

# **Bolinas Lagoon Ecosystem Restoration Feasibility Project**

## **Final Public Reports**

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### **V Project Reformulation Advisory Committee Summary of Draft Public Report**

PRAG Committee

## **MEMORANDUM**

May 23, 2006

**TO:** Bolinas Lagoon Technical Advisory Committee

**FROM:** Project Reformulation Advisory Committee:  
Gary Page – Point Reyes Bird Observatory  
Tom Moore – California Department of Fish and Game  
Gwen Heistand – Audubon Canyon Ranch  
Roberto Anima – United States Geological Survey  
William Carmen – Project Manager, Carmen Ecological Consulting

**SUBJECT: Summary of Examination of Report Entitled: “Projecting the Future Evolution of Bolinas Lagoon” and Supporting Documents**

### **RECOMMENDATION:**

The Project Reformulation Advisory Group (PRAG) recommends that the report entitled “Projecting the Future Evolution of Bolinas Lagoon” and its supporting documents be recommended by the Bolinas Lagoon Technical Advisory Committee (BLTAC) for acceptance by the Marin County Open Space District Board of Directors.

### **SUMMARY:**

The PRAG has examined the report entitled “Projecting the Future Evolution of Bolinas Lagoon”, its supporting documents, and the questions concerning the Report’s analyses and conclusions. The PRAG finds that the report fulfills its purpose as a scientific projection of past, present, and future conditions of Bolinas Lagoon, given the uncertainties inherent in assessing past and future conditions in a complex natural ecosystem.

### **FINDINGS:**

The remainder of this memorandum summarizes the PRAG’s key findings concerning the following elements of the report: A) the Conceptual Model, B) Tectonics, Dynamic Equilibrium(s), the 1854 Map, and the “Pristine Condition”, C) Sediment Accumulation and Tidal Prism Loss, D) Inlet Closure, E) Habitat and Wildlife Changes, and F) Anthropogenic Changes.

For the remainder of this memorandum, the subject report will be referred to as the “PWA (Philip Williams Associates) Report” or “the report”.

### **A. Conceptual Model**

Viewed over the long term, the lagoon responds to cycles of: 1) instant deepening caused by large earthquakes on the San Andreas Fault (at average intervals of about 350 years during the last 1600 years), 2) followed by periods of rapid sediment accumulation and reduction of tidal prism because of increased transport of littoral sediment through the

inlet and its deposition in the deepened recesses of the lagoon and 3) followed by periods of quasi equilibrium with more gradual habitat or tidal prism change.

During the rapid filling phase the littoral sediment is composed of beach sands and silt eroded from the Bolinas bluffs. Lagoon currents are strong enough to carry the fine sand and silt to the northernmost reaches of the lagoon where it is deposited. Alluvial sediment from the watershed comes into the lagoon mostly during severe storm events and averages 20-25% of the total from all sources (alluvial/total): 4500/19000 CY/yr (pre1850), 10,000/43,000 (1906-present). This percentage is expected to increase over the next 50 years as the lagoon becomes shallower and less littoral sediment is carried in to the lagoon as the strength of tidal currents diminish, although bluff-eroded silt will continue to be transported efficiently in suspension.

The rapid filling phase gradually slows until a quasi equilibrium state is reached where sedimentation is offset by sea level rise and the tidal prism is relatively stable. Waves caused by the wind become an important stabilizing force as they erode and re-suspend sediment on tidal flats thus increasing the opportunity for ebb tides to move accumulated sediment out through the inlet. It is this force in particular that promotes the longevity of unvegetated tidal flats in the quasi equilibrium period. The system remains in a state of quasi equilibrium until it is suddenly disrupted by another major earthquake.

This sequence of events has occurred five times during the past 1600 years -- presumably many more times over the past 7000 years during which Bolinas Lagoon has persisted as an intertidal lagoon. During the past 1600 years there has been one period of over 600 years and another with as few as 140 years between significant intervening earthquakes.

## **B. Tectonics, Dynamic Equilibrium(s), the 1854 Map, and the “Pristine Condition”**

The conceptual model indicates that earthquakes that deepen the lagoon are followed by a period of rapid sediment accumulation as littoral sediments are transported throughout the lagoon by strong tidal currents. As the lagoon becomes shallower, tidal dispersion weakens and there is (more or less) a balance between sediment delivery and erosional processes (largely wind wave action that prevents shallow mudflat from becoming tidal marsh). The last earthquake that substantially affected Bolinas Lagoon occurred in 1906. Our empirical perception of the lagoon is based on observations during the last 50 years when the lagoon has been in a period of rapid sediment accumulation as it tends toward a more shallow quasi-equilibrium state.

How can we apportion the observed and predicted changes in the lagoon among natural vs. anthropogenic causes? Does the 1854 map represent pristine conditions? Was the lagoon in a quasi equilibrium state in 1854?

The 1854 map shows a very shallow lagoon with well developed tidal channels in the north basin suggesting that it had been shallow for an extensive period of time. Prior to 1906, the previous earthquake occurred in 1520 (386 years previously); although we do

not know how long it takes for the lagoon to proceed from a deeper water to a shallow water condition (the rapid filling phase), by 1854 it had apparently been shallow for some time. The 1854 map is our best (and only) idea of the lagoon in a relatively pristine state and apparently in a quasi-equilibrium state.

Can we use the 1854 condition to evaluate anthropogenic impacts?

One problem is that each earthquake results in a different 1) overall subsidence, 2) west-east subsidence, and 3) north–south lateral movement. Even with no anthropogenic effects, each earthquake will result in the lagoon moving toward a unique quasi-equilibrium form because geomorphic units and channel morphologies will change. Hence, not all changes that we observe (or predict) in the lagoon based on comparisons with 1854 can be attributed to anthropogenic impacts. For example, in 1906 there was apparently differential east-west subsidence such that the west side of the fault line did not drop as far as the east side (and in some areas may have actually uplifted). Between earthquakes, the west side is creeping North, and perhaps slowly rising, relative to the east side. This, in part, may explain the rapid diminishing of Bolinas Channel and perhaps contribute to the expansion of salt marsh north of Kent Island.

A second problem is the reliability of the 1854 map and PWA's ability to derive quantitative data from it. The map appears to be reliable in depicting habitat type, distribution, and extent. It also indicates that in 1854 the lagoon was quite shallow. Estimating tidal prism is more difficult. The PWA report provides an estimate of tidal prism of 3.7 MYC (+/- 0.7 assuming +/- 0.5 ft in historic tidal range), revised from an earlier estimate of 4.5 MCY (details of estimates are provided in Appendix B of the Report). Given the numerous assumptions and estimates (historic tidal range, slope of mudflats in 1854, conical equations for estimating volume in the lagoon), the tidal prism estimate for 1854 should be viewed as crude and approximate.

### **Conclusion:**

The 1854 map provides our only picture of a relatively pristine condition of the lagoon in a quasi-equilibrium state. However, because each earthquake is unique and sets the lagoon on a different trajectory toward a quasi-equilibrium state, we cannot ascribe all changes we see in the lagoon from 1854 to the present and beyond to anthropogenic impacts.

## **C. Sediment Accumulation and Tidal Prism Loss**

### **Sediment Accumulation**

The Report discusses both sediment accumulation and tidal prism loss. Estimates of sediment accumulation are from coring data (primarily from the north basin) measured in mm/year, then extrapolated over the lagoon and corroborated with bathymetry data.

**Pre1854 Total Sediment Accumulation** = 19,000 CY /year

Alluvial delivery = 4,500 CY/year (extrapolated from Holocene erosion rates in Tennessee Valley)

Littoral sources = 19,000-4,500 = 14,500 (assumes all watershed sediment stays in lagoon)

**1854-1906 Sediment Accumulation** = 39,000 CY/year

*Note: The Report uses a value of 13,000 CY/year as an estimate for the north basin only based on coring data. If the coring data estimate is extrapolated for the lagoon as a whole, the value is 39,000 CY/year. This would lower the pre1906 estimate of tidal prism (see Figure 3-14) and make the displacement from the earthquake larger.*

Alluvial delivery = 39,000 – 14,500 = 24,500 CY/yr (Change is due to watershed delivery as littoral sediment delivery was not expected to change as the lagoon was already shallow)

Littoral sources = 14,500 CY/year

**1906-2004 Sediment Accumulation** = 43,000 CY/year

Alluvial delivery = 10,000 CY/year (Tetra-tech estimate for 1951-2001 period confirmed by PWA).

Littoral Sources = 43,000-10,000 = 33,000 CY/year (derived by subtracting watershed estimate from total accumulation; the latter from core data. Hence, all watershed sediment delivered is assumed to stay in the lagoon. Higher littoral sediments are expected due to much higher tide current velocities following deepening of the lagoon. As the lagoon becomes progressively shallower, watershed sediments will become a higher percentage of overall sediment accumulation).

## Tidal Prism Loss

The table below reflects how the tidal prism changed during various periods since 1854 (data from Report Figure 3-14).

### TIDAL PRISM LOSS (estimates without error bars)

Date	Tidal Volume (MCY)	Change from previous value	Number Years since previous value	Loss of Tidal Prism/year (CY) over interval
1854	3.7			
1906				
Pre-earthquake	3.2	- 0.5	52	9,615 <sup>1</sup>
Post-earthquake	6.7	+ 3.5	NA	
1929	5.6	- 1.1	23	47,836
1968	4.3	- 1.3	39	33,333
1998	3.5	- 0.8	30	26,666
2050	2.5	- 1.0	52	19,230
2125 <sup>2</sup>	2.0	- 0.5	75	6,666

<sup>1</sup> This value may be significantly higher if the estimated sediment accumulation from the north basin cores is extrapolated over the entire lagoon (Report confines estimate to north basin only).

<sup>2</sup> The future quasi-equilibrium period

It should be understood that sediment accumulation does not necessarily correspond directly to tidal prism loss. First, the net effect of sediment accumulation is offset by sea level rise (adding 13,500 CY/year of tidal prism). Also, sediments deposited above MHHW or below MLLW do not affect tidal prism

### **Conclusion:**

As noted, the estimated Tidal Prism loss from 1854 to 1906 may be significantly higher than the value of 9,615 CY/year in the Table. Following the earthquake, there was rapid sediment accumulation and tidal prism loss. The rate of tidal prism loss has been declining and is expected to decline further. This is due to the lagoon becoming progressively shallower as it recovers from the earthquake and tends toward a quasi-equilibrium. As the lagoon becomes shallower, tidal dispersion of littoral sediments will decrease. Wind-waves will erode and re-suspend shallow sediments on mudflats.

## **D. Inlet Closure**

The Report uses the O'Brien stability index to determine the probability of inlet closure. Closure potential is largely determined by the relative balance of wave-driven transport of beach sands and scour by ebb tidal currents. Larger and more frequent waves will deliver more sand to the lagoon inlet; smaller tidal prism and tidal range, and a wider inlet, lowers the ebb tidal power at the inlet and the ability to scour sand from the inlet.

The Report examines the occurrence of inlet closure at various tidal prism values and inlet widths. These values are from 1) current (2004) conditions, 2) year 2050 estimates, and 3) the quasi-equilibrium estimate (year 2125). Wave power values were derived from 17-years of buoy data. Stability index values of 12 or above indicate closure.

**Table 5-2. Results of Inlet Stability Analysis**

Scenario	Tidal Prism (MCY)	Inlet Width (ft at MSL)	Number of Closures (S > 12)	Maximum Value of Stability Index
1	3.5	300	0	6.9
2	2.5	300	0	9.2
3	2.0	200	0	9.4
4	2.0	300	2	13.8

**Conclusion:**

- The lagoon inlet will not close over the next 50-years given an estimated tidal prism of 2.5 MCY in year 2050.
- At the next estimated quasi-equilibrium (year 2125), tidal prism is estimated to be 2.0 MCY. With an inlet width of 200 feet (reduced by 100 ft over the current average width due to the lower tidal prism volume), the analyses suggests that the inlet would not close. With an inlet width of 300 ft., closure would occur on average every 10 years.

**E. Habitat & Wildlife Changes**

There have been dramatic shifts in habitats and, presumably, wildlife and plant communities in the lagoon since 1854. The sharpest distinction is between 1905 (largely shallow intertidal mudflat habitat) and in 1907 (a much deeper lagoon)—a shift from an estuarine to a marine habitat. This has been reversing over the last 100 years and will continue to do so—albeit at a slower rate.

The Report provides information in changes in habitats from 1854 through 2050 (and to 2125 at the predicted quasi- equilibrium). Tables 5-1 and Table 3-2 (from the Report) summarize these changes. Clearly, the change from the quasi-equilibrium in 1854 to after the earthquake (actually our first data set is 63 years after the 1906 earthquake) shows significant habitat shifts (e.g., an increase from 130 to 487 acres of subtidal channel and shallows).

Table 3-2. [Habitat Distribution in 1854 and 1929]

Habitat	1854	1929
Flood-tide island	13	0
Freshwater marsh	21	0
Salt Marsh	170	77
Intertidal flats	910	682
Subtidal Channels & Shallows	130	487
TOTAL	1244	1246

**Table 5-1. Projected Change in Lagoon Morphology**

Morphologic Unit	Year 0 Area (acres)	Year 50 Area (acres)	Change in Area (acres)	Percent Change (%)
Flood Tide Island	28	28	0	0
Flood Tide Shoal	40	40	0	0
Subtidal Channel	171	169	- 2	- 1
Subtidal Shallow	27	0	- 27	- 100
Frequently Submerged Mudflat	399	293	- 106	- 26
Frequently Exposed Mudflat	264	327	+ 63	+ 24
Salt Marsh	200	244	+ 44	+ 22
Brackish Marsh	3	5	+ 1	+ 46
Fluvial Delta	30	54	+ 24	+ 82
Transitional	5	6	+ 1	+ 17
Total*	1,165	1,165		

\* Values have been rounded to the nearest acre, resulting in slight differences between the total report and the sum of individual rows. Total value is smaller than ca. 1,200-acre value since developed areas of Seadrift Lagoon are excluded.

The largest habitat changes between 1854 and the 2050 projection shows 1) more tidal marsh and frequently exposed mudflat, 2) loss of subtidal shallow and less frequently submerged mudflat habitat, and 3) more fluvial delta and transitional habitat (due to expansion of Pine Gulch Creek delta).

The Report provides lists and descriptions of plant and animal species and communities that may be found in each of the habitat types shown in Table 5-1. Where data or anecdotal reports are available, the Report identified species that have declined in recent years (e.g., eel grass, several large invertebrates [ghost shrimp, gaper and Washington clams], shiner surfperch etc.). The Report also predicts overall trends in groups of animals based on predicted habitat shifts: e.g., one-third of the 99 invertebrates listed as occurring in the lagoon (Table 4-1) are associated with subtidal and frequently submerged mudflat and are expected to experience further declines as their habitat area



decreases. Similarly, the Report states that decreases in deeper water habitat will reduce foraging habitat for two feeding guilds of birds (diving fish-eating and diving benthos-feeding birds) and most fish listed in Table 4-2 (38 species known to occur in the lagoon). The Report also suggests how shorebirds and marsh birds may respond to the predicted shift in habitat types. Some shorebird species are expected to benefit and others to suffer population declines. Most marsh birds should benefit.

### **Conclusion:**

The Report could plainly state that the punctuated dynamic equilibrium—sudden deepening followed by rapid and then a declining rate of sediment accumulation—leads to large shifts in habitat types, ecological function, and plant and animal communities. The shifts may be rapid or incremental and are a natural consequence of the tectonics and sediment accumulation in the lagoon. However, anthropogenic impacts may (compared to a pristine condition) decrease the period the lagoon is in the more marine condition and alter the trajectory of the lagoon, the overall mix of habitat types, and the tidal prism—thus affecting plant and animal communities in the lagoon.

## **F. Anthropogenic Factors**

Several anthropogenic forces have affected the lagoon system over the past 150+ years. The most apparent include:

- Construction of Seadrift:
  - destruction of native dune plant community.
  - development of a non-native shrub and tree community.
  - elimination of overtopping of the sand spit during severe winter storms
  - filling of the lagoon leading to the loss of 0.3 MCY of tidal prism and approximately 90 acres of intertidal habitat
  - hardening of the ocean side of the spit with rip rap.
  - hardening of the lagoon side of the outer spit by a retaining wall.
  - creation of a non-tidal saline lagoon.
- Fill for Highway 1
- Fill for road and housing along Wharf Road in Bolinas
- Fill in south arm of lagoon
- Hardening (rip rap and retaining wall) of inlet at end of Wharf Road in Bolinas
- Construction of the Bolinas groin
- Construction of the retaining walls along the Bolinas bluffs
- Loss of Easkoot Creek storm overflow (“Poison Lake” at the Stinson Beach parking lot)
- Construction of the causeway in the South arm of the lagoon
- Rapid marsh expansion following the Lone Tree Mitigation Project in the south arm
- Invasion by non-native plant/wildlife species (e.g., non native dune grass which may stabilize dunes on Kent Island and lead to its expansion)
- Conversion of native bunch grass to annual grassland in the watershed

The Report identifies anthropogenic impacts that directly and indirectly influence sediment accumulation, tidal prism loss, and habitat changes. These are factors that have increased alluvial sediment delivery in the lagoon, contributed to sediment accumulation and resulted in tidal prism loss. Construction of Seadrift, housing development, logging, road building, farming, grazing, and creek channelization contribute to enhanced alluvial sediment delivery to the lagoon compared to pristine conditions. Approximately 12% of the sediment accumulation in the lagoon over the last 100 years can be attributed to enhanced alluvial sediment delivery due to anthropogenic impacts. Current alluvial sediment delivery is twice that of pristine conditions. This is most clearly seen in the continuing progradation of Pine Gulch Creek delta—a landform that was not present in 1854. Historically, the creek would change orientation during large storms and most bedload was deposited in what is currently Weber Ranch. The growth of Pine Gulch Creek delta (and to a lesser extent other creeks) will result in an estimated loss of 0.25 MCY of tidal prism over the next 50 years.

Secondary impacts from enhanced alluvial sediment delivery results from the progradation of Pine Gulch Creek delta and the resulting decrease in wind fetch and wind wave action both to the North and South of the delta. As noted previously, the 1906 earthquake resulted in differential down drop along the fault line—the western portion dropped less and may have actually elevated in some areas. This would, in part, explain why the western part of the lagoon is shallower and may also contribute to the diminution of the Bolinas Channel. Wind waves are sheltered by Kent Island (a natural geomorphic unit present on the 1854 map) and in 1854 there was tidal marsh in the sheltered area to the north of the island. The 1929 map shows Kent Island had largely disappeared and along with it much of the tidal marsh in its lee. More recent maps show the reestablishment of Kent Island, the new Pine Gulch Creek Delta, and more tidal marsh habitat than in 1854. Over the next 50 years there will be a continued shift in habitat type and an overall loss of 0.55 MCY of tidal prism resulting from conversion of low mudflat to higher mudflat and higher mudflat to tidal marsh. The Report attributes this to loss of wind wave action from Pine Gulch Creek delta. The Report indicates that this will continue and at the quasi-equilibrium (year 2125), loss of wind wave action will result in tidal marsh expansion along the west side of the lagoon (Figure 5-13), an additional increase of 80 acres and a loss of 0.2 MCY of tidal prism.

