and noted that there is likely a high
25 degree of uncertainty in any inventory estimates.

26 **4. Discuss Remaining Management Questions**

27 The ISP discussed Management Question 3 and its associated tier 2 questions.

Question 3) Are there other feasible sand mining approaches to consider in San Francisco Bay?
--

28 **ISP Discussion**

29 Members of the ISP tended to agree with one another that they should not answer this question since the
30 studies did not address it and they do not claim expertise in sand mining processes themselves. They did,
31 however, pose a consideration for regulators:

- 32 • If you want to limit the effect of sand mining to curb potential far-reaching effects, you would mine
33 certain lease areas that are isolated and do not replenish. If you want mining to have a dispersed
34 effect, you could mine in areas of high recovery or at zones of convergence.

¹ Bob Battalio later provided additional context to this statement, sharing that he has lead studies for the U.S. Army Corps of Engineers which did address these boundary conditions, and so has the U.S. Geological Service, so he doesn't believe this challenge is any more difficult than the boundary conditions in San Francisco Bay that were addressed by the Study Contractors. He emphasized the need for a different team to address coastal processes as the next logical step. He further clarified that when the studies were being scoped, he anticipated that they would have to start in the Bay and deal with several misconceptions first (e.g., that the Bay was like a river with sand going primarily one way; that the mineralogy implied a contemporary sand transport from inland California to the coast through the Golden Gate, etc.). It was also apparent that the standard of scientific/engineering practice and experience (e.g., sediment budgets, transport model) in SF Bay was focused on fine sediment transport, not sand, and hence getting a grip on sand transport in the Bay by currents was a heavy lift and a priority over more challenging areas for SF Bay practitioners (e.g., waves and littoral transport, and the Pacific Coast).

1 The ISP called attention to their earlier discussions on using adaptive management supported by a
2 monitoring program to adjust sand mining practices as certain effects are observed.

3 The ISP expanded on their statement to provide several considerations:

- 4 • There are areas (identified in Edwin Elias' work, and particularly the flood tidal delta inside the Golden
5 Gate) where sand in bedforms or bedload converges. From a sand management point of view,
6 mining from that area of convergence would likely lead to largely dispersed effects.
- 7 • Normally, sand would converge on the flood tidal delta, sand would go into suspension, then be
8 distributed widely (at least according to the modeling that was done). Dave feels that this suggestion
9 may be the opposite to the ISP's "worst case scenario" which would be taking sand out of an area
10 directly upstream of a critical area that needs the sand.
- 11 • Dave acknowledged that this may or may not be feasible because sand miners may need a certain
12 grain size or consistency in grain size.
- 13 • It may be possible to mine in the mouth of the San Francisco Marina which is otherwise dredged and
14 disposed of at Alcatraz. Additionally, it may be worthwhile to reuse the coarse sediment from tributary
15 drainage areas, where sediments are trapped and removed for flood management purposes.
- 16 • Bob acknowledged that there may not be a feasible volume available for miners.
- 17 • Bob speculated that some of the deeper, Meritt sand deposits that are sometimes dredged for
18 navigation (like at the Port of Oakland), could be mined, though it's possible that those are relic dune
19 sands and therefore finer than the miners want.

21 **Areas for Future Study**

- 22 • Development of an adaptive management strategy for mitigating any measurable impacts of sand
23 mining.

Question 3a) 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?

24 **ISP Discussion**

25 Question 3b. considered the timing of mining.
26

Question 3b) 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?

27 Members of the ISP believed it would be interesting to explore mining in wet versus dry years, but
28 acknowledged the unlikelihood of that practice being imposed due to the associated financial impacts.
29

30 Question 3c. considered what scenarios should be modeled to judge likely impacts.

Question 3c) 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)?

31 Members disagreed about the value of further modeling given the amount of uncertainty in the boundary
32 conditions. Craig, John, and Dave all felt that, at this time, the models had taken them as far as they can go.
33 Craig noted that due to the high uncertainty regarding the boundary conditions for any modeling, the
34 predictive capacity of models is significantly limited.
35

36 Bob recommended modeling and analyzing:

- 37 • Bathymetric change mapping of event scenarios such as high or low seasonal rainfall and river flow
- 38 • The effect of oceanic events on transport at the Golden Gate
- 39 • Other physical conditions that have a very strong signal, such as high rainfall flow events.

- 1 • The effect of density driven flow. There was some indication that when there is high freshwater
2 discharge out of the Bay, there is an opposite return flow on the bed (this was observed at the
3 Golden Gate and Carquinez Strait areas). He noted they had initially thought that the upper and
4 lower density layers flowing in opposite directions was not significant, but modeling says it might be.
5 • The effect of different grain sizes on transport. There had been some indication that coarser sands in
6 the Central Bay move differently than finer sands.

7 **5. Wrap Up, Next Steps**

8 Members of the ISP provided closing thoughts on the San Francisco Bay Sand Mining Studies, particularly
9 noting what they found to be surprising, helpful, or counterintuitive.

- 10 • The sand is relic.
11 • There is a high degree of interchange with the Outer Coast.
12 • The tributaries do not contribute as much sand as anticipated.
13 • The ring analysis did not show the expected, more diffusive effect in the bathymetry from the mining
14 area.
15 • The studies did not show sand moving through the Carquinez Strait, into San Pablo Bay, and down
16 into the East Bay Shore where there is sand accumulating over time. Bob reiterated his desire to see
17 this finding explored further, particularly as it relates to the density driven barrier to net flux
18 considerations.

19 While not fully unexpected, the studies did move the ISP members towards an equilibrium paradigm and relic
20 sand connection, which researchers can refine in future work. This paradigm holds there is approximately as
21 much sand going to the ocean as comes from the ocean but not quite, and there's a little difference due to
22 changes in the Bay which may or may not be anthropogenic. John will add these thoughts to the synthesis
23 document.

24 Next steps for the group are to:

- 25 • Receive the updated report outline by October 16.
26 • Receive this Meeting Summary by October 25.
27 • Develop and transmit the final version of synthesis document by October 25.
28 • Develop and distribute Draft Report for review.
29 • Schedule additional meeting to review comments.

30 Erica noted that in lieu of participating in an additional meeting, the sand study teams provided key summary
31 documents and they do not have funding for them to review and comment on the report.