A major change observed in the lagoon is the diminution of the Bolinas Channel. The 1854 map shows a large channel that connected Pine Gulch Creek to the lagoon mouth. In 1929, the channel is larger and opens directly and widely into the north basin. Subsequent maps show the channel getting smaller as Kent Island expands its size. Several factors may contribute to this trend: 1) less down drop on the west side of the lagoon (although the 1929 map does indicate that down drop contributed to a direct and wide channel to the north), 2) progradation of Pine Gulch Creek delta that cut off the channel from the north basin, and 3) growth of tidal marsh between Kent Island and Pine Gulch Creek, further cutting off the head of the channel. The Report states that anthropogenic impacts may be, in part, responsible for the latter two factors.

Summary of Anthropogenic Activities and Effect on Tidal Prism to 2050  
(from Table 5-3)

Construction of Seadrift	0.30 MCY
Creek Channelization	
Sediment delivery	0.25 MCY (direct due to sediment accumulation)
Wind fetch	0.25 MCY (resulting in salt marsh expansion)
Change in Wind Fetch	0.30 MCY (conversion of low to high mudflat)
Other Fill	0.10 MCY
TOTAL	1.2 MCY

**Conclusion:**

When taken together, all human related actions will lead to a new habitat mix and a different tidal prism (loss of 1.2 MCY between 1854 and the 2050 projection). At that point there will be more marsh and high intertidal flat and less low intertidal flat than in 1854 - during the most recent quasi equilibrium period. The tidal prism at the future quasi equilibrium point (125 years from now) is projected to be 2.0 MCY versus 3.7 MCY in 1854 and 3.5 MCY today. The Report identifies expected shifts in populations of plants and animals associated with these habitat shifts. Even with the anthropogenic-related changes, in 2050 the lagoon inlet is not projected to close.

# **Bolinas Lagoon Ecosystem Restoration Feasibility Project**

## **Final Public Reports**

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### **VI Peer Review and Public Comments on Previous Draft Reports with Responses**

Philip Williams & Associates, Ltd.

Wetland Research Associates

# **Bolinas Lagoon Ecosystem Restoration Feasibility Project**

## **Final Public Reports**

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### **VI Peer Review and Public Comments on Previous Draft Reports with Responses**

Peer review (TRG, PRAG and USACE) occurred on the administrative draft report  
(dated Dec 2005).

**Review of the Draft Reports:**

PWA and WRA, Protecting the Future Evolution of Bolinas Lagoon  
Administrative Draft, 7 December 2005;

Roger A. Byrne, Recent (1850 - 2005) and Late Holocene (AD 400 – AD 1850)  
Sedimentation Rates at Bolinas Lagoon, Marin County, California

**For the Marin County Open Space District**

**by**

**Bolinas Ecosystem Restoration Project Technical Review Group**

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**Final Review  
January 10, 2005**

Review of the Draft Reports:

PWA and WRA, Protecting the Future Evolution of Bolinas Lagoon  
Administrative Draft, 7 December 2005;

Roger A. Byrne, Recent (1850 - 2005) and Late Holocene (AD 400 – AD 1850)  
Sedimentation Rates at Bolinas Lagoon, Marin County, California

**I. Introduction to This Review**

A concerned public is asking what Bolinas Lagoon will be like in 50 years, if nothing is done to manage or control its condition. The Marin County Open Space District (MCOSSD) is sponsoring a study of the lagoon to address this question as part of the Bolinas Lagoon Restoration Project. Technical consultants for the study have used computer-based models to simulate how the lagoon mouth will respond to expected changes in lagoon depth and size that are based on empirical assessments of sedimentation inside the lagoon. Changes in lagoon depth and size are also interpreted as habitat changes to assess the ecological consequences. These forecasts of physical and ecological change are extended to the year 2050, which represents the outer limits of predictability in future conditions of the lagoon, given the current understanding of its natural variability over time. The study assumes there will be no change in how the lagoon and its watersheds are configured or managed.

The purpose of the Technical Review Group (TRG) is to help assure that the findings and recommendations of the technical consultants for the study are scientifically sound. Previous work by the TRG has focused on reviewing and advising the study's work plans and interim findings. The current focus of the TRG is on the conclusions and recommendations as represented in two draft reports for the study: "Protecting the Future Evolution of Bolinas Lagoon" and "Recent (1850 - 2005) and Late Holocene (AD 400 – AD 1850) Sedimentation Rates at Bolinas Lagoon, Marin County, California," dated December 7 and 14, 2005, respectively.

This review by the TRG incorporates commentary provided by its individual members into a single set of comments for the TRG as a whole. The commentary has been far-ranging and detailed. No subjects were intentionally avoided. While not every member of the TRG could provide authoritative commentary on all aspects of the technical work, each member provided essential expertise that the other members could not provide. Members were added to help address new technical topics as they arose. There was, however, overlapping expertise among the members for the general topics, such as the conceptual models of how the lagoon behaves as a physical system and as an ecosystem, the scientific framework for data collection and analysis, and the integrative interpretation of the findings.

This review is organized into general comments, specific comments, and a short summary of all comments. The general comments are further separated into five topics: Report Organization and Tone, Lagoon Sedimentation Rates, Forecasts of Physical Condition,

Forecasts of Ecological Condition, and Monitoring. The specific comments pertain to individual findings or recommendations either stated or implied in either report. Detailed comments regarding word choice, typographic errors, inconsistencies in terminology, and minor inconsistencies between text and graphics were provided by some TRG members to the authors on hardcopy versions of their reports, and are not included in this summary review. Such inconsistencies and errors, however small and apparently inconsequential, reduce the reader's confidence in both the data and their interpretation, and should be carefully corrected.

## **II. General Comments**

### *A. Report Organization and Tone*

The TRG recognizes that the consultants have acted upon many of its previous recommendations. The emphasis on the assessment of lagoon evolution in the absence of intercession was promoted by the TRG. The addition of an intensive investigation of historical and pre-historical sedimentation rates through coring of the lagoon was initiated by the TRG, as was the ongoing effort to establish tide gauges and a network of geodetic bench marks for the lagoon. A variety of adjustments in analytical methods and interpretive perspectives has already been suggested by the TRG and accepted by the consultants. We especially welcome the study's emphasis on gaining basic understanding about the relative roles of natural history and human history in shaping the lagoon's existing condition. The intensive, detailed, neutral assessments presented in these two reports provide a better foundation for managing the lagoon than previously existed.

The TRG recognizes that the primary purpose of this study is to assess how the lagoon will evolve over the next 50 years if nothing is done to intercede in the evolutionary processes. We have concurred with the consultants that the assessment should focus on the likelihood that the lagoon mouth might close. Some of the stated goals and objectives for managing the lagoon depend on its mouth staying open. Closure of the lagoon would trigger major changes in its ecological, recreational, and commercial functions that could nullify existing management efforts. We also recognize that dredging the lagoon would be the main action to prevent its closure. In essence, the study will be used to help decide if large-scale dredging is needed. It therefore behooves the consultants, and the TRG, to consider the likely effects of large-scale dredging when weighing the costs and benefits of not interceding in the evolution of the lagoon. Otherwise, the relative benefits of the two management scenarios are difficult to determine.

The data from both reports indicate that two major conclusions can be drawn: the lagoon mouth is unlikely to close and the overall ecology of the lagoon is unlikely to change in significant ways during the foreseeable future. The consultants' reports provide three sets of evidence supporting these conclusions. First, there are empirical measurements of sedimentation patterns and sources of sediment by a number of authors, but done most comprehensively by Byrne et al., indicating that the shallow lagoon has not closed in the past, even when land use practices and earthquakes yielded sediment loads much greater than occur now. When these and other sedimentation data are utilized in the models run by



PWA, no lagoon closure is indicated for the future. Secondly, but perhaps equally important, is the discovery made multiple times that the bulk of the sediments in the major basins of the lagoon originate from the near-shore ocean (i.e., littoral) environment and from the bluffs just outside the lagoon, rather than from the local watersheds. The sediment coming down local creeks is mostly deposited near the creek mouths. Although the initial formation of the creek deltas substantially lessened the tidal prism, the ongoing build-up of the deltas and their gradual expansion contributes little to further prism loss because it occurs very high in the intertidal zone. From these findings we can infer that one major dredging event, which according to the models would increase tidal flood flow and thus bring more sediment into the estuary, could lead only to more dredging. We can also infer that watershed management is unlikely to affect the likelihood of lagoon closure, although it would affect the future of the deltas and the fringing intertidal habitats. The third and final set of critical evidence comes from the ecological analysis indicating that future habitat changes will be insignificant, and that shorebird habitat might even increase, for a net positive overall consequence of taking no management action on behalf of the lagoon mouth. While there is evidence that eelgrass beds are disappearing, that the population of ghost shrimp may be declining, and that invasive plants may increase, the cause of each of these trends is uncertain, and there is no evidence that the trends would be stopped or reversed by dredging or other actions taken to prevent lagoon closure.

It is also clear from these reports that the San Andreas Fault plays a very large role in the natural maintenance of the lagoon. The lagoon owes its existence to the fault, and the fact that the lagoon straddles the fault has major implications for all aspects of lagoon conditions. Major earthquakes along this reach of the fault cause the bottom of the lagoon east of the fault to drop, and this renews the ability of the lagoon to receive near-shore sediment without closing. The west side of the fault drops less (and might even rise slightly), and is therefore more likely to consist of tidal flats and marshes. In fact, the most visible recent changes in lagoon condition are the increases in tidal marshes and tidal flats on the west side of the fault line, near the town of Bolinas, its harbor, and its access road. These changes are locally important, but have had no measurable effect on the lagoon mouth or the tidal range inside the lagoon. Their effect has also been negligible on the distribution and abundance of most species of plants, fishes, and other wildlife that occur in the lagoon. However, the high visibility of these changes can nurture a public concern that exceeds what is warranted by their actual effect on the lagoon ecosystem as a whole.

We find quite reasonable the consultants' conclusion that, since the lagoon is unlikely to close in the foreseeable future, no intercession in the evolution of the lagoon to prevent its closure is warranted. Other actions might be considered to improve or maintain the conditions of local creeks, roadways, boat moorings, etc., but no action is warranted to prevent closure of the lagoon mouth. While it is true that the data are not complete and that they involve potential errors that should be addressed, we find that the basic conclusion is about as well supported as might ever be expected.

We think the Administrative Report should state this message more clearly, and we think the lack of clarity has three main correctible causes, as outlined below.

1. The Administrative Draft report is unduly complicated.
  - The figures must be integrated into the body of the report. The separation of text and figures invites confusion and frustration for the reader.
  - We think there is an interesting and informative narrative about the evolution of Bolinas Lagoon that could be developed based on this study. But the story gets lost in the details of the data and their analyses. The Administrative Draft report has expanded as the major parts have been refined and completed, and now exists as an accumulation of almost all the work done by PWA, WRA, and UCB for this study. The report, and its readers, would benefit greatly from a more integrated and succinct narrative to support the main message. For example, Sections 3-5 of the report could be integrated into a single, concise discussion about the natural and unnatural processes that account for the condition of Bolinas Lagoon, past, present, and future. This integration would reveal inconsistencies within and between the component reports that should be fixed, and would identify text and figures that can either be omitted or organized into a useful appendix for the Administrative Report.
  - The discussion of adaptive management (Section 7) should more clearly identify these essential steps: formulation of management questions; their translation into monitoring objectives; collection and management of cost-effective relevant data; interpretation of the data in the context of the management questions; translation of the results into management actions; and/or re-formulation of the management questions. It should be stated that the managers will need to identify who will collect the data, who will manage the data, who will interpret the data, and who will translate the findings into management actions. Unless these specifics are resolved early-on, adaptive management is unlikely to happen.
  - The list of findings (Section 2) can be useful (see Section III, Specific Comments, below) but a concise summary of them is needed. We suggest that the authors develop a short summary narrative of their essential findings with as little caveat and equivocation as possible. This summary should succinctly state that the lagoon is unlikely to close.
2. Findings of the sedimentary study by Byrne et al. are not well integrated into the Administrative Draft report.
  - We think the two reports should remain separate. However, the report by Byrne et al. on sedimentation is fundamental to the ecological assessment of the lagoon and should be more thoroughly integrated into the Administrative Report.
  - We strongly recommend that the authors of both reports achieve closer agreement about critical topics including average sedimentation rates, the concepts of equilibria and disequilibria as the intellectual framework for system analysis, the influence of seismicity and tectonics on the spatial and temporal variability in the channel network and sedimentation patterns within the lagoon, the ecological response to tidal prism changes, and the role of extreme but recurrent natural

events, such as earthquakes, tsunamis, and major storms in the natural maintenance of the lagoon. More collaboration among the authors would greatly help organize, streamline, and clarify the Administrative Report as the primary product of the study.

A significant step in the direction of integrating the two reports and resolving discrepancies between them could be achieved by developing a common base map of the lagoon that would be used in both reports. A common base map would make it easier to visualize the spatial and temporal relationships among key data and interpretations, as for example, the location of the coring sites with respect to the geomorphic units defined in the Administrative Draft report.

3. The concept of “dynamic equilibrium” is overly applied.

- The concept of dynamic equilibrium means different things to different people and it can change meaning between scientific disciplines. The consultants need to be clearer about how they use the term. We suggest that the concept pertains to systems that are controlled by the interplay between two or more opposing processes that vary but tend to be in balance with each other, such that the system as a whole does not change suddenly to a new state without a sudden change in external forcing.
- According to this definition, the lagoon mouth is apparently in dynamic equilibrium between (simply stated) the ongoing erosion and deposition of sand. The concept helps explain why the mouth is not likely to close in the foreseeable future, and it supports the finding that the lagoon can be monitored in a way that will give adequate warning and thus reduce the risk of unexpected change.
- We do not think the concept is usefully applied to the whole lagoon. While it is reasonable to state that the lagoon, as a physical system, exhibits “equilibrium-seeking behavior” (i.e., it *tends* toward a persistent average condition over time), it is not reasonable to imply that equilibrium will actually be achieved. While it is apparent that the lagoon has existed for millennia, and that the mouth of the lagoon has not changed size in historical times, it is also apparent that the overall abundance of each geomorphic unit continues to either decrease or increase, without a “leveling-off” or asymptote being achieved. That the lagoon is a physical system tending toward an overall equilibrium between erosive and sedimentary forces does not mean that the equilibrium exists or will ever be achieved. The data show that no balance between sediment supply and demand has ever been achieved for the lagoon as a whole before some major perturbation, such as a major earthquake, tsunami, change in the rate of sea level rise, or change in land use interrupts the sedimentary processes.

We understand that some local habitat features, such as some tidal flats and the vegetated marsh plain of some tidal marshes, also exhibit dynamic equilibria.

But, unlike the lagoon mouth, these features do not comprise integral geomorphic units and in the aggregate they do not exhibit equilibrium.

Furthermore, while one can always average processes across any spatial or temporal gradient, such averaging tends to hide the variability that illustrates physical cause-and-effect relationships, and that drives a lot of ecological change. For example, the data help explain variations in sedimentation at different time scales. There is a shorter scale of days to years for variations in sedimentation driven by winds, tides, and land use. There is a longer time scale of decades to centuries that reveals the effects of sea level rise, changes in climate, and tectonic events, each of which can profoundly influence shorter term sedimentation patterns within the lagoon. Climate change is an important driver of sea level change that, in turn, can drastically alter wave energy and tides, which can alter sedimentation rates, especially within the near-shore (littoral) environment. Tectonic events are inherently unpredictable at the shorter time scales, yet can lead to dramatic and sudden alteration of short-term sedimentation patterns and rates. Long term effects of major tectonic events on the San Andreas Fault are large enough to be the major determinants of sedimentation rates, but they are predictable only in a general and probabilistic way.

- The concept of dynamic equilibrium is least applicable to the lagoon as an ecosystem. While there might be indicators for tracking “equilibrium-seeking behavior” for the physical system (i.e., the rate of change for the lagoon mouth or for total tidal prism), comparable indicators for the ecosystem are not obvious. One might consider total primary or secondary production, but the calculations would be fraught with huge uncertainties. Furthermore, the ecology of the lagoon is only partially attributable to the temporal and spatial variability in physical processes. At any given time in the evolutionary trajectory of the lagoon as a physical system, disease, biological invasions, and chance interactions among populations will help shape the communities of plants and animals. The well-documented plant invasions that affect the elevation and extent of Kent Island comprise one example of unpredictable ecological phenomena that prevent equilibrium for the ecosystem.
- The over-use and perhaps misuse of equilibrium concepts for the lagoon system as a whole affects the overall tone of the Administrative Draft report, which in turn can foster unrealistic public expectations. There is a psychological element associated with equilibrium and restoring equilibrium; equilibrium is easily interpreted as the natural state threatened by human activity. Acknowledging that the system is naturally variable, even if it expresses “equilibrium-seeking behavior” in the long-term, promotes a more realistic intellectual framework in which even occasional short-term closure is part of a natural range of conditions that the public might accept. The relationship of the lagoon to the San Andreas Fault demands and encourages this perspective; the public seems to generally accept the idea that in time lands on the west side of the lagoon will move far north of their present location; the equally well supported concept that the lagoon

is ever evolving within a broad range of natural conditions should be equally acceptable. The scientific evidence points to Bolinas Lagoon being a variable system, well adapted ecologically to respond to changes in sediment accumulation or erosion. By contrast, the equilibrium concept suggests a management or governance responsibility to reduce this variability by fighting nature: e.g., if the estuary is filling-in because of human actions, then we should be prepared to restore it to its natural state to compensate for our activities. To do so would ignore the evidence that human actions have had rather minor effects on the lagoon as a whole, and could cause ignorance of the negative consequences of the “restorative” actions themselves. We think it is more appropriate to characterize the Bolinas Lagoon system as being in “dynamic evolution” than in “dynamic equilibrium,” and that the rate of evolution for the system slows after a major perturbation. For example, it ought to be stated that the expansion of tidal flats and marshes will continue to slow until the next major earthquake, which will, at once, destroy some of them and jump-start their re-formation.

#### B. *Lagoon Sedimentation Rates*

The analysis of sedimentation rates is central to the entire study and warrants special attention in this review.

The Administrative Draft report states that the average rate of sedimentation can be calculated by comparing bathymetric surveys supervised by the USACE from 1968-1998. It's not clear, however, to what level of International Hydrographic Organization (IHO) accuracy standards these surveys were held. One might assume that they at least followed the USACE Hydrographic Surveying manual EM 1110-2-1003, which expects a resultant depth-sounding accuracy of +/- 0.5 ft for survey depths of 15 ft or less. This error would need to be figured into the possible range of bathymetric change, and this would mean that the error exceeds the estimate in at least some cases. Another factor that should be considered in determining survey accuracies is the USACE practice of establishing tidal datum control through the geodetic vertical network. This procedure must rely on computing the correct NGVD 29-MLLW offset for the survey area and establishing staff gauges in the vicinity that are leveled to geodetic bench marks, correcting for spatial time and range differences (tidal zoning) and adjusting for changes in Tidal Epochs. There is no evidence that this procedure was followed. Most importantly, there is no evidence in these reports that the elevations of the bench marks to which the surveys were related were valid, that is, still accurate. The lagoon and its environment are seismically active, and the integrity of any bench mark is therefore suspect. Finally, the analysis of shallow cores by Byrne et al. provides evidence that the bathymetric surveys for the north basin of the lagoon are not reliable.

The TRG previously asserted that the historical bathymetric surveys of Bolinas Lagoon should not be compared because they lack adequate vertical control. Unless the consultants can provide evidence that the aggregate error of the bathymetric surveys used to calculate sedimentation rates was less than the reported differences between the surveys, or unless

the survey data can be calibrated against an independent data set, then the surveys should not comprise the primary source of data about sedimentation rates.

The report by Byrne et al. provides a major and essential contribution to the understanding of the functioning of the Bolinas Lagoon sedimentary basin. Their report provides the strongest data on sedimentation rates. If the historical bathymetric surveys are valid, then they should yield results that are comparable to those reported by Byrne et al. It should be possible, for example, to use the survey data to back-calculate a mid-19<sup>th</sup> century rate of sedimentation that is comparable to the corresponding rate reported by Byrne et al.

Since Byrne et al. gathered data primarily in the North Basin, using their data to model overall changes in tidal prism requires a major assumption that their data pertain to the whole lagoon. This assumption might or might not be supported by future cores. If the data from Byrne et al. are used in this way, then a map should be prepared of the entire lagoon showing all the geological sampling locations in the context of the current geomorphic units identified in the Administrative Draft report. The authors of both reports might then consider adding caveats regarding the modeling of the lagoon based on these geographically limited sedimentation rates.

The report by Byrne et al. contains inconsistencies between text and figures that must be corrected. There are also concerns about their estimates of bioturbation depths, estimates of down-dropping during earthquakes, and the scant chronological control for the stratigraphic analyses among the many shallow cores based on their profiles of magnetic susceptibility. In each case, however, the methods of analysis seem appropriate and well-executed, and the adjustments in interpretation are unlikely to change the overall conclusions. In fact, the recommended adjustments, as previously provided by the TRG to the authors, would decrease the estimates of sedimentation rates, and thus bolster the conclusion that the lagoon is unlikely to close.

The conclusion that sedimentation rates are not adequate to cause the lagoon to close may have reduced the importance of knowing the sediment sources. However, knowing the sources and their relative contribution to the lagoon is essential to forecast how their management might affect the lagoon in the future. The knowledge of these sources gained by this study should influence any future decisions about land use around Bolinas Lagoon. The overall conclusion of the Administrative Draft report that watershed sources contribute less than half of the total input of sediment to the lagoon seems substantiated by the independent study of Holocene sediment sources by Byrne et al. However, the results in the Administrative Draft report could be better supported by further explanation of the methods and related assumptions for the watershed studies. It would be helpful to have a clearer image of how the watershed sources were assessed. Including a simple table of estimated sediment sources would assist the reader in this effort.

Additional explanation is needed for the analysis of watershed yields of sediment to support the findings presented in the Administrative Draft report. The description of the numerical modeling approach is too general for us to comment on its applicability to this system. The hydraulic modeling as described apparently does not take the size of material

into account, and it should, since this will determine the distribution of the sediment within various storage places from the creek channels to their deltas and the lagoon. Furthermore, there is scant evidence that the modeling was verified by field work. In short, the findings seem to depend heavily on modeling, but the models are not explained in enough detail to judge their efficacy. Perhaps these short comings are tolerable because the effect of watershed inputs on overall lagoon condition seem minor, but any future analysis of watershed yield, and any plans for creek restoration will need to be more comprehensive in approach and more thoroughly documented.

### *C. Forecasts of Physical Condition*

The effort to forecast changes in the average physical condition of the lagoon assumes that they would be caused mainly by changes in the lagoon mouth. We think this is a reasonable assumption based on multiple lines of evidence indicating that most of the sediment comes from outside the inlet, and given its obvious role in maintaining the tidal regime of the lagoon.

A relatively simple scoping model, the O'Brien model, has been used to predict how the lagoon mouth would respond to changes in the interplay between the tidal prism of the lagoon, which tends to keep the mouth open, and wave energy in the ocean, which tends to deposit sands in the lagoon mouth. This is essentially an application of the dynamic equilibrium concept that we agree pertains to the lagoon mouth. The only assumed change is a gradual decrease in the tidal prism due to further sedimentation in the lagoon, as evidenced in the reports by Byrne et al. and others. According to the model, if the tidal prism gets small enough, the lagoon will close.

We think the O'Brien model is appropriately used in this case. Implementing a more complex simulation model would cost much more, take longer, and would probably not yield any more credible predictions. The critical threshold value for the wave:tide stability parameter that indicates lagoon closure has been derived from studies of two other lagoons, the seasonal lagoon at the mouth of the Russian River and the restored lagoon at Crissy Field in San Francisco. The use of these data seems appropriate if issues of wave period and sediment type can be clarified (see second point in the paragraph immediately below). Confidence in the applicability of the O'Brien model to Bolinas Lagoon would be much increased by showing that changes in cross-sectional area of the mouth respond to changes in tide and wave conditions.

For the purpose of clarity and completeness, there are four aspects of this simple modeling approach that need to be better addressed in the Administrative Report. First, the model assumes that all waves are the same. The role of waves is actually a function of their period, or rather steepness. Short-period wind-waves tend to be erosive, while long-period ocean swells tend to deposit sand in the mouth, build beaches, etc. Second, the mouths of Bolinas Lagoon, Crissy Field and Russian River are exposed to very different directional wave spectra. Third, the uncertainty of the O'Brien model increases near the threshold values of tidal prism or mouth size that correspond to significant frictional energy loss,

which is ignored by the model. As closure begins, friction reduces the tidal prism, allowing for more sedimentation in the mouth that in turn increases friction and further reduces the tidal prism. This positive feedback can cause a tidal inlet to close rapidly once it crosses the threshold in size where the effects of friction can't be ignored. While it is unlikely that this threshold will be crossed in Bolinas Lagoon, it should be noted that the predictive abilities of the model decrease as the threshold is approached. The consultants should indicate that if the mouth starts to get smaller, the rate at which it decreases in size can increase, such that significant change may happen quickly. The system must therefore be monitored for early warning signs. Fourth, the stability criterion of the model depends on the mouth material. The coarseness of the sands in the mouth, and the presence of larger materials will affect how the mouth behaves. Again, the mouths of Crissy Field, Russian River, and Bolinas Lagoon have different sediments and one can expect different hydraulic radii leading to different critical values of the stability parameter.

We suggest that the models should be re-run using the sedimentation rates developed in collaboration with Byrne et al., following this review. We expect that the rates will be revised downward, such that the estimated likelihood of lagoon closure is further reduced, the existing conclusions will stand, and the figures and graphs of the report that are based on the unrevised sedimentation rates will still be appropriate.

No matter how precise the data or accurate the modeling, they cannot remove the inherent uncertainty of the Bolinas Lagoon system. The modeling results, as illustrated in the forecasts and snapshots of future conditions, either as graphs or maps, tend to imply more certainty in the future than exists. Sea level rise alone presents a very uncertain future for the lagoon. We therefore suggest that the authors plainly state in the beginning of the final reports, and repeat as necessary in later sections of the reports, that the illustrations are approximations of likely conditions, not exact indications.

We agree that all elevations of habitats should be referenced to both the local tidal datum and to NAVD88. However, there was no discussion in either report of how the NAVD88 or tidal elevations were determined. The final report must include a description of the method used to determine these elevations, and the accuracy of the determinations.

#### *D. Forecasts of Ecological Condition*

The ecosystem analysis does not contribute substantially to the explanation of sedimentation rates or their relationship to the likelihood of lagoon closure. There is too little agreement between these central issues and either the type of ecological analysis carried out or the data collected. The TRG previously recommended that the ecological data and analyses should emphasize the interactions among plants, animals, and lagoon morphology, in terms of sediment entrapment, wave energy reduction, sediment re-suspension, etc. Instead, the ecological work has focused on the possible effects of physical habitat changes on the distribution and abundance of selected populations of plants and animals.



Study plans called for using data about sediment quantity and grain size as causal variables to predict changes in the distribution and abundance of habitat types and communities. While the extensive tables and figures reporting species lists and distribution data could be useful as part of a baseline data set for monitoring future change, none of this information is explicitly linked to sediment characteristics. Such linkage could be made, and would help relate the ecological forecasts to the physical change forecasts.

The inclusion of special-status species in the ecological analysis is an example of considerable effort expended for limited results. Special status species apparently have not been a dominant determinant of management actions for the lagoon.

There are simply not enough data to address the possible effects of large-scale dredging on plant invasions and the recovery of eelgrass and Brant (a small coastal goose). These are speculative matters that cannot be resolved in the Administrative Report.

The most important results are the baseline map and the year 2050 projections, plus the maps of marsh expansion in the main text. Comparing Year 0 to Year 50 reveals some expansion of tidal marsh and low tidal flat. These results are not unreasonable, given the well-known natural histories of the plant and benthic animal populations involved.

In the final analysis, the contribution of the ecological analysis remains limited but clear. The habitat units are widely recognized and accepted, but the projected changes in them aren't large enough to be clearly detrimental, and no clearly beneficial changes would result from any action, such as large-scale dredging, to prevent lagoon closure. Because of its dependence on the forecast of physical changes, the ecological analysis cannot predict different consequences other than what physical changes are expected to cause. This does not mean that ecological changes due to other causes, including density-dependent and density-independent actions within and among populations, won't occur. In all likelihood they are occurring now and will continue to occur, but they are disregarded in this analysis of ecological response to physical habitat change. Future management of the lagoon would benefit greatly from ecological studies that reveal thresholds of habitat change that trigger measurable changes in key populations that, in turn, trigger management actions. But such studies would require much more time and funding than was available.

The greatest strength of the study is that all of its reports support the conclusion, to a greater or lesser degree, that the lagoon is unlikely to close and that dredging or any other action to prevent closure is not justified at this time. There is an absence of ecological problems that would be mitigated by such apparently unnecessary preventive actions. However, it is interesting to speculate on what might happen if the analysis were to be expanded to include the impacts of such actions, especially dredging. Manifold short-term negative impacts, such as the likely reduction in shore bird populations and disruption of the recently renewed Coho run in Pine Gulch Creek, and the disruption of current creek flows with their impacts on sediment deposition and removal would seem to strengthen the case against large-scale dredging. Presenting an assessment of the likely impacts of dredging or other actions should be considered for it would provide a broader framework within which to make decisions regarding monitoring and managing the lagoon.

### E. *Monitoring*

We strongly agree that a program of empirical observation is needed to warn of any unexpected changes in the lagoon, and we generally agree with the monitoring recommendations included in the Administrative Draft report. We caution against collecting any data that aren't essential to track trends in tidal prism of the lagoon and volume of the lagoon entrance, however. Monitoring is expensive, and there must be clear and anticipated value for any monitoring data gathered in the future.

We think that tidal range inside the lagoon is the single most important factor to monitor. It is the most cost-effective indicator of an overall change in the physical condition of the lagoon. In theory, changes in cross-section of the lagoon mouth might provide an earlier warning of potential problems. But cross-sections of lagoon entrances can be highly variable over short periods and thus many surveys may be needed to discern evolutionary trends from natural variability. We therefore suggest that the monitoring program start by installing long-term tide gauges, one at the lagoon entrance and one inside the lagoon, referenced to a basic geodetic network of bench marks whose NAVD88 elevations are published by the National Geodetic Survey. Once these are in place, periodic LIDAR or standard ground-based surveys should be able to accurately detect significant topographic changes and concomitant changes in tidal prism. We are aware that the MCOSD has been pursuing the establishment of the geodetic bench mark network and tide gauges. We are also aware that the observations made of the network of geodetic bench marks established earlier this year did not meet federal standards. It is essential that the bench marks be re-occupied with better quality GPS equipment to correct this deficiency, and that the tide gauges be installed according to federal standards.

The modeling effort suggests that some hydrological measurements should be made concurrently inside and outside the lagoon. If tidal levels in the lagoon and wind-waves outside the lagoon are monitored together, then a change in the stability index for the lagoon mouth could be detected. This warning could precede a change in tidal prism. Data on ocean swells are already available from the Coastal Data Information Program (CDIP), but local observation of wind-waves would have to be initiated. If tide heights are monitored inside and outside the lagoon, then the tidal ranges that bracket the lagoon mouth could be compared to obtain indices of sill heights at the mouth and, more importantly, to assess frictional loss of energy at the mouth (providing a warning if the no-friction assumption of the O'Brien model is violated).

A critical aspect of monitoring that was not addressed in either report is the interpretation of the monitoring data. We strongly recommend that the managers of the lagoon identify a neutral party to collect and interpret the data in the context of the managers' questions and objectives. We caution against any liberal interpretation of the monitoring results as triggers for dredging. The interpretation must be conservative and based on a number of consecutive years of clear indications of a developing problem. Local stewardship of the program should be considered.

### III. Specific Comments

The following comments pertain to the statements of conclusions in Section II of the Administrative draft report. The comments are referenced by number to the statements.

1. Add tectonics and land use.
2. Remove reference to dynamic equilibrium (see general comments above).
3. Replace “punctuated” with “reset.”
- 4,5. Indicate more clearly that hydrology affects morphology, which in turn affects hydrology, and that plants and animals invade, colonize, inhabit and influence the resulting landforms.
6. Remove reference to dynamic equilibrium (see general comments above) and simply state that the system has been persistently fully tidal since the previous great earthquake.
7. Add land development (housing, harbors, hardening of the spit, etc.).
8. Rectify these values against those provided by Byrne et al.
9. De-emphasize the notion of environmental or system “balance.”
10. Rectify these values against those provided by Byrne et al., and report ranges that reflect the uncertainty of the estimates.
11. Rectify these values against those provided by Byrne et al., report ranges that reflect the uncertainty of the estimates, but note that a future decrease in sedimentation rate is expected.
12. Note that the various sediment sources vary in importance around the system, with watershed sources contributing mostly to peripheral changes.
13. Note that aggradation of the deltas do not contribute much to prism change.
14. Be consistent with #12; sediments from the bluff can at least sometimes dominate beach sands.
15. Remove reference to dynamic equilibrium (see general comments above).
16. Note that Bolinas Channel may have enlarged during the 1906 earthquake.
17. Omit reference to equilibrium. Consider that strong winds that occur from SE during major storms can reduce the value of the Delta as protection against waves; Kent Island may provide more protection at these times.
18. Remove reference to dynamic equilibrium (see general comments above).
19. See # 14 and #12 above.
- 20, 21. Consider the perspective that most of watershed yield is trapped on the delta and thus contributes little to prism change.
22. See # 17 above.

23. See #16 above. Consider that Bolinas Channel has progressively shifted south since the 1906 earthquake, while it has shoaled and narrowed, but that another earthquake might re-open the channel.
24. Remove reference to dynamic equilibrium (see general comments above), and consider importance of lesser or no subsidence on west side of lagoon.
25. Consider that the data on land use suggest that the sediment supply from local watersheds will decrease as they recovers from logging, intensive grazing, etc.
26. Note that this is a moderate estimate for the future rate of sea level rise.
27. State clearly that it is unlikely that the lagoon mouth will close.
28. This usage of the equilibrium concept is appropriate.
29. Consider stating “probably will occur” – the existing statement seems too certain given that the supply of sediment might decrease (see # 25 above).
30. No comment.
31. State that the decline in eel grass is not explained by the data collected for this study.
32. Consider that the sediment supply from Bolinas bluffs and from the local watersheds may decrease while sea level rises, and report prism estimates in ranges that reflect their uncertainty.
33. Data do not clearly support this statement. Consider that overall species diversity might actually increase during habitat evolution because of succession, invasion, plus persistence of refugial populations.

#### **IV. Summary of TRG Major Conclusions and Recommendations**

The following summaries are derived directly from the text of Sections 1 and II above.

- A. The TRG finds reasonable the approach and conclusions of this study - specifically that the lagoon mouth is unlikely to close and that the overall ecology of the lagoon is unlikely to change in the foreseeable future. The final study report should plainly state these findings.
- B. The differences in system behavior between the east and west sides of the San Andreas Fault should be discussed more fully, since they help explain why the tidal inlet is unlikely to close despite the visible sedimentation on the west side.
- C. The final reports from the different consultants must agree with each other on the details about the relative roles of natural history and human history on shaping the lagoon, on sediment sources and net sedimentation rates, on the role of extreme events, and on the applicability of equilibrium concepts. The report by Byrne et al. provides the most credible data about sedimentation rates.

- D. While the concept of dynamic equilibrium pertains to the lagoon mouth, it does not pertain to the entire lagoon as a physical system or as an ecosystem. For the lagoon as a whole, a term such as “dynamic evolution” is more appropriate than the term dynamic equilibrium.
- E. The methods of modeling and analyzing watershed processes including especially sediment yield should be explained well enough to support the argument that local watersheds are not a very important source of sediment for the lagoon.
- F. While the modeling effort to predict behavior of the lagoon mouth is reasonable and appropriate, the assumptions of the model and its basic limitations should be further explained.
- G. To be relevant to the central topic of sedimentation in the lagoon, the ecological forecasts should focus more on the expected interactions between sedimentation, vegetation, and tidal regime. Vegetation should be regarded as a component of the physical structure of the lagoon as well as habitat.
- H. The findings of the reports should be further summarized into a short narrative that tell the story of lagoon evolution and culminates with the basic finding that the lagoon is unlikely to close in the foreseeable future.
- I. Monitoring should emphasize early detection of net changes in the size of the lagoon mouth. The essential data are tide heights inside and outside the lagoon, referenced to geodetic bench marks, according to federal standards.
- J. The essential steps in adaptive management that lead from formulating management objectives, through collecting and interpreting data, to management actions and refining the objectives should be outlined. The consultants should state the need to identify who will collect and manage the monitoring data, who will interpret them in the context of the management goals and objectives, and who will be responsible for any needed management actions.

## **Response to TRG Comments dated 10 JAN 2006 on Administrative Draft (7 DEC 2005)**

The thoughtful insight and review by the Bolinas Lagoon Technical Review Group (TRG) is greatly appreciated. Their comments have led to several revisions, as described below, and improved the quality of the report.

TRG comments were provided in detail and summarized in Section IV of their 10 January 2006 document. The paragraphs below are our response to the central issues outlined in their General Comments (Section II).

### *1. The Administrative Draft is unduly complicated.*

We have acted on several TRG suggestions in order to clarify the central messages of the report. Specific changes included the following:

- Inserting figures into the main body of the report.
- Adding a concise summary of essential findings before the list of specific conclusions.
- The list of specific comments was slightly edited to increase the clarity of the bullets. However, as mentioned below, we have retained the use of punctuated dynamic equilibrium as a useful intellectual framework.