32 The ISP adjourned the meeting at approximately 5pm.

1 **Appendix A – Meeting Chat**

2 13:25:35 Craig Jones: Might best be stated that the ISP used the best available science to inform the
3 questions posed to them. The BCDC will use the management questions and ISP informed answers to
4 inform permitting decisions.

5 13:43:55 Erica Johnson, she/her, SCC: I believe the research teams used the same subembayment
6 boundaries - I can double check

7 13:51:07 Bob Battalio: The study RFP document from the Coastal Conservancy has context for the
8 sand studies...including appendices.....here is the title of the document:

9 CALIFORNIA STATE COASTAL CONSERVANCY

10 REQUEST FOR PROPOSALS AND QUALIFICATIONS:

11 Fall 2020 Research to Understand Impacts of

12 Bay Sand Mining on Sand Supply and Transport in San Francisco Bay and Outer Coast

13 July 10, 2020

14 14:05:08 Erica Johnson, she/her, SCC: Teams used the same subembayment boundaries, SFEI has
15 a map. Lease areas are in the SCC RFP (Bob posted above, I can provide). Maybe a superimposed graphic
16 of the two would help

17 14:07:40 Jamil Ibrahim: Erica - plz provide shapefiles for polygons noted above.

18 15:23:25 Sara Azat, NOAA Fisheries: That was a huge surprise to me. [Note: the timing of this
19 comment suggests Sara's remarks were in reference to the ISP's surprise around the studies' related to
20 sand sources.]

Sand Mining Studies ISP Report Development Meeting 4

Virtual Meeting (Zoom)

March 4, 2024, 9:00 AM – Noon

1

2

Discussion Highlights

MEETING GOALS:

- 4 • Clarify any outstanding Independent Science Panel (ISP) edits to the Summary Report, including
- 5 incorporation of any additional comments or addressing conflicting guidance, if any.
- 6 • Receive clarifying questions from the Sand Studies Technical Advisory Committee (STAC).

ATTENDANCE:

INDEPENDENT SCIENCE PANEL:

David Schoellhamer, USGS Emeritus
Bob Battalio, ESA Consulting

John Largier, UC Davis
Craig Jones, Integral Consulting

9 Note: Paul Work resigned from the Independent Science Panel in January 2024, but did review and provide
10 comment on the draft report. His contributions are discussed in this meeting.

OBSERVERS:

Bay Conservation and Development Commission (BCDC)	Brenda Goeden, Jaime Lopez, Pascale Soumoy, and Rose An Yue
California Coastal Commission	Jeremy Smith
California State Lands Commission	Christopher Huitt and Jennifer Mattox
California Water Board	Jazzy Graham-Davis
NOAA Fisheries	Sara Azat
State Coastal Conservancy (SCC)	Erica Johnson
Lehigh Hanson/ Martin Marietta	Erika Guerra, Mike Bishop
Lind Marine	Bill Butler
GHD (consultant to mining companies)	Aaron Holloway, Nick Sadrpour

STUDY COORDINATORS:

13 Lisa Beutler, Jamil Ibrahim, and Marisa Perez-Reyes, Stantec

SUPPORTING MATERIALS

- 15 • Meeting chat (attached as Appendix A)
- 16 • Session PowerPoint
- 17 • Time-stamped meeting transcript
- 18 • Meeting recording

1 **SUMMARY**

2 **1. Welcome, Housekeeping**

3 Prior to the start of this meeting, a draft copy of the Summary Report was made available for editing to the
4 ISP on January 3, 2024. The ISP met independently on January 25 and February 13, 2024 to review the
5 document together and make collective decisions about its contents. At these meetings, the ISP made
6 specific requests of the STAC to provide additional context regarding the lease area names, the request for
7 proposal process for the study teams, and Stantec's role. BCDC, and SCC staff were provided access to
8 make those edits in tracked changes for sections 1-2 while the ISP focused on refining their responses to the
9 scientific content in sections 3 and 4.

10 Members of the STAC have had access to a view-only, live copy of the Report and its Appendices since
11 January 3. Members of the STAC that wish to provide comment have been invited to do so by submitting a
12 letter on their agency or organization's letterhead. It has been recommended that those who wish to submit
13 comments wait until after this fourth and final Report Development Meeting to do so.

14 Erica Johnson (SCC) shared that Paul Work has resigned from the ISP due to conflicting commitments in his
15 personal life but noted that he did provide written comments and several suggestions for changes to the
16 Summary Report for his fellow ISP members to consider.

17 **2. Review Draft ISP Summary Report**

18 The ISP reviewed the draft report section by section and provided direction to the study coordinators on how
19 to best address unresolved comments. The following summary provides high-level points of discussion.

20 Brenda Goeden (BCDC) acknowledged that there are still a number of outstanding comments for her to
21 resolve in the document (including development of the Summary Report's citation). She will be working
22 alongside Stantec and the ISP to provide information.

23 **Lease Areas:** The group reviewed Bob Battalio's comment in Section 1.2, regarding possible inclusion of
24 historic sand mining lease areas. Several lease areas near Alcatraz and Carquinez Strait were active during
25 the period that was studied by the scientific teams. Mining in those areas should be described in the report;
26 Stantec and Brenda should collaborate on the language. Beyond that, however, the ISP decided historic
27 mining areas that predated the start of the mining data used in the studies does not need to be characterized
28 in this report.

29 **Mined Volumes:**

- 30 • Prior to the meeting, Paul Work left a comment on listing the typical extracted volumes or depth
31 changes associated with a particular mining event, in order to provide readers less familiar with the
32 process with needed context. David Schoellhamer agreed with Paul's suggestion and Brenda
33 indicated that this information is readily available in the form of presentations from sand miners and
34 details included in permit applications. Building on this, Bob suggested it would also be useful to
35 provide annual and/or decadal volumes of mining. BCDC has this information as well.
- 36 • Table 2 lists the annual permitted sand mining volumes. At the time of the meeting, the table
37 contained values that were consistent with the California State Lands Commission's permitted
38 volumes, which total to 2.039 million cubic yards. The permitted volume, however, was reduced to
39 1.426 million cubic yards annually in the BCDC, Regional Water Quality Control Board, and U.S.
40 Army Corps of Engineers permits. The table's permitted volumes should be updated for consistency
41 with the lower BCDC permit volumes. The group also requested the Table 2 title be revised to clarify
42 the volumes are for the 2015-2025 period, the "proposed permit" volume column should be deleted,
43 and a peak annual volume column could be included.