### *2. Findings from Byrne et al. are not well integrated.*

The Administrative Draft report did not integrate all of the UCB findings, mostly because the Byrne et al. report was not finalized until after 7 Dec. We have now reviewed the complete UCB report and made the following changes:

- Added a section on the role of large earthquakes
- Created a figure showing UCB core locations on top of our Year 0 geomorphic units.
- Cited the late Holocene sedimentation rates report from the two long-cores.
- Cited the mineralogy of the North Basin sediments & their likely origin (bluff-eroded silt)
- Cited the evidence of *Cerithidea californica* shells as evidence of intertidal habitats in the mid 19<sup>th</sup> century. (This generally confirms our interpretation of the 1854 T-sheet.)
- Cited apparent evidence of the 1700 tsunami (or Little Ice Age?).

There appears to have been confusion regarding how we used the Byrne et al. sedimentation rates, and those based on the 1968-98 surface models. This is described in more detail below. Generally, our projections of future morphology in the North Basin were already established by applying the post-1906 sedimentation rates derived by Byrne et al. (As discussed below, the use of the 1968-98 surface models in establishing future change was limited to the Pine Gulch Creek delta – an area not covered by the UCB cores.)

### *3. The concept of dynamic equilibrium is overly applied.*

We have edited the report to emphasize geomorphic evolutionary trajectories and the role of major earthquakes in resetting the lagoons evolution. We agree that ‘equilibrium seeking behavior’ describes the evolution of individual geomorphic units and key attributes of the whole lagoon. However, use of this terminology inevitably poses the question in the public mind –“what equilibrium?” We have therefore continued to describe ‘dynamic equilibrium’ as a conceptual end

state while acknowledging that because of re-adjustment after major tectonic events the lagoon may have never achieved it.

We believe this discussion of the appropriateness of defining dynamic equilibrium to be very important in interpreting the future of the lagoon. Our conceptual model of the lagoon is that it is a self-organizing sedimentary estuarine form that persists due to the balance between sedimentation, and the creation of 'accommodation space', both from continual sea level rise and from infrequent episodic tectonic subsidence events. In projecting an equilibrium form we have evaluated how the lagoon morphology would adjust over the next few centuries in response only to projected sea level rise. We find that this projected morphology and associated tidal prism—the asymptote of the evolutionary trajectory, does equilibrate as a fully tidal system. In other words, the lagoon does not require another major earthquake within the next few centuries to persist as a tidal system. The role of these earthquakes is to punctuate the dynamic equilibrium state, reinitiating evolutionary trajectories that converge on a particular estuarine morphology, which is in turn changing over time.

We did not intend to imply that the ecosystem is in dynamic equilibrium. Our discussion above, and the use of dynamic equilibrium in the report, is restricted to physical morphology.

#### 4. *Lagoon sedimentation rates.*

There appears to have been confusion regarding our use of net sedimentation rates derived from recent core analysis (Byrne et al, 2005) and that from the 1968-98 bathymetric surveys. In general, we projected future morphology by: (1) assessing planform changes to each geomorphic unit; (2) modifying specific points along the hypsometric curve based on these planimetric changes; and (3) graphically integrating the difference between the Year 0 and Year 50 hypsometric curves. Note, that we did *not* apply one gross sedimentation rate to project future lagoon morphology or tidal prism.

The TRG recommends we apply the recently developed net sedimentation rates from Byrne et al. in our models of future morphologic change. This was done to our approach in the North Basin to project changes in the subtidal shallows and mudflats. (The post-1906 Byrne rate was adjusted for accelerated sea level rise and multiplied by mudflat slopes to determine lateral changes to high/low mudflats.) The sedimentation rate applied to subtidal shallows and mudflats in the South Arm (from Macdonald and Byrne) is very similar to the post-1906 rate in the North Basin (6 mm/yr vs. 6.8 mm/yr).

We have revised the report such that the post-1906 rate of sediment accumulation is now based solely on extrapolating the average rate from Byrne et al (6.8 mm/yr). This leads to an average sediment accumulation rate of 43,000 CY/yr (as opposed to 45, 000 CY/yr in the draft report – a median value between the rates derived from extrapolating the UCB data and applying the surface models).

We have used the 1850-1906 and post-1906 rates from Byrne et al. to estimate late-19<sup>th</sup> century tidal prism changes and explain 20<sup>th</sup> century tidal prism losses, respectively. Since Byrne measured net sedimentation, these rates cannot be applied to compute tidal prism changes (subtidal deposition does not affect tidal prism). However, as noted in the report, the extrapolated Byrne rates are consistent with the 20<sup>th</sup> century tidal prism losses established from inspecting the 1929 T-sheet and 1968-98 GIS models (ie., our estimate of 20<sup>th</sup> century tidal prism loss is ~80% of sediment accumulation ).

Specifically, the use of the 1968-98 GIS models were limited to:

- Help explain the late-20<sup>th</sup> century rate of tidal prism loss. (Specifically, we plotted the 1998 and 1968 tidal prism values based on the surface models. The rates of tidal prism loss are in

general agreement with the 1929 T-sheet and what would be expected from extrapolating the UCB data. We've added an appendix summarizing these computations.) As noted above, this hindcast derived from the surface models was *not* applied to project future tidal prism change.

- Confirm that the rate of watershed delivery from Pine Gulch Creek with values computed from rating curves, bedload transport modeling, and watershed yield.
- Project radial extension of the Pine Gulch Creek. We applied the volumetric accumulation rate, established from the 1968-98 TINS, to half-cone equations in order to assess radial progradation. This is the only instance in which results from the 1968-98 surveys were used to project future change.

Although use of the data from the 1968-98 TINS was limited, we have added a short description of the benchmark re-surveys to address potential errors in their reported elevations (Appendix B). In addition to the re-survey of the NOS benchmark on Wharf Road, PWA performed a level loop to Caltrans benchmark along Highway 1. Once the original NGVD elevations of both benchmarks were compared to the revised NAVD elevations (VERTCON was used for NGVD/NAVD datum conversions), we observed only a 0.07-0.08 ft change in elevation. These changes were well below the +/- 0.25 ft range used to assign probably error bars to the 1968 and 1998 tidal prism values.

#### 5. *Forecast of physical conditions*

- a. Inlet closure. At the suggestion of the TRG, we have qualified the O'Brien analysis by stating its limitations more clearly. We have also included a short discussion of how closure could occur rapidly if the inlet enters a 'friction-dominated' regime.
- b. Lagoon morphology. As noted above, the use of the 1968-98 GIS models in our future projections of lagoon morphology were limited to Pine Gulch Creek. We believe this is valid because: (1) the 1968-98 rate of volume accumulation on the delta matches our estimate of watershed delivery from this creek; (2) data in Byrne et al. are derived from cores taken outside of the Pine Gulch Creek delta and do not account for the fluvial processes that form this feature.

#### 6. *Monitoring*

Given the significance of an open inlet on the lagoon's ecology, and the uncertainties associated with the inlet stability analysis, we believe it is prudent to monitoring for change in closure potential. We agree that the most obvious indicator would be tidal monitoring. (Long-term tidal monitoring would also help establish more precise tidal datums.)

In addition to tidal monitoring, we believe that monitoring along select mudflat transects is also prudent. This would confirm our hypothesis that locally generated wind waves will keep mudflat elevations below colonization elevation in exposed areas. We believe the balance between erosive wind waves and depositional processes are important in determining mudflat elevation between earthquakes.

Based on comments from the PRAG, we have added more elements to the biological monitoring program.



NOTE: In the process of working to increase consistency with the Byrne et al. data, we revised our estimates of 1854 & 1929 tidal prism. The revised values are based on an equation we feel is more appropriate (the volume between two conic sections) and are summarized in Appendix B. These revisions have led to smaller historic values, and are more consistent with the (generally) similar distribution of mudflat/marsh in 1854 and Year 0.

## **Response to PRAG Comments**

**Gary Page (PRAG member)**

**Comments on Administrative Draft: Bolinas Lagoon Ecosystem Restoration Project**

Three areas where the draft report could be improved are the summarization of information on potential human effects to the lagoon's current and future status, more detailed information on the invertebrates, fish and birds likely to be affected by the habitat changes, and a clearer rationale for the proposed adaptive management plan.

**Summarization of information on potential human affects on the lagoon's current and future conditions.**

The summary is not clear as to the potential affects of human activities on changes in lagoon morphology and tidal prism. This information should be summarized carefully to enable the public to understand the human impact. Here are some suggestions for the Conclusions based on points presented throughout the report.

**RESPONSE:** We have re-written many of the specific conclusions to make the message more clear. Also, we have added a concise (1-page) summary of key findings at the very beginning of Section 2.

Making Points 8-10 more specific:

**1854-1906**

8. At the time of the first bathometric surveys in 1854 the morphology of Bolinas Lagoon appears to have been in dynamic equilibrium with sea level rise offsetting sedimentation. The tidal prism (definition) of approximately 4.2 million cubic yards (MCY) was sufficient to keep the inlet open under the most extreme wave and tidal conditions. Subsequently, logging, grazing and other landscape changes increased sediment delivery to the North Basin reducing tidal prism by 0.5 MCY to about 3.7 MCY at the time of the large earthquake on the San Andreas Fault in 1906.

**RESPONSE:** We have revised the estimates of tidal prism based on the 1854 and 1929 T-sheets, by using an equation we think is more accurate (see Appendix B). This has reduced the 1854 estimated tidal prism to 3.7.

9. The 1906 earthquake was responsible for a sudden 3.7 MCY increase in tidal prism to 7.2 MCY through subsidence of the rock underlying the lagoon. **Would it have been 7.7 MCY if there had been no anthropogenic affect between 1854 and 1906?**

**RESPONSE:** We believe the amount of tidal prism increase is mostly related to the magnitude and nature of individual earthquakes. The sediment texture (grain size) and depth is also likely important in that dynamic compaction occurs along with vertical displacement. In general, we do not believe the 1906 down-drop, and hence tidal prism increase, would have been substantially different without 1854-1906 anthropogenic effects.

It would further help to summarize points 11-24 very succinctly to enable the public to easily understand how natural and human factors may have altered the lagoon from 1906 to present.

RESPONSE: Some of these have been re-worded. As noted above, we have also included a concise narrative before the list of specific comments.

Here are the main points I got from your report:

1906 to Present

Since 1906, natural process and human activities have resulted in net sedimentation in the lagoon and a reduction in tidal prism of about 3.7 MCY to about 3.5 MCY today. **Can this 3.7 MCY loss be partitioned between anthropogenic and natural forces? Can you estimate what the tidal prism would be today had there been no anthropogenic affect between 1854 and 1906?**

RESPONSE: As noted above, we have revised our estimates of historic tidal prism based on re-computing the values derived from T-sheets.

It is not possible to say precisely what the 'natural' form of the lagoon should be today, since large earthquakes like the 1906 event significantly alter the lagoon form and channel network, particularly near the inlet. However, we have developed estimates of how much tidal prism has been lost due to the two most direct anthropogenic modifications: Seadrift Lagoon and channelization of Pine Gulch Creek.

10a. The sudden down drop of the lagoon floor during the 1906 earthquake greatly increased the tidal prism and the amount of sandy sediment swept in through the lagoon mouth and deposited in the interior.

RESPONSE: As noted by Byrne, much of the littoral sediment is bluff-eroded silt. Coarser beach sands mostly deposit on flood-tide shoals and islands closer to the inlet.

10b. Human actions in the watershed and channelization of Pine Gulch Creek caused the Pine Gulch delta to extend into Bolinas Lagoon. Creek bed channelization eliminated flood plain sedimentation which in turn increased the rate at which gravel and coarse sand from the Pine Gulch Creek watershed deposited in Bolinas Lagoon. Similar deltas formed near the mouths of steep creeks that drain Bolinas Ridge but their effect on lagoon tidal prism and habitats was much less than those of the Pine Gulch Creek watershed.

10c. The growth of Pine Gulch Creek delta into the lagoon and its colonization by tall dense riparian vegetation altered wind patterns. The result was the development of an

area sheltered from turbulent waves between Pine Gulch delta and Kent Island which in turn allowed mudflats there to be colonized by salt marsh.

10d. The sedimentation between Kent Island and Pine Gulch also filled in the head of Bolinas Channel, thereby reducing the ability of tidal scour to maintain a large channel. The connection between Bolinas Channel and Pine Gulch Creek was eliminated as the head of the Kent Island Channel filled in and the mouth of Pine Gulch Creek migrated north. **Doesn't this result in decreased ability of the lagoon to flush sediment coming in from Pine Gulch Creek? If so, in the future would the relative balance of sediment accumulation between fluvial and littoral sources shift toward the fluvial?**

**RESPONSE:** Much of the coarse watershed is deposited on the fluvial deltas near the mouth of Pine Gulch Creek. This sediment would not of been transported out of the lagoon even if the head of Bolinas Channel had not filled with material. It is difficult to say if the smaller Bolinas Channel means less alluvium is removed. However, it is clear that segregating Bolinas Channel from other portions of the lagoon will reduce its cross-sectional area and depth, since the tidal scour will diminish.

10e. Fill was placed in the lagoon, particularly during the development of the Seadrift sandspit.

2000-2005

In 50 years we project a further loss of 1.2 MCY of tidal prism to 2.5 MCY compared with the estimated 4.2 MCY in 1854. Since sedimentation will still be outpacing sea level rise, the lagoon will still be filling in but the lagoon inlet will only be subject to closure under extreme combinations of strong El Nino storms and weak neep tides. The net loss of 1.7 MCY of tidal prism from 1854-2005 can be attributed to human activities directly and indirectly as follows (see Table 6.3):

- 0.30 MCY -- fill associated with the Seadrift development.
- 0.10 MCY -- fill placed elsewhere in the lagoon, especially along Highway 1.
- 0.25 MCY -- increased creek bed load delivery.
- 0.25 MCY -- reduced wind wave action between Pine Gulch Creek and Kent Island
- 0.80 MCY -- affect on wind fetch and resulting waves from Pine Gulch Delta protrusion and construction of Seadrift Seawall

**Note:** The last two bullet points are difficult to understand. These bullet points are derived from table 6.3.

**RESPONSE:** Project 50-yr tidal prism loss is ~ 1MCY. Note: We have revised our estimates of 1854 tidal prism, and this has affected the findings presented in Table 6.3 of the administrative draft. See new table. Also, note that the 0.3 MCY associated with Seadrift Lagoon is the long-term loss. Approximately half of this was temporarily offset

by dredging a ‘borrow’ channel along the outboard side of the newly constructed dike (portions of this borrow channel are still present).

Associated with loss of tidal prism will come changes in the composition of subtidal, intertidal and super tidal habitats over the next 50 years. Apparently the eelgrass beds in subtidal habitat of the Bolinas Channel have already disappeared. Future habitat changes in are listed in table 6.1 and summarized below:

- No change in extent of flood tide shoals inside the lagoon entrance.
- No change in the size of the flood tide island (Kent Island).
- Loss of 2 acres of the current 171 acres of subtidal channel.
- Loss of all 27 acres of current subtidal shallow ponded habitat.
- Loss of 106 acres of the current 399 acres of frequently submerged mudflat.
- Increase of 63 acres to the current 264 acres of frequently emerged unvegetated mudflat.
- Net loss of 43 acres of mudflat (combining frequently and infrequently submerged).
- Increase of 44 acres to 244 acres of salt marsh.
- Increase from 3 to 5 acres of brackish marsh.
- Increase from 30 to 54 acres of creek delta.
- Increase from 5 to 6 acres of transitional habitat.

The numbers of acres lost do not tell the whole story with regard to level of impact. There should be some way to rate habitat as to importance to estuarine dependent fish and for marine fish.

**RESPONSE:** See TRG comments regarding importance of projected morphologic change on ecology.

**Is there any way to calculate the habitat changes from 1854-2050? The tidal prism changes are related to 1854 but the habitat changes are related to 2000.**

**RESPONSE:** Fewer habitat types are listed in the 1854 T-sheet (e.g, intertidal flats are not differentiated by “typically submerged” or “typically exposed”). However, we have listed the acres of marsh, intertidal flats, and subtidal channel in the 1854 T-sheet (see Appendix B).

**Need more specific information on the invertebrates, fish and birds likely to be affected by the potential habitat changes**

Compared to the detail presented on tidal prism changes and habitat changes summarized above, there is only very general information on the organisms likely to be affected by the habitat changes. More detail should be presented.

Invertebrates

Table 5.1 lists 99 invertebrates documented for Bolinas Lagoon. The tidal zone in which they occur is also listed. It is probably reasonable to expect the 34 species (includes Washington Clam) identified as using the mid and low tide habitats or just low tide habitats as losing habitat over the next 50 years. This is a third of the listed invertebrates. Notable among these species are Fat Innkeeper worm, Rock Crab, Blue Mud Shrimp, Soft shelled Clam, Geoduck, Washington Clam, and Gaper. The Washington Clam is probably already gone and the beds of Gaper Clams greatly reduced in extent.

**RESPONSE:** We agree that many invertebrates will lose habitat over the next 50 years; however, species-specific impacts were not discussed due to the large-scale focus of the document. The report was modified to reflect the fact that the species mentioned in the comment will lose habitat.

## Fish

Table 5.2 lists 38 species of fish identified in the lagoon. Tom Moore of Dept. of Fish and Game has done the most recent sampling of fish in the lagoon. Here are his comments on fish in the lagoon.

**“I went back to our fish survey data to try and pull out more gear-specific species composition. I looked at our trawl data as basically sampling the subtidal channel habitat. Our catch data from the beach seine and stick seine represented the subtidal shallow and frequently submerged habitat species composition.**

**There is an amount of crossover of species captured by all the gears and thus utilizing all the habitats, such as schooling plantivores like topsmelt and jack smelt. We typically did our survey work on days with tides in the mid-range (3-4 ft) which meant that subtidal-shallow and freq. submerged mudflats were flooded and species that utilized these habitats should have been present ( just not enough time and too much current to effectively sample a number of areas on just the high). If I had the time and personnel, I would focus on just high tide collection in shallower habitats for a more representative sample.**

**Most fish captured in the subtidal shallow and frequently submerged mudflats were small benthic oriented fishes, both small fish and small (juvenile) fish utilizing this area as nursery grounds ( have to discount the large bat rays and leopard sharks that forage here on high tides but that is another aspect/use of these habitats). I see this as particularly insidious loss because this is the largest area of loss in all the coastal areas from development and sedimentation.**

**One of the things about Bolinas Lagoon subtidal channel habitat is the lack of fringing eelgrass and any subtidal eelgrass that would afford cover for fish in higher habitats as tide drops. So, as their habitat diminishes in Bolinas lagoon, unlike other more typical coastal areas, their mortality rate will increase due to this lack of cover/complex habitat (that’s why I am pushing for native oyster restoration or eelgrass restoration).**

**Species that will be impacted the greatest belong to benthic-oriented (eco guild) fish, typically juvenile life stages but not always. They would include:**

**Flatfishes- speckled sanddab, English sole, starry flounder, California Halibut**

**Roundfishes- Pacific staghorn sculpin (dominant by number) and others; arrow goby, yellowfin goby (exotic), and others; cabezon; shiner, walleye, dwarf, and barred surfperch, juvenile rockfish spp.**

**Sharks and rays- leopard shark and bat ray, bottom feeders on inverts in those habitats.**

**Invertebrates- shrimps, *Crangon* spp. and *Heptacarpus* spp. are important prey items for fishes and others that utilize these habitats. Crabs- Dungeness, red rock, slender, Oregon cancer crab, and green crab (exotic); usually small juvenile sizes in these habitats.**

**Schooling plantivores (eco guild) not as impacted as benthic-oriented fishes but will suffer with loss of access to this habitat- jacksmelt, topsmelt, and surfsmelt. Pacific herring, PWA report mentions Pacific herring with more emphasis than warranted since I believe they are substrate-limited in Bolinas Lagoon with regard to spawning habitat but I believe the juveniles (most likely entrained into Bolinas Lagoon similar to Bodega Bay) utilize these habitats.**

**RESPONSE:** We agree that many fish species, which use habitats within the lagoon at various life stages, will lose habitat over the next 50 years; however, species-specific impacts were not discussed due to the large-scale focus of the document. Text was added to the report to address the fact that fish will likely be impacted by changes in the lagoon's habitats.

Birds

Habitat changes will affect the habitat potential for many bird species.

Birds Facing Potential Habitat Losses

1. Diving fish-eating birds: examples are Common Loon, Double-crested Cormorant, Brown Pelican, Western Grebe, Osprey, Red-breasted Merganser, Elegant Tern, Caspian Tern, and Forsters Tern.
2. Diving benthos feeders: examples are Horned Grebe, Greater Scaup, Ruddy Duck, Common Goldeneye, Bufflehead, and Surf Scoter
3. Dabbling benthos feeders exploiting frequently submerged tidal flat: examples are Northern Pintail, American Wigeon, Northern Shoveler, and Gadwall.



4. Long-legged shorebirds exploiting frequently submerged tidal flats: examples are Marbled Godwit and American Avocet

#### Species Facing Potential Habitat Trade-offs.

1. Loss of frequently submerged habitat may be offset by increase in frequently emerged tidal flat and/or salt marsh: examples are Long-billed Curlew, Whimbrel and Green-winged Teal.

#### Species Facing Potential Habitat Gains

1. Shorebirds using frequently exposed intertidal habitat: examples are Black-bellied Plover, Least Sandpiper, Western Sandpiper, Dunlin, Sanderling, Black Turnstone, and Willet.
2. Species relying on salt marsh: examples are Savannah Sparrow.
3. Species relying on brackish marsh: examples are Black Rail, Common Yellow throat and Marsh Wren.

RESPONSE: Like other groups and guilds, there will be gradual shifts in bird community structure as habitat gains and losses occur. To address large scale changes, we did not address all species in the report. In response to the comment, some of the species mentioned were added to the text to illustrate impacts of gradual habitat change on feeding guilds.

#### **Proposed adaptive management plan**

The proposed adaptive management plan will appear to most people as the main conclusion drawn from the report. It will be viewed negatively by some as just more study.

The function of the proposed adaptive management study is not clear. Some monitoring is proposed to see if the future hydrological and sedimentation projection rates are correct. Since no decision has been made on whether the changes projected in this report are acceptable and require some intervention, proposing studies to measure the accuracy of the projections, does not answer the key question of when intervention is warranted.

RESPONSE: We agree that open-ended monitoring is not appropriate. Instead, we have recommended (and prioritized) monitoring focused at managing key uncertainties. The first is inlet closure. Based on the limitations of the O'Brien analysis and the potential ecological consequences of closure, we think it is prudent to track inlet closure potential. Also, as stated in the report, the exact balance between erosive and depositional processes over the mudflats is unclear. Collected elevation information at selected transects would provide useful information regarding how stable mudflat platforms are in wind-swept portions of Bolinas Lagoon.

What actions, if any, should be taken now to arrest the rate of some of the predicted changes to the functioning and habitat composition of the lagoon? If some actions are proposed and implemented then monitoring should be conducted to measure their effectiveness. If no actions are taken future monitoring will not be adaptive unless triggers are set for actions based on some criteria. Right now we don't know if the current study should trigger actions.

**RESPONSE:** We agree that this monitoring will not lead to adaptive management decisions unless triggers are established. We suggest that the new findings from the UC Berkeley study and this report be used to revisit, and possibly revise, the goals and objectives that would be the basis for indicators and triggers.

The biological section on monitoring argues for certain indicator species and emphasizes locally nesting herons and egrets over migratory birds indicating factors outside the lagoon can affect local migratory bird abundance. While this is true, it is also true that factors such as predation can affect colony nesting birds such as heron and egret rookeries causing them to move. I would argue that biological monitoring should look at communities of invertebrates, fish and birds.

**RESPONSE:** Based on this comment and those received from DFG, we recommend monitoring be conducted for invertebrates, fish, and birds.

**Tom Moore (PRAG member)**

**Comments on Administrative Draft: Bolinas Lagoon Ecosystem Restoration Project**

The PWA report is first and foremost a technical document dealing with the physical aspects, the geomorphology and hydrology, and secondly, the ecological aspects in a 50-year projection. The quantity and quality of physical data are impressive, especially compared to the biological data. In trying to stay in my realm (fish and their habitats) I felt that I didn't have a lot of real data to work with. Many of my questions, such as those on eelgrass, probably can't be answered by this report.

What is clear to me is that Bolinas Lagoon is quite different than other local coastal embayments in a number of respects. I was struck by the lack of complex intertidal and subtidal habitat. By this I mean, there was (1992) very little subtidal vegetation (eelgrass or algae) and other rocky intertidal or subtidal habitat. In our fish surveys in the lagoon we used otter trawl, beach seine, stick seine and crab traps to survey the lagoon habitat types. Two distinct areas had the highest species numbers of species, the Bolinas Channel (Kent Island Channel?) and the intertidal/subtidal area on inside of the east side of the inlet. Bolinas Channel had eelgrass beds and the area inside the inlet had a rocky bottom with some algal cover. The unvegetated mudflats and sandy channels did not support this type of species diversity.

- Why did Bolinas only have a very small amount of eelgrass when other local estuaries have relatively large and healthy eelgrass resources?

RESPONSE: Not known. It may have been absent in the late 1850s when the lagoon was primarily shallow mudflat with subtidal channels similar to today. The 1906 opened up the tidal prism and there was significantly more deep water habitat. Eelgrass may have colonized the lagoon, but as sedimentation has decreased tidal prism and the amount of deeper water habitat, the eel grass no longer occurs.

- And why only in the Bolinas Channel? I don't mean to fixate on the Bolinas Channel but it supported the only eelgrass bed in the lagoon and had the highest fish species diversity also, and now the eelgrass is almost gone and it seems, so is Bolinas Channel.

RESPONSE: Not known.

- I may have missed it, but I really couldn't find any information on how important the Bolinas Channel is to the tidal prism and lagoon functioning and what will it look like in the future. Ecologically, I know it was a unique and valuable habitat in the lagoon and supported a diverse assemblage of fish in a number of life-stages.

RESPONSE: See top of page 72. It will continue to decrease in size as tidal marsh expansion between Kent Island and the Delta limits the daily flow of ebb and flood tides.

To me, the rapid erosion of the eelgrass beds and the simultaneous filling of the channel in just 10 years or so, bring home the message that change can be quick in the Lagoon.

- What was the threshold or key environmental event that led to this?
- Was this a redistribution of Lagoon sediments or input from outside?

RESPONSE: The expansion of Pine Gulch Creek delta and the expansion of tidal marsh between Kent Island and the Delta has constricted the channel. Rather than a major connection to the northern part of the lagoon, the channel is constricted and will drain the tidal marsh resulting in less tidal scour with subsequent sedimentation and decline in size and function.

In Section 6.9.1 of the Draft, Expected Shifts in Habitat Dist. And Abundance,

Subtidal Channel- Subtidal channel is said to represent about 15% of the total area of the lagoon and will have a very small decrease of only about 2 acres over 50 years.

- In many other local bays, a small change such as this would be OK since most subtidal channels are fringed with eelgrass. In Bolinas Lagoon, the loss of the highest-value subtidal channel habitat with fringing eelgrass just happened in Bolinas Channel and is still occurring.

RESPONSE: Noted.

Subtidal Shallow- The text states that this is a small area (2.3%) of the total area and is used as a nursery area (as is subtidal channel). Text states that there will be loss of habitat to benthic flatfish species and invertebrates and that small fish utilizing it as a nursery area will move into other areas

- While small in area, this is another valuable habitat loss that will impact multiple species, at different life stages, and an important prey-base. There is a reason all the animals are using this habitat.
- Not all habitats are equal, and just adding-up the total areas, doesn't really estimate the impact of its loss (ecological function as stated in the text).

RESPONSE: Noted and report modified.

Frequently Submerged Mudflat- While the text doesn't calculate the expected decrease in the next 50 years (27%) this is a habitat with a large expected decrease in area and with expected impacts to fish populations. This is also an area where data have been collected for quite a while on fish eating birds. Text suggests using bird abundance and diversity as an indicator of adverse changes in fish abundance associated with habitat type decline.

- I would suggest rather that monitoring through direct surveys of fish populations

be done in this and the other habitats.

**RESPONSE:** Done

## Fish

Table 5.2 lists 38 species of fish identified in the lagoon. Many of these are likely to be affected by loss of subtidal ponded habitat and frequently submerged habitat. How many of the 38 species may be present in lower numbers in the future because of loss of flooded habitat: Species in the following families looked susceptible to me: Atherinidae 2 spp; Bothidae 2 spp; Clupeidae 1 spp; Cottidae 3 spp; Embiotocidae 8 spp; Engaulidae 1 spp; Hexigrammidae 1spp; Myliobatidae 1spp; Osmeridae 1spp; Perichthyidae 1spp; Pleuronectidae 3 spp; Scorpaenidae 1 spp; and Trakididae 1 spp.

**RESPONSE:** We agree that many fish species, which use habitats within the lagoon at various life stages, will lose habitat over the next 50 years; however, species-specific impacts were not discussed due to the large-scale focus of the document. Text was added to the report to address the fact that fish will likely be impacted by changes in the lagoon's habitats.

Section 7.2- states that "As expressed in these goals, the over-arching strategy is to allow for natural geomorphic and hydrologic processes to maintain the resources of the lagoon (Goal 1, Objective 3). This is a recognition that development of habitats (Goal 1, Objective 2) and biological uses (Goal 1, Objective 1) rely on natural processes that drive the geomorphic evolution of the lagoon".

- Does this mean we sit back and watch to see if we need to jump-in and do something or can we try to enhance the existing system as it currently is.?

**RESPONSE:** This is a question that will be addressed in the next steps of the planning process with public input. The MCOSD and the State and Federal partners are obligated to complete the Feasibility Study and EIR/S (a draft Feasibility and DEIR/S were completed in 2002). Whether and what type of restoration/intervention measures will be considered then.

Stuck in Goal 1, Objective 2, is the word "enhance". It is not in the description of Goal 1.

- I have to admit, I am confused as to whether enhancement is a proposed activity or something that will occur by itself?

**RESPONSE:** The list of Goals and Objectives listed in the report are those developed for the 1996 Bolinas Lagoon Management Update. Considering our significantly improved understanding of how the lagoon functions and changes over time, we

recommend revisiting these Goals and Objectives as part of the next steps in the planning process.

A number of pilot projects are being done in SF Bay using native oyster restoration to provide habitat complexity, along with other benefits such as increased water clarity, in subtidal shallow and frequently submerged habitat types. Additionally, small-scale eelgrass seeding projects using buoyed floats to scatter eelgrass seed are being evaluated. Recent work by Merkel and Associates developing a model for predicting suitability of areas for eelgrass growth and restoration may be useful in identifying potential areas for eelgrass establishment.

The reason I mention these small restoration projects is because it seems the document is focused, and maybe we are still, on big projects (intervention) involving dredging large areas and potentially having big impacts. Also, it seems that the process will take a long time to determine if we will do anything. Recent changes to CEQA allow small scale (< 5 acre) restoration projects to be implemented in a very short time. The two projects, oyster restoration and eelgrass seeding, deal directly with issues we have seen in Bolinas Lagoon and will continue to experience at some level in the future.

RESPONSE: The TRG strongly recommended that the report focus only on the 50-year projection and not on restoration/intervention alternatives. One figure (Fig. 6-1) originally mentioned “a large scale project”—this was inadvertent and has been changed. If purpose and need is determined, a range of restoration/intervention alternatives, large and small, should be considered.

Section 7.4.2 – I would suggest adding Fish as a species to be monitored.

RESPONSE: Done.

With regard to the Figures and Tables- as they exist now, they pretty much stand alone and are not referred to in the text.

RESPONSE: The figures and tables have been integrated into the text.

In Figures 7.1-7.3 restoration action/experiments is on a large-scale.

- No small scale enhancement experiments allowed?

RESPONSE: This has been changed. The next steps of the planning process (completing the Feasibility Study and EIR/S), with public input, will determine purpose and need for intervention. A range of restoration alternatives—not just a single large project--- may be evaluated.

- Are all actions to be interventions to protect birds or mammals? Reality may be at the project level that certain ESA fish species (coho and steelhead) will drive the activity permitted. The Lagoon is Essential Fish Habitat and a consultation with NOAA Fisheries will be needed to obtain a COE permit.

RESPONSE: Consultation and permits from numerous agencies will be required before any activity occurs in the lagoon. As noted above, the Feasibility and EIR/S must be completed as part of the planning process. The TRG strongly recommended that the report focus only on the 50-year projection and not on restoration/intervention alternatives.

- Need to update text on page A-14 in Appendix A as to status of coho and steelhead.

RESPONSE: Report modified.

In summary, I found it quite difficult to evaluate the PWA report trying to focus on fish or fish habitat. I found myself in agreement with the studies that dredging is probably not justified at this time. As to fish and fish habitat, I think a significant loss of habitat has already occurred in the Bolinas Channel. The monitoring and management section needs to be more clear and should include enhancement as a goal on a smaller scale now rather than to wait until sometime later for possible large scale intervention to restore.

RESPONSE: Again, the Report focuses on the 50-year projection. Restoration or intervention alternatives were specifically not discussed in the report. The section on adaptive management was to present in outline what an adaptive management plan involves. As noted above, the inadvertent allusion to a large-scale project was modified.

**Roberto Anima, PhD (PRAG member)**

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**Comments on Administrative Draft: Bolinas Lagoon Ecosystem Restoration Project**

Overall the report needs reorganization, editorial review, and a clarification of terms used or coined in the report.

I recommend:

- Historic evolution of the lagoon is presented first so that the public learns first what the lagoon is and what brought it to its present state.
- The key physical and biological processes of the lagoon
- Existing lagoon conditions
- Future evolution of the lagoon.
- The conclusions and recommendations
- Monitoring and adaptive management recommendations.

This might present a more coherent succession of information and recommendations.

**RESPONSE:** Sections 3 & 4 have been combined, and we have included a concise summary of key findings before the list of specific conclusions.

There is no mention of the effects of the ebb tides into and out of the lagoon. They too have the ability to transport sediment. This needs to be addressed. Tidal prism was increased with the 1906 event; this shift in dynamic equilibrium should have gone on the side of increased tidal prism. What the report says is that since the shift we have decreased the tidal prism by .2 MCY in 92 years. Is this the result of anthropogenic effects on the sedimentation patterns in the lagoon? If so, then why shouldn't there be some sort of moratorium on any development or changes to the surrounding water shed, if, in fact, the sedimentation is due to human induced changes.

**RESPONSE:** Tidal dispersion and tidal asymmetry are discussed in length in the report. Tidal dispersion in particular is noted as a key processes related to the sediment dynamics of the lagoon.

The report states that the 1906 down-drop *increased* the lagoon by 3.5 MCY.

Almost all of the watershed is already protected by public and private (Audubon Canyon Ranch).



It would further help to summarize points 11-24 very succinctly to enable the public to easily understand how natural and human factors may have altered the lagoon from 1906 to present.

**RESPONSE:** Done.

The tidal prism increased to 7.2 MCY between 1854 to 1906, 52 years. From 1906 to 1998 the shift was from 7.2MCY to 3.5 MCY a .2 MCY in 92 years in spite of the unchecked development around the lagoon. Could this .2 MCY been avoided if development hadn't taken place? Not mentioned in the report.

**RESPONSE:** We have revised our estimate of tidal prism derived from the 1854 T-sheet, based on an equation we feel is more accurate (see Appendix B). This has significantly reduced the difference between 1854 & 1998 (Year 0) tidal prism.

The mouth of the lagoon has remained open in spite of the development that has taken place within the lagoons watershed. The sediment deposited in the interior of the lagoon wasn't only material moved into the mouth alone much of this material came from the watershed.

**RESPONSE:** As discussed in Byrne et al. (2005), most of the sediment accumulated since 1906 originate from littoral sources.

Some mention needs to be made that the differences in the amounts of sediment delivered to the lagoon is reflected on where human induced changes have occurred in the water shed.

**RESPONSE:** The report does properly note that the most significant anthropogenic-induced changes have occurred at the fluvial delta near the mouth of Pine Gulch Creek and Seadrift Lagoon.

How does the unmanaged watershed and the continuing runoff derived sediment contribute to the sediment sources?

**RESPONSE:** The most significant increases are to bedload delivery.

The fill placed in the lagoon, particularly during the development of the Seadrift sandspit, is not much emphasized. The public needs to be made aware of how development such as this is detrimental to the life of the lagoon.

**RESPONSE:** We have provided an estimate of the long-term loss of tidal prism due to Seadrift Lagoon – approximately 0.3 MCY.

We need to ask the question of how the unchecked development has had adverse effects on the lagoon. How can this be controlled in the future to slow the decrease in tidal prism?

**RESPONSE:** Most of the watershed is already protected. See comment above.

## Fish

Table 5.2 lists 38 species of fish identified in the lagoon. Many of these are likely to be affected by loss of subtidal ponded habitat and frequently submerged habitat. How many of the 38 species may be present in lower numbers in the future because of loss of flooded habitat: Species in the following families looked susceptible to me: Atherinidae 2 spp; Bothidae 2 spp; Clupeidae 1 spp; Cottidae 3 spp; Embiotocidae 8 spp; Engaulidae 1 spp; Hexigrammidae 1spp; Myliobatidae 1spp; Osmeridae 1spp; Perichthyidae 1spp; Pleuronectidae 3 spp; Scorpaenidae 1 spp; and Trakididae 1 spp.

**RESPONSE:** Report modified.

**Response to USACE Comments**

**Cindy Tejada**  
Senior Project Planner  
US Army Corps of Engineers  
San Francisco District

Technical

1. The concept of dynamic equilibrium is difficult to fully comprehend from the text. It is unclear whether the dynamic equilibrium the lagoon will reach in the near future is different from the dynamic equilibrium that it would have (and did) reach under natural conditions. In the past, under natural conditions, did the lagoon reach its dynamic equilibrium X # of years after a given earthquake and then stay in that dynamic equilibrium until the next earthquake? And if so, does that mean that the logging & grazing (etc.) that occurred in the 1850's accelerated this process, causing the lagoon to reach its dynamic equilibrium sooner? Or is the lagoon progressing towards a new (different) equilibrium?