44 **Study Bounds:** In Section 2.3, John Largier highlighted the sentence that discusses the use of the Delta and
45 Pacific Ocean as useful boundaries and the group worked together to refine its meaning to emphasize the
46 role those geographic markers play as traditional boundaries due to the historical information available.

47 **Stratigraphy:** Because an actual stratigraphic analysis was not included in the rescoped studies, the ISP
48 recommended replacing references to "stratigraphy" with "fingerprinting sand sources."

49 **SedTrails:** The report should include a paragraph that briefly describes the SedTrails work that was
50 performed by USGS and Deltares, which the ISP, STAC, and study teams all received informational
51 presentations on during the Quarterly Research Update Meetings. There should also be a statement in the

1 Report that acknowledges that the ISP, in providing this synthesis, have relied on their own expert opinion as
2 well as well as research and review of literature independent of this group. References to research have
3 been provided where possible, however, not all work that my have informed the ISP's analysis can be
4 provided.

5 **Model Calibration Limits:** In Section 2.4.2, the ISP provided recommendation on how to best characterize
6 the extent to which the UnTRIM Bay-Delta model did or did not account for wave driven processes.
7 Additionally, the group highlighted that there were not data to validate or calibrate the computed bedload
8 sand transport and it was instead calibrated against data describing suspended sediment concentrations. A
9 footnote has been added to describe those limitations. Dave provided several associated studies to link to
10 (Downing-Kuntz et al., 2021 and Erikson et al., 2013), but suggested description on this would fit better in
11 Section 4 on key information gaps.

12 **Section 3:** The group acknowledged Paul's comment in Section 3 about potentially noting that material that
13 fills a dredged area may have different characteristics to what was mined, but the group decided against it.
14 The ISP discussed the appropriate level of uncertainty to express in Section 3.3, which provides high-level
15 responses to the Tier 1 sand mining management questions. The ISP will work offline to refine.

16 **Section 4:** Bob highlighted that a recommendation to conduct an inventory of beaches and other sand
17 shoals needs to be called out somewhere in Section 4. The group decided to include it in the key information
18 gaps section. Stantec is in the process of developing the recommendations from the study teams on areas
19 for future study.

20 **Executive Summary:** The ISP weighed in on key elements to include in the Executive Summary and
21 provided direction to Stantec to draft it for their review prior to the next iteration of the Report.

22 3. Receive Clarifying Questions from the STAC, Next Steps

23 Aaron Holloway (GHD) raised concerns that the appendix document titled "Responses to Sand Mining
24 Management Questions" may be misconstrued as the ISP's final responses to the questions, when it is in
25 fact a summary of their discussions on the questions. The group decided to rename the document:
26 "Discussion/Responses to Sand Mining Management Questions."

27 Upon request for clarification from the STAC, the group discussed next steps for Report refinement and how
28 the STAC can expect to weigh in. The STAC expressed a preference for providing comments on a near-final
29 version of the report in the hopes that the ISP and study coordinator can consider their comments before
30 finalizing the report. The ISP confirmed this approach and added that, if possible, they would like for the
31 study teams to provide review and comment on the draft Report. Erica noted that they did have access to
32 review an early draft of the report, but that the latest version could also be distributed. The updated schedule
33 is as follows:

- 34 • **March 15, 5:00 PM Pacific:** Stantec will provide the ISP with the next best draft that includes the
35 Executive Summary.
- 36 • March 16-28: ISP will review and edit Executive Summary and updated Report.
 - 37 ○ Erica will schedule a meeting during this period for the ISP to meet and discuss.
 - 38 ○ Deadline for final ISP edits: **March 28, 11:59 PM Pacific.**
- 39 • **March 29, 9:00 AM Pacific:** Semi-Final Summary Report released for STAC and Research Team
40 review.
- 41 • March 30 - April 10: STAC and Research Team review Draft Report and provide comments via email
42 to Erica Johnson.
 - 43 ○ Deadline for emails to Erica: **April 10, 11:59 PM Pacific.**
- 44 • April 11-23: ISP to review STAC and Research Team comments and make edits.
 - 45 ○ Deadline for final ISP edits: **April 23, 11:59 PM Pacific.**
- 46 • **April 24, 9:00 AM Pacific:** Final copy of Summary Report released.
- 47 • **May 3, 11:59 PM Pacific:** Deadline for Comment Letters to be appended to final ISP Report.
- 48 • **May 10, 5:00 PM Pacific:** Final Report with Appendices will be distributed to the full group.

49 4. Closing

50 The ISP adjourned the meeting at approximately Noon.

1 **Appendix A – Meeting Chat**

2 00:16:41 Lisa Beutler: Hi Erica - pleas make me a co-host.

3 00:42:48 William Butler: As a point of clarification for the volumes - the proposed volumes for the
4 CSLC leases are simply the peak volumes that are currently permitted by BCDC and ACOE.

5 00:44:22 Brenda Goeden: thanks Bill, that's helpful

6 00:55:50 Erica Johnson: We can check if it was mentioned in SFEI's annotated bibliography since it
7 was shared with the group

8 01:16:08 Craig Jones: Also away for 2 minutes.

9 01:54:09 Craig Jones: Humor moment: Is a 'diffusing sediment excavator depression' a good tool for
10 sand mining?

11 02:26:00 Sara Azat (NOAA Fisheries): Section 3.3.2 would read better if the first paragraph was made
12 into more than one sentence.

13 02:26:04 Brenda Goeden: ok with me.

14 02:26:09 Jeremy Smith, CA Coastal Commission: fine with me

15 02:26:11 Sara Azat (NOAA Fisheries): Yes

16 02:43:17 Brenda Goeden: I think on your acronyms and abbreviations, you should check in with Erika
17 on whether its more appropriate to note Martin-Marrietta rather than Hanson.

18 02:44:10 Erica Johnson: Thanks Sara and Brenda, I took note of your comments in the chat

19 02:50:27 William Butler: Sorry, having problems with my Zoom freezing. We would be interested in
20 providing comments on a NEAR-final report, with the hope being that the ISP and Stantec might consider our
21 comments before finalizing.