Response: We have attempted to clarify the use of punctuated dynamic equilibrium in the report and emphasized that lagoon may not reach dynamic equilibrium between the few hundred years between earthquakes. However, we do believe it is correct to state that the lagoon tends towards an equilibrium form that balances erosive and depositional processes. Anthropogenic changes that modify important sediment dynamics generally results in an evolutionary trajectory towards a *different* equilibrium form.

2. Your report emphasizes the significance of the contribution of littoral sediments to the lagoon's net sedimentation rate (saying that the bottom drop caused by earthquakes creates sediment sinks), and this would have happened (did happen) under natural conditions. The contribution of watershed sediment is de-emphasized in your report because, it is stated, the overall contribution of watershed sediments is comparatively low. The significance of those mid-nineteenth century watershed practices (and current practices, especially at Pine Gulch Creek), and the impact they had on the shape of the lagoon, cannot be denied, however. In another draft of something I read earlier, you stated that "sea level rise will overtake PGC delta accretion in approximately 177 years, at which point the delta will have grown radially by 530 feet." Has this (human-induced) increased rate of sedimentation *not* affected the future shape/formation of Bolinas Lagoon? Especially when you consider that sedimentation rates are higher in that area due to the presence of vegetation & the lack of wind-wave erosion. Getting back to my first comment, has Bolinas Lagoon been put on "fast forward" towards its natural dynamic equilibrium, or is it approaching an altered dynamic equilibrium? The answer to this question could determine the future of Corps activities on this project...

Response: We believe the lagoon is approaching a different equilibrium form. This is primarily due to: development of Seadrift Lagoon, which impounded a portion of the tidally active Bolinas Lagoon; and increased delivery of watershed sediments (especially bedload), which has formed a delta at the mouth of Pine Gulch Creek. However, as the Byrne data reveal, most of the sediment accumulated in the intertidal and subtidal portions of the North Basin since 1906 originates from littoral sources.

## Editorial

1. Pg 25, last paragraph. I think Pickleweed Island no longer exists. Please check with someone from BLTAC or Ron Miska.

Response: Text revised

2. Pg 25, first paragraph. After “rock cod,” the following appears: (, I think the species name is missing.

Response: Text revised

3. Pg 28, second paragraph. After “the great blue heron,” it should read *is* a permanent resident of the area (not *are permanent residents*).

Response: Text revised

4. Fig 5-4: at the top of the figure, a noun is missing in this sentence: Majority of watershed delivery occurs during infrequent periods of intense ---*what?*

Response: Text revised

5. Fig 3-6. While it might be obvious to most, I think Bolinas Lagoon should be added to one of the categories listed on this figure. Also, as Bill Brostoff mentions in his comments (he requested a definition of “lagoon”), I think there may need to be a short paragraph on the difference between lagoons and estuaries as this was certainly a matter of debate when we released the draft reports in 2002. If it is really a spectrum, where open estuary lies on one end of the spectrum and hyper saline or freshwater lagoon lies on the other, we need to determine where the “natural” state of Bolinas Lagoon lies on that spectrum (and where it currently lies, if its condition has changed). For example, some commenters made the statement that since “natural” lagoons filled in “naturally” anyway, why should anything be done in Bolinas Lagoon? I guess this was based on the strict definition of lagoon, which is a body of water that is often (always?) closed to the ocean, whereas most of us can agree that Bolinas Lagoon is not a lagoon (by definition) but an estuary, and since it lies on an active fault line, perhaps it defies the standard definitions?

Response: We have added “lagoon” and “estuary” to the glossary. Figure 3-6 from the Admin Draft has been removed, as part of the re-organizing suggested by the TRG.

We do not believe that all lagoons naturally “fill in”. This depends on the sediment budget of any particular lagoon. Evidence from the recent UCB study reveals that in the case of Bolinas Lagoon, large earthquakes along the San Andreas Fault have a major role in the maintenance of Bolinas Lagoon.

6. Page 1. Last sentence of 2<sup>nd</sup> paragraph. It states that MCOSED decided to reformulate the ERP in order to develop a “cost effective” and scientifically sound plan.... I don’t see anything in this document that discusses the costs (or benefits) of any plan or part thereof. I’m not sure where that statement came from or why it is in the text.

Response: Text revised to omit cost-effectiveness.

**Comments on "Projecting The Future Evolution Of Bolinas Lagoon"**  
**Administrative Draft (PWA Ref. # 1686.02)**  
**Prepared by PWA and WRA, 7 December 2005**  
**By Craig Conner**  
**Water Resources Section, San Francisco District**  
**US Army Corps of Engineers (CESPN-ET-EW)**

**Editorial Comments**

- The Conclusions and Recommendations section should be moved to the end of the report; an Executive Summary section can be added to the beginning of the report.

RESPONSE: We have kept this section at the beginning in order to provide a summary of key findings. Also, at the request of the TRG, we have added a concise narrative before the numbered list of specific conclusions.

- In the final version of the report the figures should be integrated within the text and placed as close as practical to where they are first cited in the report.

RESPONSE: Done.

- Some paragraphs are not formatted properly (see page 42 for an example). Please check the formatting of all paragraphs before submitting the final version of this report.

RESPONSE: This was a problem with the PDF processes. Problem corrected.

- Some references cited in this report are not included in the References section; please check all references and update the References section in the final version of this report.

RESPONSE: Done.

**General Comments**

- This report provides information and analyses on the historical, present, and future without project conditions of Bolinas Lagoon. The information, results, and conclusions presented in this report are similar to those given in the Corps draft Feasibility Study report (USAED-SF 2002a) and as such provide greater assurance about our understanding of without project conditions at Bolinas Lagoon.

- The report contains one appendix on the biological field studies. The report does not contain an engineering appendix documenting the data sources and their accuracies, more detailed description of methods used in their analyses and their associated assumptions and limitations, independent data checks, and quality control certification. An engineering appendix is needed to corroborate the information, analyses, and conclusions given in this report. Without an engineering appendix the results and conclusions given in this report should be considered speculative at best.

RESPONSE: The Bolinas Lagoon TRG has provided comments on the general approach and findings. Also, many of the essential findings are based on results from the recent UCB sediment core study – which does describe details of the pollen dating and other analyses.

- This report relies heavily on the assumption that if you create new similar physical conditions as exits for certain present habitats, that these habitats will populate in a similar manner in the new physical environment. Previous work (Zedler & Callaway 1999) has indicated that this assumption may not be true for all restoration projects. Further explanation is needed in this report on why the authors feel this is a good assumption for this project site. References to where this assumption has been successfully applied to other restoration projects would be helpful.

RESPONSE: No habitat creation or restoration actions are described in this document. Instead, the purpose of this study is to evaluate the No Action alternative.

### **Specific Comments**

**Sediment Budget, Sediment Dynamics And Equilibrium Form (Page 8):** A table should be added to this section summarizing the Sediment Budget results. The table should include all sources and sinks of sediment, their volume amounts along with the uncertainties in the estimates, and should sum to zero. A schematic containing this same information (possibly overlain on a photograph of the area) may also be helpful to the reader.

RESPONSE: Since the values of the sediment budget have varied over the Holocene and historic record, we have not added numbers to specific tables/figs. Instead, the quantities of 20<sup>th</sup> century alluvial and littoral accumulation are spelled out in the text (including succinct bullet points).

**Intertidal Mudflats (Page 26):** A definition, table, and schematic should be given for Local Mean Sea Level (LMSL) as it relates to other important vertical datums. The difference in elevation between LMSL, MSL, MLLW, MHW, NGVD29, and NAVD88 should be specifically given as these datums are important for engineering and regulatory purposes for the project.

RESPONSE: We have included a table of the published NOAA tidal datums for Bolinas Lagoon, as well as the conversion between NGVD and NAVD (based on VERTCON), in an appendix.

**Sea Level Rise (Pages 36 & 37):** The authors should consider a range of sea level values, including using curve 3 from the National Research Council Report (NRC 1987), and show the sensitivity of sediment budget results to the various assumed values of sea level rise. The authors should then select one value for sea level rise and provide an explanation as to why they feel the chosen value best represents what will happen at Bolinas Lagoon over the next 50 years.

RESPONSE: We have established estimates of future sea level at Bolinas Lagoon by applying a *projected acceleration* to the *observed rate* of 20<sup>th</sup> century sea level rise. Specifically, we have applied the median projected acceleration due to eustatic effects (1 mm/yr<sup>2</sup>) established by IPCC (2001) to the observed 20<sup>th</sup> century rate from the Presidio gage (NOAA web site). We have reported an error bar on the effects of future sea level rise on tidal prism by doubling the acceleration to 2 mm/yr<sup>2</sup>. More discussion of future sea level rise is included in our response to TRG comments.

**Changes In Tidal Prism And Inlet Stability (Page 41-42):** A common engineering method for determining tidal inlet stability is Escoffier's analysis (van de Kreeke 1992; Escoffier 1940). This method was applied to Bolinas Lagoon by the Corps and the results indicated that the tidal inlet is unstable (USAED-SF 2002b). The authors of this report did not conduct an Escoffier analysis, nor comment on the past analysis, in their assessment of tidal inlet stability. The authors should provide further explanation as to why they feel an Escoffier analysis was not needed for their assessment.

RESPONSE: Several conventional methods provide information on inlet stability, but the time-varying O'Brien method is the only analysis that quantifies the *frequency* of possible inlet closures. The Escoffier analysis in particular does not include the effects of incident waves – a critical driver that influences inlet closure.

**Trends In Lagoon Evolution Beyond 50 Years (Page 44, Figure 6-12):** This section and Figure 6-12 conflict with results given on pages 41 and 42 of this report and other previous work (USAED-SF 2002b). Further explanation is needed to account for these differences and on what is meant by a long-term equilibrium condition.

RESPONSE: The methods used by PWA and USACE-SF differ significantly, and it is not surprising that the two projections of future conditions differ. For example, the USACE-SF analysis did not consider the effects of sea level rise or the influence of locally generated and erosive wind-waves. Additionally, the present analysis relies heavily on findings from the recent UCB study (Byrne et al., 2005). Our definition of long-term means beyond Year 50 but before the next large earthquake along the San Andreas Fault.

**Suggested Monitoring At Bolinas Lagoon (Pages 54-57):** This monitoring plan emphasizes more physical processes monitoring of Bolinas Lagoon than biological monitoring (which would be done on five year intervals). This monitoring plan presumes a direct connection between physical processes and biological/ecological responses at Bolinas Lagoon. Further explanation, information, and data are needed to justify this



presumption. It appears from the text that a simple monitoring program consisting of a topographic and biological survey every 5 years may be sufficient for adaptive management needs.

RESPONSE: We have proposed monitoring elements that are tied to key uncertainties. Monitoring of the inlet and lagoon tides is particularly important since the potential ecological consequences of closure are significant.

### **References**

Escoffier, F.F. (1940). **The stability of tidal inlets**, *Shore & Beach*, 8(4): 114-115.

NRC (1987). **Responding To Changes In Sea Level: Engineering Implications**, *National Research Council, National Academy Press*, Washington, DC, 148 pp.

USAED-SF (2002a). **Draft Feasibility Report Bolinas Lagoon Ecosystem Restoration Project**, *US Army Engineer District San Francisco and Marin County Open Space District*, San Francisco, CA, June 2002.

USAED-SF (2002b). **Bolinas Lagoon Ecosystem Restoration Water Resources Appendix**, *US Army Engineer District San Francisco*, San Francisco, CA, 11 June 2002.

van de Kreeke, J. (1992). **Stability of tidal inlets; Escoffier's analysis**, *Shore & Beach*, 60(1): 9-12.

Zedler, J.B. and J.C. Callaway (1999). **Tracking wetland restoration: do mitigation sites follow desired trajectories?**, *Restoration Ecology*, 7(1): 69-73.

Interim Review of Administrative Draft of Bolinas documents – 12/23/05  
by William N. Brostoff, Ph.D. SPN ACOE

1. The current draft appears to be substantially improved over the previous one and I appreciate the attention given to the comments I provided on the previous draft.
2. There appear to be no major technical problems in the current version. However, there are several items of concern which should be addressed before the draft is finalized for public distribution. These include clarifying the use of some technical terminology, revising one figure, and some minor editing.
3. The addition of the “Glossary” is a major improvement and will greatly contribute to public understanding of the document. Several terms should be added:

- a. Evolution (I am uncomfortable with the way this term is used throughout the document and in particular how it relates to “dynamic equilibrium.”

Response: [See TRG comments.](#)

- b. Dynamic equilibrium (especially in the context of item 15 on p 4 where it is stated that the 1906 earthquake disturbed the dynamic equilibrium, is this different from ‘constant state of flux’ on p 11 when talking about the inlet? ).

Response: [See TRG comments](#)

- c. Lagoon (this was brought up at one public meeting; also “intertidal lagoon” as used on p.2; a classic definition of a lagoon includes periods of closure so maybe this needs to be addressed).

Response: [done.](#)

- d. Siltation.

Response: [done.](#)

4. While I appreciate the increasing attention to the causal relationship between earthquakes (other than the 1906) and increased tidal prism, it would be helpful to tighten the linkage (e.g., p 2).

Response: Text added to reflect findings from recent UCB study.

6. Item 30 on p 5 (...major changes ... not expected...) should be more detailed.

Response: We wanted to keep the bullets brief. More detail is in the main body of the report.

7. Under ecological functions (item 4.2, p 14-15) it is stated "... habitat types...influence the species that dominated the system..." This seems to be circular reasoning since habitat types are often defined by the species present. Please reword.

Response: As stated in our previous conceptual models, and in this report, we believe that bed elevation relative to tidal datums is a major driver in determining habitat type.

8. Examples of editing that needs tidying up: p 24, 2<sup>nd</sup> to last line alga = singular, algae = plural; p 15, 4.3, 2<sup>nd</sup> paragraph subject very agreement impact ...were.

Response: the text has been edited for typos / grammar in several places.

9. Figure 3-6 is excellent in concept and synthesizes a lot of information, however, it needs to be tidied up since the hypersaline lagoon is shown as having a lower salinity than the open estuary.

Response: At the request of the TRG, we have re-organized this section. This reorganization has led to the removal of this figure.

10. It would be helpful to standardize measurements. Siltation is reported in mm, depths in ft.

Response: Since sea level rise and estuarine sedimentation are often referenced in SI units, we have used both English and SI in certain places. This allows for better linkage with UCB report.

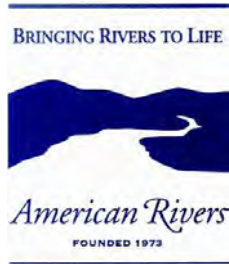
# **Bolinas Lagoon Ecosystem Restoration Feasibility Project**

## **Final Public Reports**

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### **VI Peer Review and Public Comments on Previous Draft Reports with Responses**

The Public commented on the draft public report  
(dated Feb 2006).



March 31, 2006

Via email: [scrubjay@sbcglobal.net](mailto:scrubjay@sbcglobal.net)

William Carmen, Project Manager  
Bollinas Lagoon Ecosystem Restoration Feasibility Study  
MCOSD  
3501 Civic Center Drive  
Suite 415  
San Rafael, CA 94903

Re: **American Rivers Comments on the February 2006 Draft Reports  
Bollinas Lagoon Ecosystem Restoration Feasibility Project**

Dear Mr. Carmen:

American Rivers submits these comments on the February 2006 Draft Reports prepared in connection with the Bollinas Lagoon Ecosystem Restoration Feasibility Project.

American Rivers is a national conservation organization dedicated to protecting and restoring the nation's rivers and wetlands. American Rivers has more than 40,000 members across the country, including in the state of California, and works in partnership with thousands of river and conservation organizations. American Rivers has two California field offices, including one in Marin County. American Rivers has been an active participant in the Bollinas Lagoon Ecosystem Restoration study process.

### **General Comments On The Draft Reports**

Both Draft Reports make it quite clear that Bollinas Lagoon is a healthy, self-sustaining, and resilient ecosystem. The Report prepared by Philip Williams & Associates (PWA) also makes it clear that Bollinas Lagoon will not experience any significant habitat changes over the next 50 years. Both Draft Reports also conclude that human intervention is not needed.

These conclusions are fully supported by the Bollinas Lagoon Technical Review Group Review Comments on the Draft Reports:

The data from both reports indicate that two major conclusions can be drawn: **the lagoon mouth is unlikely to close and the overall ecology of the lagoon is unlikely to change**

**in significant ways during the foreseeable future.** The consultants' reports provide three sets of evidence supporting these conclusions. First, there are empirical measurements of sedimentation patterns and sources of sediment by a number of authors, but done most comprehensively by Byrne et al., indicating that the shallow lagoon has not closed in the past, even when land use practices and earthquakes yielded sediment loads much greater than occur now. When these and other sedimentation data are utilized in the models run by PWA, no lagoon closure is indicated for the future.

\* \* \*

We find quite reasonable the consultants' conclusion that, since the lagoon is unlikely to close in the foreseeable future, no intercession in the evolution of the lagoon to prevent its closure is warranted.

Peer Review Comments on Administrative Draft Reports I & II with Responses by Consultants at 2, 3 (emphasis added)

Both Draft Reports also make it clear that the dredging plan proposed by the U.S. Army Corps of Engineers (Corps) was based on incorrect assumptions about the lagoon's natural history and natural processes. Contrary to the Corps' claims, the lagoon clearly is not at risk of filling in and becoming upland or freshwater marsh, and the major source of sedimentation within the lagoon is from the littoral side not from the watershed. The Draft Reports also make it clear that the Corps' lack of understanding led it to propose a dredging plan that was entirely unnecessary and would have exacerbated the very problem it claimed it was addressing.

The Technical Peer Review Group comments on the Draft Reports also bear out these conclusions:

Secondly, but perhaps equally important, is the discovery made multiple times that the bulk of the sediments in the major basins of the lagoon originate from the near-shore ocean (i.e., littoral) environment and from the bluffs just outside the lagoon, rather than from the local watersheds. The sediment coming down local creeks is mostly deposited near the creek mouths. Although the initial formation of the creek deltas substantially lessened the tidal prism, the ongoing build-up of the deltas and their gradual expansion contributes little to further prism loss because it occurs very high in the intertidal zone. From these findings we can infer that one major dredging event, which according to the models would increase tidal flood flow and thus bring more sediment into the estuary, could lead only to more dredging.

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The greatest strength of the study is that all of its reports support the conclusion, to a greater or lesser degree, that the lagoon is unlikely to close and that dredging or any other action to prevent closure is not justified at this time. There is an absence of ecological problems that would be mitigated by such apparently unnecessary preventive actions.

However, it is interesting to speculate on what might happen if the analysis were to be expanded to include the impacts of such actions, especially dredging. Manifold short-term negative impacts, such as the likely reduction in shore bird populations and disruption of the recently renewed Coho run in Pine Gulch Creek, and the disruption of current creek flows with their impacts on sediment deposition and removal would seem to strengthen the case against large-scale dredging.

Peer Review Comments on Administrative Draft Reports I & II with Responses by Consultants at 2, 11.

While we believe that the Draft PWA report should state this message more clearly, the science is now clear that no intervention in the lagoon is warranted at this time.

### Next Steps

As a result of the overwhelming conclusions of the Draft Reports, American Rivers strongly urges the Marin County Open Space District to advise the Corps that there is no longer any local sponsor interest in working with the Corps to develop an ecosystem restoration project for Bolinas Lagoon. This would not preclude any local efforts to implement monitoring as recommended in the Draft Reports or any other local action, but it would remove the Corps from the process of determining what should or should not happen with respect to the future of Bolinas Lagoon.

This is vital for a number of reasons. First, it is now clear that there is no need for the type of large scale dredging project proposed by the Corps for Bolinas Lagoon. Second, the Corps has demonstrated that it does not have the ability to properly evaluate and plan a project for Bolinas Lagoon. Indeed, it is clear that the plan proposed by the Corps would have caused significant harm to the Lagoon ecosystem. Third, minor fixes to the Corps' planning process for Bolinas Lagoon will not ensure that any future Corps study will be of an acceptable quality. The problems at the Corps that led to the flawed Bolinas Lagoon study are systemic in nature and are producing unacceptable project planning across the country.

For example, just this month, the Government Accountability Office (GAO) testified to Congress that "the Corps' track record for providing reliable information that can be used by decision makers . . . is spotty, at best." Four recent Corps studies examined by GAO "were fraught with errors, mistakes, and miscalculations, and used invalid assumptions and outdated data." These studies "did not provide a reasonable basis for decision-making." GAO also testified that the problems at the agency are "systemic in nature and therefore prevalent throughout the Corps' Civil Works portfolio." As a result, effectively addressing the problems at the Corps "may require a more global and comprehensive revamping of the Corps' planning and project management processes rather than a piecemeal approach." United States Government Accountability Office, *Corps of Engineers, Observations on Planning and Project Management Processes for the Civil Works Program*, Testimony Before the Subcommittee on Energy and Resources, Committee on Government Reform, House of Representatives, March 15, 2006, GAO-06-529T. A lengthy list of studies carried out by independent experts over the past ten

years highlighting critical flaws in Corps project planning and systemic problems with the agency is attached at the end of these comments.

The future of the ecological jewel that is Bolinas Lagoon is far too important to trust to the hands of the agency that has repeatedly proved itself incapable of proper and ecologically sound project planning.

**Specific Comments on the PWA Report**  
**“Projecting the Future Evolution of Bolinas Lagoon Public Draft”**

While a careful reading of the PWA report makes it clear that no intervention in the lagoon is warranted at this time, the report does not state this clearly enough. The report should state very clearly that: (1) the lagoon mouth is unlikely to close in the foreseeable future; (2) the overall ecology of the lagoon is unlikely to change in significant ways during the foreseeable future; and (3) as a result no intervention is warranted at this time.

Rather than make these statements clearly, the PWA Report perpetuates the image of a lagoon at risk. Most notably, the report focuses significant attention on the risk and ramifications of inlet closure without making it clear that inlet closure is not at all likely to occur.

Page 1: The PWA Report significantly misstates the purpose of the Draft Reports. The PWA report states that the purpose of the review is to “develop a scientifically sound plan with greater support from the community and regulatory agencies.” This is not an accurate statement and improperly presupposes that a restoration project is actually needed. This purpose statement should be corrected.

As was made clear to the Marin County Open Space Board of Directors, the purpose of the reevaluation of the Corps’ June 2002 plan is to determine whether there is any need at all for an ecosystem restoration project for Bolinas Lagoon:

It is necessary to critically review the need for a plan to restore Bolinas Lagoon as a consequence of the serious questions raised concerning the plans put forth by the United States Army Corps of Engineers in the June 2002 Draft Feasibility Report and Draft EIR/EIS for the Bolinas Lagoon Ecosystem Restoration Project. Following meetings with the Corps and representatives of the Bolinas Lagoon Technical Advisory Committee (BLTAC) earlier this year, the Open Space District proposes to assume the lead role in completing the Feasibility Phase of the project. Public comment concerning the 2002 Feasibility Report made it clear that the purpose and need for the restoration project had not been satisfactorily demonstrated. An accurate, scientifically sound prediction of Bolinas Lagoon’s condition in 50 years, without implementing any remedial actions such as dredging, fill removal or reducing sediment inputs, is necessary so that the District, the BLTAC and the general public can make a fully informed decision concerning lagoon restoration.



September 9, 2003 Letter from Ronald Miska to Marin County Open Space District Board of Directors regarding the new agreement with PWA for hydrological and ecological consulting services related to the Bolinas Lagoon Ecosystem Restoration Project, at 1, available at <http://www.co.marin.ca.us/depts/pk/main/os/pdf/agreementhydrologybolinaslagoonsept903.pdf> (last visited March 30, 2006).

Page 7, Paragraph 26: This paragraph states that under extreme combinations of strong El Nino storms and weak neap tides sand accumulation in the inlet channel might be able to induce closure even with a tidal prism of 2.5 MCY. The Union of Concerned Scientists have reported that “severe El Nino years mean that sea levels and coastal waves along the California coast are already unusually high and winter storms can bring torrential rains.” Union of Concerned Scientists, *Climate Change in California: Choosing Our Future*. Have these effects been included in the assessment contained in this paragraph? Also, how long would the inlet be likely to remain closed during such an extreme event?

Page 8, Paragraph 29: This paragraph should state that the modeling makes it clear that it is in fact unlikely that the inlet would close.

Page 8, Paragraph 32: The PWA report states (at page 7, paragraph 25) that over the next 50 years, tidal prism is predicted to reach  $2.5 \text{ MCY} \pm 0.3 \text{ MCY}$ . Even the most occasional inlet closure, however, is not predicted to occur unless tidal prism reaches 2 MCY. Thus the report’s own findings make it clear that tidal prism will not reach a point that would lead to a threat of even occasional inlet closure during the next 50 years. The threat is almost certainly even less severe than suggested, since the PWA report makes it clear that only a conservative estimate of sea level rise was utilized (see comments below on the sea level rise estimates used by PWA).

Thus, it is clear that tidal prism is not expected to drop to the 2 MCY level required to see the changes discussed in paragraph 32. While it may be useful to understand the implications of inlet closure, this discussion should be clearly prefaced with the statement that closure is not predicted by any model utilized by PWA.

Without a clear statement that inlet closure is not at all likely, the discussion of the impacts of inlet closure is misleading. It suggests that there is a very real danger to the Lagoon, when no such danger exists. This could lead the public and decision makers to believe that intervention is needed to prevent inlet closure despite the fact that closure is not a realistic possibility.

Also, to provide meaningful guidance on the likelihood of inlet closure even at 2 MCY, the report should provide information on the probability of closure. For example, is there a 5% chance of closure once every decade at a tidal prism of 2 MCY, or is there a 25% chance of closure under that scenario. Also, to assist the reader in understanding the ecological risks of inlet closure, the report also should answer the following questions. If the inlet is likely to close, how long is it likely to remain closed? How long would the inlet have to remain closed to see the kind of changes referred to in paragraph 32?

Page 70: The PWA report uses a 2001 global warming model to estimate sea level rise over the next 50 years. Very recent evidence suggests that sea level rise is likely to be much more rapid

than previously predicted. The latest information on sea level rise should be factored into the PWA analysis. See, e.g., National Center for Atmospheric Research News Release, *Arctic, Antarctic Melting May Raise Sea Levels Faster than Expected*, March 23, 2006 available at <http://www.ucar.edu/news/releases/2006/melting.shtml> (last visited March 27, 2006); Juliet Eilperin, *Antarctic Ice Sheet Is Melting Rapidly*, Washington Post (March 3, 2006) available at <http://www.washingtonpost.com/wp-dyn/content/article/2006/03/02/AR2006030201712.html> (last visited March 31, 2006).

Page 84, 3<sup>rd</sup> full paragraph: The report should provide information on the documented closures of coastal lagoons to help the reader determine whether those lagoons are appropriate reference sites. Answers to at least the following questions would be useful. What are the reference lagoons? Do they have similar morphology and wave action to Bolinas Lagoon? Crissy Field and the Russian River are mentioned on page 87 – are these the reference lagoons? Are there others? Since Crissy Field is artificially designed (and as American Rivers understands that project, it has an inherent design flaw that at least in the past has led to frequent closures), is it an appropriate reference site to use? How many closures were evaluated? How long did the closures last? What weather conditions precipitated the closures? What were the ecological impacts of those closures?

Page 84, 4<sup>th</sup> full paragraph: The model used by PWA predicts the first instance of inlet closure when tidal prism is reduced to 2 MCY with an inlet width of 300 feet. But the paragraph goes on to say that no closure was simulated at 2 MCY “when the inlet width was reduced to its expected value of 200 ft.” This suggests that the inlet width is predicted to be 200 feet and not 300 feet. If the inlet width is actually predicted to be 200 feet then the statement that inlet closure could occur at 2 MCY is even more misleading than discussed above. It is important to clarify which inlet width scenario is actually expected.

The reference to 2 MCY being only “slightly below the value predicted in 50 years” also appears to overstate the potential for closure. Since the report concludes that tidal prism will drop by 1 MCY over the next 50 years to 2.5, the extra .5 drop needed to get to 2 MCY would constitute a significant additional loss of tidal prism. It should once again be clearly stated in this paragraph that tidal prism is not in fact predicted to drop to 2 MCY.

Page 84, last paragraph: It is important to provide information on the length of time it would take for the inlet to reopen under the scenarios described in this paragraph, as the length of closure is critical for determining the impacts of closure.

Page 87, Table 5-2: Which of the three scenarios is most likely to occur? Also, the table should include the scenario discussed on page 84 of 2 MCY at a 200 foot inlet opening.

### **Conclusion**

By letter dated September 2, 2005, American Rivers, Environmental Action Committee of West Marin, and the Sierra Club urged adoption of a two-tiered indicator for human intervention in Bolinas Lagoon that would trigger restoration efforts only if they are needed to ensure the Lagoon’s continued ecological viability and evolution. First, an ecosystem restoration project

should be considered for Bolinas Lagoon only if the Lagoon's dynamic processes, structure, and ecological functions have become so degraded that the Lagoon can no longer function as a natural, self-sustaining system that can recover from external disturbances. If that indicator is triggered, a restoration plan should be adopted only if outside independent experts determine that the plan would measurably improve the ecological condition of the Lagoon to make it more self-sustaining and resilient to external perturbations. A copy of this letter is attached to these comments.

The Draft Reports and the concurrence in the Reports' findings by the Technical Peer Review Group make it clear that the first trigger for human intervention cannot be met. Bolinas Lagoon is a healthy, self-sustaining system that has – and can – recover from external disturbances.

American Rivers strongly urges the Marin County Open Space District to advise the Corps that there is no longer any local sponsor interest in working with the Corps to develop an ecosystem restoration project for Bolinas Lagoon. Instead, the Lagoon should be monitored.

Very truly yours,

A handwritten signature in black ink, appearing to read "Melissa Samet". The signature is written in a cursive, flowing style.

Melissa Samet  
Senior Director, Water Resources

Attachments

## **Corps Project Planning Flaws Are Common Place At The Corps** *A Summary of Studies by the National Academy of Sciences, Government Accountability Office, Army Inspector General, and Independent Experts*

A decade of reports from the National Academy of Sciences, Government Accountability Office, Army Inspector General, U.S. Commission on Ocean Policy, and independent experts have revealed a pattern of stunning flaws in U.S. Army Corps of Engineers project planning and implementation, and urged substantial changes to the Corps' project planning process. Changes needed to address concerns raised in the studies summarized below are included in S.2288, the Water Resources Planning and Modernization Act of 2006.



2006 (March), GAO (GAO-06-529T), **Corps of Engineers, Observations on Planning and Project Management Processes for the Civil Works Program:** finds that “the Corps’ track record for providing reliable information that can be used by decision makers . . . is spotty, at best.” Four recent Corps studies examined by GAO “were fraught with errors, mistakes, and miscalculations, and used invalid assumptions and outdated data.” These studies “did not provide a reasonable basis for decision-making.” The recurring problems “clearly indicate that the Corps’ planning and project management processes cannot ensure that national priorities are appropriately established across the hundreds of civil works projects that are competing for scarce federal resources.” Problems at the agency are “systemic in nature and therefore prevalent throughout the Corps’ Civil Works portfolio” so that effectively addressing these issues “may require a more global and comprehensive revamping of the Corps’ planning and project management processes rather than a piecemeal approach.”

2006 (February), **American Society of Civil Engineers, External Review Panel Progress: Report Number 1:** finds that the catastrophic failure of the Corps’ New Orleans hurricane protection system “demonstrates” that “fundamental flaws were part of how the system was conceived and developed.”

2005 (November), R.B. Seed, P.G. Nicholson, et al. (Report No. UCB/CITRIS – 05/01), **Preliminary Report on the Performance of the New Orleans Levee Systems in Hurricane Katrina on August 29, 2005:** finds, based on field investigations performed by several teams of engineers and scientists in the wake of the passage of Hurricane Katrina, that three major and costly breaches in New Orleans levee systems appear to have resulted from stability failures of the foundation soils and/or the earthen levee embankments pointing to failings in the design and oversight of construction of the levees by the Corps of Engineers, and that many of the other levees and floodwalls that failed due to overtopping might have performed better if conceptually simple details had been added and/or altered during their original design and construction.

2005 (September), GAO, (GAO-05-946), **Army Corps of Engineers, Improved Planning and Financial Management Should Replace Reliance on Reprogramming Actions to Manage Project Funds:** finds that the Corps’ excessive use of reprogramming funds is being used as a substitute for an effective priority setting system for the civil works program and as a substitute

for sound fiscal and project management. In FY 2003 and 2004, the Corps reprogrammed funds over 7,000 times and moved over \$2.1 billion among projects within the investigations and constructions accounts.

2004 (October), National Academy of Sciences, **Review of the U.S. Army Corps of Engineers Restructured Upper Mississippi River-Illinois Waterway Feasibility Study (Second Report)**: finds flaws in the models used by the Corps to predict demand for barge transportation and concludes that these flaws preclude a demonstration that expanding the locks is economically justified. NAS also concludes that the Corps' study does not provide sufficient attention to inexpensive, nonstructural navigation improvements that could ease current barge traffic.

2004 (September), U.S. Commission on Ocean Policy, **An Ocean Blueprint for the 21st Century Final Report of the U.S. Commission on Ocean Policy**: recommends that the National Ocean Council review and recommend changes to the Corps' civil works program to ensure valid, peer-reviewed cost-benefit analyses of coastal projects; provide greater transparency to the public; enforce requirements for mitigating the impacts of coastal projects; and coordinate such projects with broader coastal planning efforts. Also recommends that Congress modify its current authorization and funding processes to encourage the Corps to monitor outcomes from past projects and study the cumulative and regional impacts of its activities within coastal watersheds and ecosystems.

2004 (May), Congressional Research Service (RL32401), **Agriculture as a Source of Barge Demand on the Upper Mississippi and Illinois Rivers: Background and Issues**: finds that the grain traffic forecasts being used by the Corps to justify lock expansion on the Upper Mississippi River were overly optimistic as more and more grain is used to produce ethanol, livestock and other value-added products – products that are generally shipped by truck and rail, not barge. CRS further reports that significantly more grain is now being shipped by rail to Canada and Mexico (since passage of NAFTA) and to West Coast ports for shipment to Asia.

2004, National Academy of Sciences, **U.S. Army Corps of Engineers Water Resources Planning: a New Opportunity for Service**: recommends modernizing the Corps' authorities, planning approaches, and guidelines to better match contemporary water resources management challenges.

2004, National Academy of Sciences, **Adaptive Management for Water Resources Project Planning**: recommends needed changes to ensure effective use of adaptive management by the Corps for its civil works projects.

2004, National Academy of Sciences, **River Basins and Coastal Systems Planning Within the U.S. Army Corps of Engineers**: describes the challenges to water resources planning at the scale of river basins and coastal systems and recommends needed changes to the Corps' current planning practices.

2004, National Academy of Sciences, **Analytical Methods and Approaches for Water Resources Planning**: recommends needed changes to the Corps' "Principles and Guidelines" and planning guidance policies.

2003 (October), GAO (GAO-04-30), **Improved Analysis of Costs and Benefits Needed for Sacramento Flood Protection Project**: finds that the Corps dramatically miscalculated the costs and benefits of the Sacramento Flood Control Project in California, over-counted the residential properties that would be protected, miscalculated the area that would be protected, and used an inappropriate methodology to calculate prevented flood damages. GAO recommends that the Corps improve its cost benefit analysis and cost accounting procedures and submit the project to independent review (estimated to cost \$57 million in 1996, by 2003 project costs had skyrocketed to between \$270 and \$370 million).

2003 (August), Pennsylvania Transportation Institute (PTI), **Analysis of The Great Lakes/St. Lawrence River Navigation System's Role in U.S. Ocean Container Trade**: finds fundamental flaws in the Corps' plan to expand the Great Lakes navigation system, including a host of factors not considered by the Corps that make the Great Lakes ports unattractive to international containerized cargo. PTI concludes that the Corps has not demonstrated that expansion is needed or that it would produce the claimed benefits and has not developed the necessary cost estimates to support an accurate benefit-cost analysis of the project.

2003 (May), Pew Oceans Commission, **America's Living Oceans, Charting a Course for Sea Change, A Report to the Nation, Recommendations for a New Ocean Policy**: recommends enactment of "substantial reforms" of the Corps, including legislation to ensure that Corps projects are environmentally and economically sound and reflect national priorities. Recommends development of uniform standards for Corps participation in shoreline restoration projects, and transformation of the Corps over the long term into a strong and reliable force for environmental restoration. Also recommends that Congress direct the Corps and other federal agencies to develop a comprehensive floodplain management policy that emphasizes nonstructural control measures.

2002 (September), GAO (GAO-02-803), **Oregon Inlet Jetty Project: Environmental and Economic Concerns Need to Be Resolved**: finds that the Corps' economic analysis does not provide a reliable basis for deciding whether to construct the project, as it relies on outdated and incomplete data and unsupported assumptions, and fails to account for risk and uncertainty in key variables that could significantly affect the project's benefits and costs. In addition GAO reports that Departments of Commerce and the Interior do not believe that the Corps has adequately mitigated for environmental concerns, including the project's impact on fish larvae migration, beach erosion, and wildlife habitat. GAO recommends that the project not proceed if the environmental concerns cannot be addressed.

2002 (June), GAO (GAO-02-604), **Delaware River Deepening Project: Comprehensive Reanalysis Needed**: finds that the Corps overstated the project's benefits by 200 percent (the GAO found at most \$13.3 million annual benefits vs. the Corps' \$40.1 million), that the Corps' benefit cost analysis was based on invalid assumptions and outdated information, and that the Corps could not explain its own analysis and instead blamed \$4.7 million of the differential on a

computer error. GAO concludes that the Corps' analysis is so flawed that it can not provide a reliable basis for deciding whether to proceed with the project, and makes numerous recommendations for improving the Corps' analysis.