22 02:52:17 Sara Azat (NOAA Fisheries): I had assumed that our comment letters would be on the final
23 draft - not that the final report would be edited based on our comments.

24 03:01:08 Craig Jones: Apologies all. I have a hard stop at noon! Thank you all and I will stay posted
25 for action items. Thank you all!

26 03:02:09 Jamil Ibrahim: Current title of Appendix F is "Appendix F - Independent Science Panel
27 Report Development Meeting Summaries and Responses to Sand Mining Management Questions"

28 03:02:23 Erica Johnson: This is what I have for a rough timeline...

29 Next steps ~ 7 weeks total:

30 Executive summary - 2 weeks

31 ISP review and edit – 2 weeks

32 Semi Final version – April 1, STAC and Research Teams review – 1.5 weeks

33 Send comments via email to Erica, ISP review and edit – 1.5 week turnaround

34 Final version out, send in comment letters – 1.5

35 03:03:14 Erica Johnson: Sorry, 8.5 weeks

36 03:03:54 Brenda Goeden: this also reminds me that Gillian may also not be on the STAC list - please
37 double check. Can't remember her last name.

Appendix E, Attachment 5 – ISP Discussion/Responses to Sand Mining Management Questions

The following is an aggregate summary of the ISP's points of discussion on the Sand Mining Management Questions which occurred at their report development meetings. Summaries from those meetings are included in this Appendix F. The questions were discussed out of order, over a four-month period, during which several of the reports had not yet been released, therefore, some elements may reflect an iterative understanding that unfolded over time.

Question 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?

The ISP confirmed they have learned a great deal from the study findings; however, the majority did not feel that the studies were sufficient to answer the question with a high degree of confidence. David Schoellhamer thought the studies showed sand mining to have a measurable and demonstrable impact on sediment transport but could not necessarily say the same for supply.

When prompted to advise on considerations for the Bay Conservation and Development Commission (BCDC), the ISP observed that they can draw conclusions about useful data points to monitor in an adaptive management framework.

Overall, the ISP emphasized that they are much better prepared to answer the management questions now than they were at the start of the studies.

Areas for Future Study

- Transport of fine sands.
- Contribution of waves to sediment transport, particularly at the Golden Gate, and the ability for huge oceanic surges to propagate.
- Deep core for stratigraphy analysis.

1a) Does sand mining influence sand transport through SF Bay?

The ISP agreed that it appears that sand mining does influence transport through SF Bay; however, the ISP was not sure about effects on coastal beaches, if any. There was also less certainty about how effects are manifesting in San Francisco Bay. For example, the Suisun Bay mining area may or may not be affecting sand supplies to the North/Central Bay, and there's a question about the significance of the effects of the mining in Central Bay during the short term. Conceptually, the long-term effects are where you'd see the most impact. John Largier expressed that the studies didn't provide new insights as to whether mining affects supply to beaches.

1ai) How does sand mining impact the volume or characteristics of sand supplies to the beaches (In-Bay and Outer Coast)?

Members of the ISP agreed that the studies indicate sand mining does have an impact on the volume or characteristics of sand supplies to beaches; however, there is not enough information to surmise the extent of the effect. One of the ISP's draft synthesis findings reads: "exchange of sand between Central Bay and the Ocean (Anchor QEA) creates a common pool of relic sand (UT Austin). Sand mining reduces the size of that pool (Sand Budget). How big the pool is and thus the significance of that reduction is unknown."

Effects on beaches were not addressed by the studies due to capacity limitations. One could spatially scope a study, but defining the boundary conditions would be very complex. Bob Battalio agreed, but noted that several prior studies have addressed these boundary conditions, and this is the next logical step in understanding the potential effects of sand mining.¹ There is no evidence that In-Bay beaches, in

¹ Bob Battalio later provided additional context to this statement, sharing that he has lead studies for the U.S. Army Corps of Engineers which did address these boundary conditions, and so has the U.S. Geological Survey, so he doesn't believe this challenge is any more difficult than the boundary conditions in San Francisco Bay that were

Appendix E, Attachment 5 – ISP Discussion/Responses to Sand Mining Management Questions

particular, would be impacted, but they didn't study it. The lack of an inventory of beach sands is a known data gap. John suggested there is little to support the expectation that the beaches would be impacted. Bob disagreed and said that the mined sand at Presidio Shoals appears to be replenished from somewhere.

Craig Jones emphasized the ISP's agreement that one can expect sand mining in one area to cause a deficit elsewhere or reduce the supply to the Outer Coast. However, it would be extremely difficult to see the signal from that, and he doubts there is any way to track specific effects at a given location with any reasonable degree of certainty. Bob noted that he's authored two papers that address shore changes and their causes, and link changes at Ocean Beach and Crissy Field. The study contractors and ISP could not address the effect of sand mining on beaches in this phase of the work.

Areas for Future Study

Bob recommended further study priorities in the following areas:

- Inventory of San Francisco Bay beaches, including details on sand and sediment characteristics, spatial extents, and volumes. This information can be used to improve the sand budget study.
- Extend the stratigraphy study to include sand deposition areas, and perhaps the shoals and offshore, Bay floor, and include the Richmond and Brooks Island area. The inventory plus the stratigraphy analysis would help in understanding sand transport pathways. The sand transport pathways can then inform an update to the sand budget. (Currently, the sand budget (SFEI) indicates that sands from local tributaries are conveyed to the Golden Gate whereas the model (Anchor QEA) indicates this sand isn't transported that far.)
- Extend the study to include the offshore, ocean-side areas. Despite the challenges, he thinks it would be worthwhile.

All the members of the ISP concurred with Bob's recommendations and noted that there is likely a high degree of uncertainty in any inventory estimates.

1a) Does sand mining change the way sand moves from subtidal shoals to intertidal flats, marshes and beaches?

The ISP felt that the studies did not speak to this question definitively, and it remains an important question to keep on the table. Marsh-fringing beaches, though assumed to make up a small portion of the sand budget, are critical to protecting and preserving marshlands. Other recent work has revealed that there are significant quantities of sand in intertidal flats and there are questions about how sand is transported to those flats. ISP members believed that sand transport is from subtidal shoals to beaches, rather than to intertidal flats and marshes. Bob knows of studies that show sand deposited at flats and beaches, but the source(s) of the sand were not identified. Subtidal shoals were not studied, but BCDC may be able to learn from other current work on studying beaches, estuaries, and enclosed bays.

1a) Does sand mining influence sand waves and their contributions in transport processes?

The ISP expressed interest in meeting with the Deltares study team to gain additional clarity on how their work responds to this question. To the extent that some members felt comfortable drawing conclusions, they shared that it appears sand mining does influence sand waves in that it removes them, but the significance and extent seemed uncertain. Regarding the second question, there are spatial resolution issues, and the contractors did not provide an interpretation of physical change on the transport process.

addressed by the Study Contractors. He emphasized the need for a different team to address coastal processes as the next logical step. He further clarified that when the studies were being scoped, he anticipated that they would have to start in the Bay and deal with several misconceptions first (e.g., that the Bay was like a river with sand going primarily one way; that the mineralogy implied a contemporary sand transport from inland California to the coast through the Golden Gate, etc.). It was also apparent that the standard of scientific/engineering practice and experience (e.g., sediment budgets, transport model) in SF Bay was focused on fine sediment transport, not sand, and hence getting a grip on sand transport in the Bay by currents was a heavy lift and a priority over more challenging areas for SF Bay practitioners (e.g., waves and littoral transport, and the Pacific Coast).

Appendix E, Attachment 5 – ISP Discussion/Responses to Sand Mining Management Questions

The ISP also expressed interest in cross-referencing the USGS reports to identify divergent and convergent zones.

1aiv) Has sand mining altered the grain size distribution of in-bay or outer coast sand resources?

The ISP felt that the degree to which the studies focused on grain size was not sufficient to answer this question, though they did think it would be possible to tease out several conclusions from the newer reports.² The ISP also remarked that the Sand Budget Report's as-yet unwritten conclusion section may provide insights for this question.

David suggested the question could be addressed through evaluation of grain size in the Bay before and after sand mining, but noted that if a change were detected, it may be due to other factors aside from sand mining. Craig Jones expressed doubt that a before and after approach would be sufficient to answer the question.

Areas for Future Study

- Greater distinction between coarser and finer sands
- Deeper study on the capacity for different grain sizes to move in suspension
- How different grain sizes move via bedload transport
- Grain size distribution at the Bay's boundaries (in and out flows)

1av) Does sand mining result in sand sinks and resultant changes in flux to the Outer Coast?

Yes, the study reports do point to sand mining leading to sand sinks and resultant changes in flux to the Outer Coast, however, the relationship of the findings to one another are not entirely clear yet. Paul Work said he'd need to refer back to the studies' assumptions to answer this question. John thinks the models do show an influence and provided comments about density driven flow. Craig specifically called attention to the need for discussion on how the results of the sand budget and provenance studies agree or disagree with one another.

Bob described the studies' findings by geographic area, including:

- Anchor QEA's model predicts that sand mining reduces transport in and around the Central Bay.
- The ring analysis indicates that the southern lease area (Presidio Shoals) is recovering whereas the northern area (Point Knox Shoal) is not (i.e., the depressions left by mining tend to remain).
- In the northern Central Bay area, it appears that coarser, relic sands are diminishing, but it's not entirely clear that those sands aren't being replenished.
- In Suisun Bay, contrary to what they'd previously thought, the model shows more sand moving upstream than downstream (between the San Pablo Bay and the Delta), yet anecdotal observations indicates sand does appear to be moving from San Pablo to Central Bay.
- We don't have resolution of the sand transport pathways within the subembayments.

1b) What is the source of mined sand in the lease areas? Is it "relic" sand, or "new" sand transported into the system?

The ISP expressed a high degree of confidence in the report findings which conclude that the mined sand in the lease areas is relic, in the sense that it was delivered between 15 and 20 thousand years ago. The sand source could be connoted as "new" to the system in the sense that it is moving into and around the Bay. Bob elaborated that he thinks the relic medium and fine grain sands are moving, but he isn't sure that the coarser sands are moving.

² At the time of this discussion, SFEI's Sand Budget Report had just been released in draft form.

1bi) What is the ratio of relic to new sand found in mined sand?

The ISP built on their response to the previous question to state that the Stratigraphy Report's findings clearly suggest the vast majority of mined sands are relic.

1bii) How much of what's available is being mined?

In response to the ISP's request for clarification on how "available" is defined, Brenda Goeden (BCDC) shared that permitting decisions typically define "available" as the amount minable to a depth of 90 feet because that's the range most modern mining equipment can reach. Bill Butler confirmed Brenda's response and noted that the baseline is arbitrary and there is certainly some equipment that could go deeper. David noted that the answer to the question changes depending on whether it's defined relative to equipment reach or down to bedrock, or whether shoals outside the permitted areas are considered.

Without data on the volume or depth of sand in the shoals, the ISP found this question difficult to answer, though they did note that the volume of mined sand is on the same order of magnitude as other flows within the system (like dredging). Bob expressed doubt that anyone has an estimate of the Central Bay deposit's base level. Some members of the ISP felt that the reports addressed the question but that they would need to investigate them further.

1biii) Is it better for the physical environment to mine "relic" sand or "new" sand?

The ISP's response to this question was mixed.

Bob observed that sands coming into the Bay along Crissy Field Shore, depositing in the San Francisco Marina, are considered by some to be a nuisance and that littoral transport may currently be in excess of what is needed. In that sense, there is a possibility that sand mining could be considered sustainable and extracted without causing direct erosion. If, however, sand was to be removed from a littoral cell that would have otherwise been delivered to the San Francisco Bar and beaches, then there are potential impacts which would be difficult to trace, given the possible 30-year lag time. Further, Bob pointed to potential future needs for building shorelines to keep pace with sea level rise and indicated that the question of whether mining is sustainable touches on public trust issues. Bob also mentioned the possibility for sand being taken out of the flood control channels, but there are practical differences associated with that approach and opted not to comment much further.

Craig shared that this question represents a disconnection for him. He said the budget shows one thing, and the ring analysis also says something. The UT study seems to confirm that the mined sand is relic. He reflected that if a massive amount of that sand is coming in from offshore, then perhaps the mining is sustainable, but he has further questions about how large that quantity is and what they are contending with.

John critiqued the choice to use "better" in the management question because it implies a value judgement. He unpacked some of the implied assumptions that frame the question, noting that it appears to be set in the geologic timeframe of one century, over a certain spatial area. He said considerations differ for a huge reservoir (sand deposit) versus a small reservoir. He noted a potential problem with mining relic sand, which is that it changes morphology, which then changes hydrodynamics and affects plankton and other ecosystems. He remarked that if a value judgement were to be made, then mining relic seems like the less good alternative. On the other hand, John spoke about the difficulties of defining what is "new," and whether one beach or littoral cell may be conceived of as connected to one another. He proposed thinking about sand as "sloshing" between the Bay and Outer Coast, drawing a line around that dynamic process.

David suggested that a helpful way to reframe the question would be to answer whether it is better to mine in areas that experience a higher degree of transport as opposed to areas that are relatively stationary. Building on John's characterization of the Golden Gate, for example, sand "sloshes" in and out of the Bay, generating a tremendous amount of exchange, whereas there is little transport in the northern part of the Bay. The ISP felt that the conceptualizing of sand in littoral cells could help guide considerations of whether removing sand from a cell would have downstream impacts.

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Paul concurred with David's proposal to characterize areas as more or less dynamic vs stationary.

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

Generally, the ISP did not feel that this question could be definitively answered based on the available information; however, they did feel that the study findings held relevant insights on tipping points to monitor and adaptively manage for. The following considerations were shared:

- There are other anthropogenic influences aside from sand mining that are contributing to bathymetric change trends, including hydraulic mining. For this reason, establishing cause and effect for sand mining specifically would be difficult.
- David remarked that the bathymetric change trend for the past 150 years has been largely dictated by hydraulic mining, not sand mining. David made mention of erosion in other subembayments where sand mining isn't occurring.
- Craig felt that the data to-date do not show "massive" long term changes in bathymetry due to sand mining, though there do appear to be "scarring" effects that persist for multiple years as a result of sand mining in the Central Bay (this is where decadal data would be useful).
- The bathymetric change trends do offer good information on what metrics could be monitored to avoid reaching a tipping scale, where conditions would then become irrecoverable. Members of the ISP echoed their earlier statements about pulling information from across the study to inform an adaptive management monitoring strategy.
- To John's earlier point, there may be other tipping point effects associated with deepening the Bay besides sand transport, such as saltwater intrusion and effects on plankton.
- The mining areas' recovery rates differ greatly.
- Bob remarked that earlier scientific thought supposed that contemporary river sediment supplies from inland California were being disrupted by sand mining, and these new studies suggest that that is not happening.
- The sediment budget and bed change totals were not correlated in time series with dredging and mining, though the scales are on the same order. Members of the ISP differed on whether they thought this correlation could be conducted or not, given the number of other confounding factors that could also contribute to any observed trends. John suggested that the best shot at understanding those effects would be found at the ring analysis scale.
- Bob estimates that sand transport in the Golden Gate littoral cell, between the Central Bay and the offshore shoals, has a 30-year time lag between an event and its observable effects. He noted, also, that the effects don't occur in a stationary system: sea level has been steady, but the San Francisco Bar has been shrinking and rotating at a slow pace.

Areas for Future Study

- Development of metrics to monitor for tipping points in an adaptive management strategy.
- Additional analysis on correlating the sand budget (perhaps Central Bay, specifically) with the sand mining time series (though there was some disagreement among ISP members on the efficacy of this).

1d) Does sand mining alter the geomorphology of the Bay floor beyond the mining location such that sand transport/supply are significantly impacted?

The ISP affirmed the significance of this question and indicated that they learned some things from the studies, namely that the ring analysis does not show short-term impacts of sand mining to areas surrounding the localized areas. Most of the ISP, however, expressed interest in better understanding

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longer-term implications for areas that appear to recover more slowly, since it is possible that there could be significant impacts.

- The ring analysis generally found that impacts are localized and don't echo outward. David said that at the scale of the lease area, they can say with some confidence that impacts aren't growing or expanding outward at a tremendous scale, though he noted this observation is qualitative.
- Craig said that just because tipping points haven't been reached yet doesn't preclude the eventual possibility for continued digging in areas of low recovery to result in changes to geomorphic and hydrodynamic feedback. He again highlighted the importance of understanding what it would take to reach that threshold.
- John offered that slow replenishment suggests a lag response. He said the model could estimate the rate of that response, but it could be 20-years down the road.
- Paul reflected that the ring analysis is helpful for answering questions on a small time and spatial scale and it would be difficult to project their findings forward to answer whether mining will significantly alter geomorphology moving forward. At the scale of the ring analysis, Paul agreed it doesn't appear that mining alters geomorphology at a significant scale.
- Bob also concurred that there doesn't appear to be clear, discernable evidence of geomorphic effects beyond local mining areas. He noted, though, that given the intensity of currents and waves which weren't included in the study, diffusion and dispersal would make it hard to track even large sand removals in a system like the Bay. He concluded that although they don't see effects, they cannot conclude that those effects won't occur.

Other points of discussion included:

- Changes in the size of the San Francisco Bar as well as sea level rise have unknown implications for sand supply and transport, which make it difficult to definitively answer this and other questions.
- Bob expressed puzzlement around why Point Knox Shoals haven't recovered and what that could mean for sand transport. It seemed that there were sand waves on the bed that were part of a dynamic equilibrium sand transport process. After sand mining, those sand waves did not reform and the reason for that is unclear. Does it take more sand? More power? Or less? And does the sand transport through the system increase or decrease? He suggested this is something that Edwin from SFEI might be able to formulate thoughts on. Craig recalled that report being useful, but did not have specific details to share.

Areas for Future Study

- Long-term effects of sand mining on Bay floor geomorphology beyond the mining locations need to be better understood.

1e) 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?

The mining areas do not have the same effects on sand transport pathways and associated impacts. The two areas should be examined separately. David added that part of the reason for this is the Central Bay mining area's proximity to the Pacific Ocean relative to the Suisun Bay mining area.

Areas for Future Study

- The origin of sands in the East Bay shoals (near Richmond) is still a mystery. Some sand movements haven't been explained yet, particularly the sand that makes its way through the Carquinez Strait to San Pablo Bay and is then dispersed.

Question 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?

The anticipated effects of mining on sand transport and supply depend on types of mining and locations. For example, the studies indicated that little to no transport was occurring in Central and North Bay; so, in that sense, mining has little to no effect. In flood shoals (the convergent zones between land and sea), sand is suspended and dispersed widely across the system; so, on a short-term scale, mining also has little effect on transport or supply. On the other hand, for transport pathways that bring sand to desired places like beaches, there may be issues if mining reduces sand transport through the Golden Gate; it's a highly localized question.

In light of the place-based nature of the answers, there was widespread agreement from the ISP to develop robust monitoring protocols and adopt an adaptive-management approach. Some noted that good monitoring could be more valuable and responsible than prolonged study. Monitoring could indicate whether mining is approaching a tipping point in sand recovery or if it triggers different, undesired effects like pulling from other areas.

Brenda requested the ISP weigh in on what monitoring they would recommend. John replied that smart, strategic, and diagnostic measurements will take time to come up with, but it seems that smart, affordable approaches exist. Bob offered several recommendations:

- Inventory the extent of SF Bay beaches, including the size of the beaches, how much sand they contain, and the size of that sand.
- With that data set, use satellite imagery to track and estimate volume change.
- Develop a data sharing repository on beach geometry and grain size. Several projects are already collecting cross-sectional data.
- Areas of priority could include: SF Bay beaches (not necessarily Ocean Beach—that is being monitored by USGS currently and hopefully funding will continue), Central (Berkeley, Richmond, Rodeo), South Central Bay, North of Dumbarton (not just north of San Mateo beach), and Crissy Field. He noted that far South may not be as important (though there is a project at San Lorenzo, Long Beach).
- Additional sediment cores in SF Bay for texture and stratigraphy information.
- SF Bay wave data.

The ISP acknowledged the studies' limitations to answer this question on a longer timescale for cumulative effects because the studies were more focused on shorter time scales. Short term effects do not seem substantial, but long-term effects are not well understood. Sand mining is not only anthropogenic activity that could affect sand transport/budget, so while the mining volume is significant relative to the fluxes, there are a community of associated dynamics. Much more clarity in proximal space and time is needed, particularly at specific, local areas. Additionally, the full implications of the stratigraphy report on this question aren't well known. The ISP expressed interest in hearing the study teams' perspectives on their limitations and areas of uncertainty (for example, Stratigraphy wanted deeper cores in SF Bay). The ISP stated that adaptive management and monitoring would help address uncertainty, and suggested follow up to discuss/determine appropriate monitoring.

There were several specific study findings that the ISP wanted to be further explored:

- One of the findings seemed strange and warranted further study. It's hard to believe that the amount of sand traveling through the system in a bigger fluvial event (wet winter) would be seemingly non-existent. Moreover, the tributary system didn't seem to be important in the overall sand budget to SF Bay (the ISP flagged this as a question to explore once the SFEI report is in).

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If sand isn't traveling through the system, where is the increased volume of sand that's appearing on beaches under those circumstances coming from?

- Bob called attention to another study finding, which indicated that reduced sand mining could result in less sand flux out of SF Bay at the Golden Gate, which could result in reduced supply for ocean beaches. At a high level, the scale of the potential effect, and the scale of uncertainty, aren't clear.

Areas for Future Study

- Further verification of the finding that suggests the amount of sand traveling through the system in a bigger fluvial event (wet winter) is seemingly non-existent.
- Origin of increased sand on beaches in wet years.
- Origin of sands accumulating in the northern Central Bay (Richmond, Berkley area).
- Assess the degree of uncertainty of the finding which indicates that reduced sand mining could result in diminished supply for beaches as a result of reduced flux in at the Golden Gate.
- Clarity in proximal space and time of other associated anthropogenic dynamics.
- In-Bay studies could use repeated bathymetric surveys to track individual bedforms and estimate bedload sand transport rates.
- In-Bay studies could also include sensors on bridge pilings that measure grain size distributions as well as turbidity, collocated with the current turbidity/suspended sediment concentration measurements, to evaluate the amount of sand suspended into the water column and transported as suspended load.

2a) Is there regional uplift/subsidence or other factors that would confound evaluation of sand mining effects?

The group acknowledged that, aside from the bathymetric change analysis developed by USGS as part of the sand budget, uplift and subsidence were not addressed through the studies. Still, the ISP generally felt that uplift and subsidence are not likely confounding factors in the evaluation of sand mining effects (it may be closer to the tertiary level). Study teams have discussion sections in report that should identify other factors, and those factors should be considered in ISP discussions.

Regarding the question of whether other effects may be confounding the evaluation of sand mining effects outside uplift/subsidence, Bob noted that there has not been an inventory of the littoral zone (shallow subtidal, inter-tidal, and wave run-up), so it isn't known yet whether beaches in the SF Bay are growing or shrinking.

Areas for Future Study

- Evaluation of sand erosion at beaches – volume of sand in SF Bay beaches and shoals and evaluation of whether that volume has changed much over time
- Unknown factors referenced in sand study reports

2b) Is there a seasonality to sand transport?

The ISP agreed that the studies have clarified the patterns and factors involved, but intra-annual and seasonal variability is still uncertain. Seasonality may be different than previously thought. The ISP flagged that this question may be addressed in the analyses that haven't yet been released.

The ISP discussed how the findings suggest that density-driven flow is occurring in high outflow years. Results show more sand coming into SF Bay through the Golden Gate during wet periods, whereas previous thoughts were rivers brought sand/sediment in to the Bay and out through the Golden Gate during wet periods. It was previously assumed that high outflows would result in net seaward transport of sand; however, the modeling shows that suspended, finer sediments are moving out through Golden

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Gate in an upper layer while a lower layer of denser water is transporting sand landward into SF Bay, resulting in a net sand transport into the Bay. John remarked that the two-layer flow finding makes sense and pointed to examples from Tiburon and San Pablo Bay.

John and Bob spoke about the extent to which wave driven littoral transport is better understood as a result of the studies. Bob reflected that modeling has adopted it as a piece of the picture, but it's still a data gap that would be important to understand at some point. Bob estimated the volume could be between 50,000 and 100,000 cubic yards, which is significant but perhaps well-known enough to focus on other questions.

Craig highlighted what he felt to be a profound finding from the Stratigraphy Report, which is that the substantial portion of sands in the Central Bay are sourced from the Outer Coast. Oceanic/coastal effects are not well understood; relationship between SF Bay and Pacific Ocean are uncertain.

Areas for Future Study

- Density driven flows and sand transport
- Sand transport driven by oceanic forcing
- Flux due to wave-driven littoral transport, particularly addressing uncertainty along Marin Coast
- Sand transport at the Golden Gate

2c) What is our current technical ability to model sand transport to and from the Bay?

The ISP remarked that the model is great for exploring short-term trends but cannot speak much to the long-term questions under discussion. The ability of the model to predict transport to and from SF Bay is constrained by the amount of data available to set boundary conditions. Boundary conditions limit the ability to simulate transport to and from SF Bay (on long-term basis). Model analysis effectively simulated short-term conditions but is inherently limited due to boundary condition limitations.

2d) 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?

The ISP reflected that while the studies did not yield a much better understanding of the relationship between the outer coast beaches and sand mining in SF Bay, they do feel studies provided a good understanding of how sand reaches the mining areas and that studies focused on the right things. Stratigraphy results demonstrate that the Pacific Ocean is likely a larger source/supplying sand to SF Bay over longer term period, and the ring formation/scale cascade analyses show highly localized impacts of sand mining that rapidly diminish as you travel away from the mined area. The ring analysis study, however, is limited in that it does not speak to the longer-term cumulative effects, so the ISP cannot make definitive conclusions. The ISP also noted that it's not likely that outer coast beach erosion is sand mining source; however, due to uncertainty about coastal analysis, studies focused on in-Bay effects. Studies of in-bay effects did not point to any conclusions about long-term effects related to coastal beaches.

Areas for Future Study

- Evaluate mining areas separately and develop locally appropriate areas of focus
- Oceanic and wave processes informing transport at the Golden Gate zone
- Resolution of finer or coarser than medium sands in transport
- Reducing uncertainty around the finding that outer beaches are the primary source of sands in SF Bay
- Analysis of long-term, cumulative effects of sand mining on SF Bay and outer coast beaches

2e) 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?

At first, members of the ISP remarked that the level of effort for monitoring and modeling required to reduce uncertainty may not be warranted because the effort would not significantly reduce uncertainty. Bob shared that the studies provided a better understanding sand fluxes at the Golden Gate, and that was the highest priority. The question now for the ISP is determining the level of priority of studying sand transport beyond the Golden Gate.

Bob also raised the question of whether the study findings do anything to combat the perception that mining is resulting in erosion of outer beaches, to which he pointed to the Anchor QEA finding that sand flux out of the Golden Gate may be reduced as a result of mining.

Areas for Future Study

- Fluxes at the Golden Gate
- Address Central Bay mining relative to conceptual framework

2f) Under currently permitted mining levels, would erosion be measurably influenced by 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?

The ISP concluded that there is not enough information to definitively answer this question, particularly at the 30- and 50-year time horizons. Although the studies don't show that there is a definitive effect, they don't go far enough to rule out the possibility or contradict the findings from the 2012 compilation. The ISP remarked on the inertial scale of systems like this, which can be steady in an oscillating way, and it's not certain that those effects could be discerned. The group also acknowledged the powerful and dynamic nature of the system and the resulting degree of uncertainty in the data due to major events, time-scale processes, and dredging.

Craig noted that because the littoral transport of sediments across Ocean Beach is of the same relative order of magnitude as the sediments coming into SF Bay, the littoral fluxes warrant further study.

Areas for Future Study

- Ocean-estuary connection
- Longer-term littoral fluxes

Question 3: Are there other feasible sand mining approaches to consider in San Francisco Bay?

3a) 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?

Members of the ISP tended to agree with one another that they should not answer this question since the studies did not address it and they do not claim expertise in sand mining processes themselves. They did, however, pose a consideration for regulators:

- If you want to limit the effect of sand mining to curb potential far-reaching effects, you would mine certain lease areas that are isolated and do not replenish. If you want mining to have a dispersed effect, you could mine in areas of high recovery or at zones of convergence.

The ISP called attention to their earlier discussions on using adaptive management supported by a monitoring program to adjust sand mining practices as certain effects are observed.

The ISP expanded on their statement to provide several considerations:

- There are areas (identified in Edwin Elias' work, and particularly the flood tidal delta inside the Golden Gate) where sand in bedforms or bedload converges. From a sand management point of view, mining from that area of convergence would likely lead to largely dispersed effects.
- Normally, sand would converge on the flood tidal delta, sand would go into suspension, then be distributed widely (at least according to the modeling that was done). Dave feels that this suggestion may be the opposite to the ISP's "worst case scenario" which would be taking sand out of an area directly upstream of a critical area that needs the sand.
- Dave acknowledged that this may or may not be feasible because sand miners may need a certain grain size or consistency in grain size.
- It may be possible to mine in the mouth of the San Francisco Marina which is otherwise dredged and disposed of at Alcatraz. Additionally, it may be worthwhile to reuse the coarse sediment from tributary drainage areas, where sediments are trapped and removed for flood management purposes.
- Bob acknowledged that there may not be a feasible volume available for miners.
- Bob speculated that some of the deeper, Meritt sand deposits that are sometimes dredged for navigation (like at the Port of Oakland), could be mined, though it's possible that those are relic dune sands and therefore finer than the miners want.

Areas for Future Study

- Development of an adaptive management strategy for mitigating any measurable impacts of sand mining.

3b) 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?

Members of the ISP believed it would be interesting to explore mining in wet versus dry years, but acknowledged the unlikelihood of that practice being imposed due to the associated financial impacts.

3c) 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)?

Members disagreed about the value of further modeling given the amount of uncertainty in the boundary conditions. Craig, John, and Dave all felt that, at this time, the models had taken them as far as they can

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go. Craig noted that due to the high uncertainty regarding the boundary conditions for any modeling, the predictive capacity of models is significantly limited.

Bob recommended modeling and analyzing:

- Bathymetric change mapping of event scenarios such as high or low seasonal rainfall and river flow
- The effect of oceanic events on transport at the Golden Gate
- Other physical conditions that have a very strong signal, such as high rainfall flow events.
- The effect of density driven flow. There was some indication that when there is high freshwater discharge out of the Bay, there is an opposite return flow on the bed (this was observed at the Golden Gate and Carquinez Strait areas). He noted they had initially thought that the upper and lower density layers flowing in opposite directions was not significant, but modeling says it might be.
- The effect of different grain sizes on transport. There had been some indication that coarser sands in the Central Bay move differently than finer sands.