2002 (May), GAO (GAO-02-574), **Scientific Panel's Assessment of Fish and Wildlife Mitigation Guidance:** finds that the Corps has proposed no mitigation for almost 70% of its projects, and for those few projects where the Corps does perform mitigation, 80% of the time it does not carry out the mitigation concurrently with project construction.

2002, National Academy of Sciences, **Review Procedures for Water Resources Planning:** recommends creation of a formalized process to independently review costly or controversial Corps projects.

2001, National Academy of Sciences, **Compensating for Wetland Losses under the Clean Water Act:** highlights the significant problems with mitigation efforts to date, including mitigation carried out by the Corps (this report looks at issues beyond the Corps).

2001, National Academy of Sciences, **Inland Navigation System Planning: The Upper Mississippi River-Illinois Waterway:** finds that the Corps was using a fundamentally flawed model to assess the lock expansion project; Congress should direct the Corps to fully evaluate use of nonstructural measures; the Corps was not properly accounting for the environmental consequences of its proposed plan; and the Corps' adaptive mitigation strategy is inconsistent with the principles of adaptive management articulated in the natural resources management literature.

2000 (November), Department of the Army Inspector General (Case No. 00-019), **Investigation of Allegations against the U.S. Army Corps of Engineers Involving Manipulation of Studies Related to the Upper Mississippi River and Illinois Waterway Navigation Systems:** finds that the Corps deceptively and intentionally manipulated data in an attempt to justify a \$1.2 billion expansion of locks on the Upper Mississippi River, and that the Corps has an institutional bias for constructing costly, large scale structural projects.

2000 (February and September), Leonard Shabman and Laura Zepp, Department of Agricultural and Applied Economics Virginia Tech, **An Approach for Evaluating Nonstructural Actions with Application to the Yazoo River (Mississippi) and Review Comments on Yazoo Backwater Area Reformulation:** finds that the Corps' proposal to construct the \$191 million Yazoo Backwater pumping plant in Mississippi overestimates just the agricultural benefits by \$144 million, and claims almost \$3 million in annual benefits that are explicitly prohibited by the Corps' own rules.

1999, National Academy of Sciences, **New Directions in Water Resources Planning for the U.S. Army Corps of Engineers:** recommends key changes to the Corps' planning process and examines the length of time and cost of Corps studies in comparison with similar studies carried out by the private sector.

1994, National Academy of Sciences, **Restoring and Protecting Marine Habitat: The Role of Engineering and Technology:** finds, among other things, that the Corps and all federal agencies with responsibility for marine habitat management should revise their policies and procedures to increase use of restoration technologies; take into account which natural functions can be restored or facilitated; improve coordination concerning marine resources; include environmental and economic benefits derived from nonstructural measures in benefit/cost ratios of marine habitat projects; and examine the feasibility of improving economic incentives for marine habitat restoration.



**American Rivers  
Environmental Action Committee of West Marin  
Sierra Club**

September 2, 2005

Via Email

Mr. Ronald Miska  
Assistant General Manager  
Marin County Open Space District  
Marin County Civic Center  
3501 Civic Center Drive, Room 415  
San Rafael, CA 94903

Mr. William Carmen  
[scrubjay@sbcglobal.net](mailto:scrubjay@sbcglobal.net)

Mr. Phil Williams  
Mr. Don Danmeier  
Philip Williams & Associates  
720 California Street  
San Francisco, CA 94108

Re: Bolinas Lagoon Ecosystem Restoration Project – Indicators for Human Intervention

Dear Sirs:

Our organizations urge adoption of a two-tiered indicator for human intervention in Bolinas Lagoon that would trigger restoration efforts only if they are needed to ensure the Lagoon's continued ecological viability and evolution. This is necessary to ensure that any future recommendations for an ecosystem restoration project are based on actual restoration needs.

We urge the use of the following indicators. First, an ecosystem restoration project should be considered for Bolinas Lagoon only if the Lagoon's dynamic processes, structure, and ecological functions have become so degraded that the Lagoon can no longer function as a natural, self-sustaining system that can recover from external disturbances. If that indicator is triggered, a restoration plan should be adopted only if outside independent experts determine that the plan would measurably improve the ecological condition of the Lagoon to make it more self-sustaining and resilient to external perturbations.

The indicators for intervention identified in the October 27, 2003 memorandum prepared by Philip Williams & Associates do not address the functionality of the Lagoon, but instead are based on the goals and objectives in the *Bolinas Lagoon Management Plan Update*. These goals

and objectives are inappropriate for determining whether or not an ecosystem restoration project is needed. They do not address the functionality of the Lagoon, and the information presented at the August 2, 2005 public meeting strongly suggests that they also do not reflect the natural evolutionary trajectory of Bolinas Lagoon. Restoration should work to return an ecosystem to its historic evolutionary trajectory, but use of indicators like those outlined in the October 27, 2003 memo would do just the opposite. They would trigger intervention to keep the Lagoon at an arbitrarily selected point in its ecological development. It is equally unacceptable to establish an intervention trigger based primarily on a desire to accommodate recreation or other needs of convenience (such as allowing boat access), as such intervention also would seek to keep the Lagoon in a static and inappropriate point in its ecological development.

Our organizations urge you to ensure that any indicators for intervention included in the report being prepared by Philip Williams & Associates or in any subsequent report prepared by the County be based solely on ensuring the ecological viability and continuation of the natural evolution of the Lagoon, and not open the door for efforts that are not ecologically sound or desirable.

Please do not hesitate to contact any of us if you would like additional information.

Sincerely,

Melissa Samet  
Senior Director, Water Resources  
American Rivers  
6 School Street, Suite 200  
Fairfax, CA 94930

Catherine Caufield  
Executive Director  
Environmental Action Committee of West Marin  
Box 609  
Point Reyes Station, CA 94956

Gordon Bennett  
Sierra Club Marin Group Chair  
40 Sunnyside Drive  
Inverness, CA 94937

cc: Bolinas Lagoon Technical Advisory Committee



# AUDUBON CANYON RANCH

4900 Highway One • Stinson Beach, CA 94970

Tel: 415/868-9244 • Fax: 415/868-1699 • Website: [www.egret.org](http://www.egret.org)

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March 31, 2006

William Carmen, Project Manager  
Bolinás Lagoon Ecosystem Restoration Feasibility Study  
MCOSD  
3501 Civic Center Drive  
Suite 415  
San Rafael, CA 94903

Re: Bolinás Lagoon Ecosystem Restoration Feasibility Project Draft Reports, February 2006

Dear Bill:

ACR's comments on September 25, 2002 regarding the Bolinás Lagoon Restoration Project Draft EIR/S indicated that the consequences of the No Action Alternative were poorly assessed with respect to sediment sources and transport, sea level rise, earthquakes, and variable episodic events. ACR appreciates the efforts made by MCOSD, Phil Williams Associates (PWA), Wetlands Research Associates (WRA), and UC Berkeley in developing a 50 year projection of Bolinás Lagoon physical and habitat evolution under the No Action Alternative. We feel that these reports are an essential step towards understanding the natural processes that affect Bolinás Lagoon and should help guide future decisions regarding this important natural resource.

There are several areas where ACR has some questions and/or concerns:

### **Project Background:**

We feel it would be helpful for the lay reader if the Project Background provided by MCOSD at the beginning of the report included the following information:

- A more complete description of the context of this report. This report was in response to the lack of information in the No Action Alternative portion of the 2002 DEIR/EIS prepared by the Army Corps of Engineers. The report is not a replacement for a full DEIR/S. The report does provide a reasonable estimate based on available information of what the Bolinás estuary might look like in 50 years if there is no intervention. The relationship of this report to the Feasibility Study that was released coincident with the DEIR/S is confusing to many people and should be clarified.
- The steps required to complete the DEIS/R process. We feel it would be helpful to provide this information in the MCOSD Project Background and relate it to the Project Schedule.

### **Variable and episodic events**

One of ACR's initial concerns regarding the DEIR/S and Feasibility Study was that predictions of inlet closure and changes in tidal prism were unrealistically based on average, rather than variable rates of sediment accretion, storm runoff and wave action. Analysis of future conditions

needs to incorporate the cumulative effects of events associated with heavy storms and patterns of climate change.

- In light of more recent articles in the journal *Science* regarding potential sea level rise over the next hundred years, are the consultants still comfortable with their estimate of 0.4 feet of sea level rise over the next 50 years?
- Has it been possible to develop more specific data with regards to episodic alluvial sediment delivery as a result of the 12/31/05 storm and subsequent storm events?
- The 50 year projection assumes no earthquake. The report should include the most recent estimates of the likelihood of a major earthquake in the lagoon area of the fault within this time period.

### **Littoral sediment delivery and quantification**

- The sentence on page 15, “*Although ocean waves and tidal currents easily transport fine-grained silt eroded from the face of the cliffs, only a fraction of this material makes its way through the inlet and into the lagoon due to complex circulation patterns in Bolinas Bay,*” contrasts with, “*Additionally massive bluff erosion would [have] increased the supply of fine-grained silt available to be transported into the lagoon by tidal currents.*” More clarification regarding the relative importance of contributions from fine-grained bluff material to the sediment budget would be helpful.
- ACR recognizes that this report is looking at the No Action Alternative. However, conclusions that the major source of lagoon sediment are littoral and that the 1906 earthquake increased tidal prism, thereby increasing the rate of littoral sedimentation in the lagoon seems to support the Technical Review Group (TRG) statement that “*a major dredging event would increase the tidal flow, bring in more sediment to the estuary, and could lead to more dredging.*” Is this a statement PWA concurs with?

### **Dynamic Equilibrium**

The current draft report addresses many of the concerns and includes many of the comments made by the Technical Review Group and members of the Project Reformulation Advisory Group regarding the application of the term “dynamic equilibrium” to the overall lagoon. PWA conclusions are based on the assumption that the 1854 lagoon was close to dynamic equilibrium conditions. PWA evidence for this assumption includes the presence of sinuous channels, fully developed mudflats, and the lack of prograding deltas at the mouths of Pine Gulch Creek and other tributaries. Is there relevant evidence from the sediment cores that substantiates this assumption?

### **Habitat projections**

It appears from the report that habitat types and changes have been projected based on changes of elevation and underlying geomorphology. This may be too simple a model. Vegetation can play a role in habitat evolution creating feedback loops that lead to an outcome not predicted by physical changes alone.

### **Monitoring and Adaptive Management Strategy.**

ACR agrees that regardless of the future trajectory of the project, establishing a rigorous monitoring system, supported with ongoing financial commitment, is an important next step. Key indicators suggested by PWA are valuable: tidal range inside Bolinas Lagoon; size of tidal

inlet; mudflat elevations; regular bathymetric surveys; and aerial mapping and monitoring of habitat transects. However, more detail with respect to biological monitoring is required. Which species of birds, fish, and invertebrates do the consultants feel would provide the most useful information? In addition, the Management Objectives established for Bolinas Lagoon must be reevaluated and should incorporate the new information presented in this report.

**Report Format**

Considering the size and complexity of this project report, we feel it is important to combine the Project Background, Introduction, and Conclusions and Recommendations into an available document with a proviso that each conclusion references the supporting section(s) of the main reports.

Again, we would like express our appreciation to the County of Marin for providing the public with this important study. Thank you for this opportunity to comment.

Sincerely,

Maurice A. Schwartz  
Executive Director

Gwen Heistand  
Resident Biologist

March 16, 2006

William Carmen, Project manager  
Bollinas Lagoon Ecosystem Restoration Feasibility Study  
3501 Civic Center Drive, Suite 415  
San Rafael, CA 94903

Re: Bollinas Lagoon

Dear Mr. Carmen:

By all means and with all means

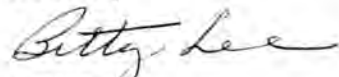
Keep the Tides of Ocean Water Flowing into the Bollinas Lagoon

We question what is "healthy" for the Bollinas Lagoon, and at the same time we observe this jewel disappear, destined to become a marsh, and ultimately turn into dry land with little use and no beauty – except possibly for developers.

It is doubtful that the clam digging days can be restored, but surely the Bollinas channel can be dredged to keep the flow of water to allow fish to feed and propagate, birds to search for food, people to enjoy, and a safe haven for boats.

I am hopeful the Bollinas Lagoon will be dredged and restored, so we can again enjoy the jewel, a God-given beauty that was bestowed to the area.

Sincerely



Betty Lee  
3785 Catecroft Lane  
Cool, CA 95614

530-887-1690

I guess all of us on the bluff are quite concerned about the rapid erosion from this winter's storms. Is it possible to gain permission to add rock or "rip"- "rap"? Could this also be an alternative to or addition to piers or groins being constructed to help slow down the activity? Could there be State or federal monies available for this? thanks for any feedback.

*SEVWAVE@aol.com* wrote:

Dear Bill ,

It was a pleasure to meet you at the Bolinas Lagoon Technical Advisory Committee meeting in Stinson on March 3.

I just want to reiterate what I said there so that you will be able to include this in your upcoming report.

Based on the new knowledge that much of the sediment filling the lagoon is coming from the ocean cliffs,

and

Based on the past practice in Bolinas of using small groins very widely spaced along the beach to keep the ocean from attacking the cliffs directly and thus minimizing ocean erosion,

I would like to propose that a simple groin system be considered to help allay the cliff erosion and the resultant filling in of the lagoon.

Thank you for preparing the community feedback report.

I understand that you need to collect all feedback by March 31.

Best regards,  
Suzanne Ciani

Tel: (415) 868-2239  
Cell: (415) 307-8867

Bill Barton, PhD (Clinical Psychologist)  
St. Mary Medical Bldg.  
2166 Hayes St. Suite 203  
San Francisco 94117  
415 775 9222

**BOLINAS LAGOON FOUNDATION**

**Post Office Box 444**

**Stinson Beach, California 94970**

March 19, 2006

Dear Bill:

Bolinas Lagoon Foundation is pleased to submit its comments on the Draft Report prepared by "PWA Associates et al" released on February 10.

Our reaction to the 50-year projection for Bolinas Lagoon is mixed: relief that the mouth of the lagoon is unlikely to close in the stated time frame, but serious concern that the habitat balance, and resultant health of the lagoon, will continue to deteriorate. Specifically we are concerned about the loss of deep-subtidal habitat, eelgrass, and bivalve species.

These conditions lead us to the conclusion that it is time to take positive steps to preserve Bolinas Lagoon. The lagoon's survival as a healthy tidal estuary requires a limited restoration project, a project designed to restore deep-subtidal habitat and the lost eelgrass beds. Oysters and clams should be reintroduced into Bolinas Lagoon as part of the project as well.

The 2002 Draft Feasibility Study Report/EIR/EIS enumerated a number of suggestions for deepening subtidal habitat. If a project along the lines suggested were to include the restoration of the Bolinas Channel (where eelgrass beds once were) and its connection to Pine Gulch Creek, a number of ancillary benefits would result, including increased circular tidal flow and access for spawning fish to Pine Gulch Creek without passing the Harbor Seal haul-outs adjacent to the main channel.

Perhaps there are better steps that could be taken; that's for the experts to decide. Our focus should be on the goal of sustaining and improving the long-term health of Bolinas Lagoon, and we call on Marin County Open Space District to initiate a restoration program now.

Sincerely,  
Bucky Mace, for the Foundation Board

Endorsed by: \_\_\_\_\_

Printed Name: \_\_\_\_\_ Date: \_\_\_\_\_, 2006

Peter Arrigoni   Barbara Boucke   Mimi Lowrey   Ewan Macdonald   Kerry Mazzoni

Bob McGrath   Rob Robinson   Henry Safrit   David Todd



<b>Responders to Board Letter to Bill Carmen</b>	<b>First Batch</b>
Orian Lee London	3-19-06
Katherine Randolph	3-20-06
Christiane P. deBord	3-21-06
June R. Lilienthal	3-21-06
Katherine Beacock	3-22-06
Claudia Chapline	3-22-06
Helen K. Cahill	3-22-06
J. Brooks Crawford	3-22-06
Ashley M. Grimm	2-22-06
Keith F. Hansen	3-22-06
Charlene Harvey	3-22-06
Steven R. Krolik	3-22-06
Charles F. Lowrey	3-22-06
Mary R. Lowrey	3-22-06
Shirley R. Moyce	3-22-06
Ginny Otis	3-22-06
Web Otis	3-22-06
James E. Palmer	3-22-06
Bill Robbins	3-22-06
Henry Safrit	3-22-06
Harold Schwarm	3-22-06
Agnes Shapiro	3-22-06
Carolyn C. Timmins	3-22-06
Bruce L. Tow	3-22-06
Lois M. Tow	3-22-06
Lillie Anderson	3-23-06
Philip C. Barbour	3-23-06
W. N. Bucklin III	3-23-06
Philip A. Crane, Jr.	3-23-06
Sandra Cross	3-23-06
Annie Crotts	3-23-06
Ilene R. Danse	3-23-06
James A. Danse	3-23-06
Albert K. Engel	3-23-06
Jon Francis	3-23-06
Sandra Francis	3-23-06
Jim and Margaret Gault	3-23-06
Amanda Grimm	2-23-06
Chris Harrington	3-23-06
Colleen Hicks	3-23-06
John T. Lee	3-23-06

Gail D. Mace	3-23-06
Sharon and Paul Melodia	3-23-06
Anne DeBeers Rand	3-23-06
Chris Ruppe	3-23-06
Ginger Taylor	3-23-06
David K. Todd	3-23-06
Ann Walsh	3-23-06
Sharon and Don Wilcox	3-23-06
Peter and Midge Ziske	3-23-06
Barbara Boucke	3-24-06
Josh Churchman	3-24-06
Daniel P. Gregory	3-24-06
Mary L. Gregory	3-24-06
Lillian J. Letter	3-24-06
Stephen Morrison	3-24-06
Arno and Sherry Penzias	3-24-06
Charlotte Prozan	3-24-06
Bill Robbins	3-24-06
Scott Smith	3-24-06
Dieter Tede	3-24-06
Sergio Vergara	3-24-06
Jim Wintersteen	3-24-06
Lynda Balzan	3-25-06
Kerry Mazzoni	3-25-06
Nancy Olin	3-25-06
Marden N. Plant	3-25-06
Kendrick Rand	3-25-06
George Sequeira	3-25-06
Greg and Jeanne Sherfey	3-25-06
Eli and Carroll Botvinick	3-26-06
Peter Crawford	3-26-06
Kate and Wes Moore	3-26-06
Patrick A. Moore	3-26-06
Thomas A. Belshe	3-27-06
Bill Bradford	3-27-06
Maria Garrigues	3-27-06
Imants and Jeannie Krese	3-27-06
Thomas E. Morton	3-27-06
Philip J. O'Brien	3-27-06
Margaret Smith	3-27-06
John C. Thuma	3-27-06
Robert R. Tufts	3-27-06
Brooks Walker	3-27-06

Mason and Wendy Willrich	3-27-06
Polly and Ward Wolff	3-27-06
Robert and Judy Aptekar	3-28-06
Delanie S. Borden	3-28-06
Ralph Camiccia	3-28-06
Terry Camiccia	3-28-06
Judith Franchi	3-28-06
Mustafa Halawa	3-28-06
Cecilia Herbert	3-28-06
James H. Herbert, II	3-28-06
Mike and Sheila Humphreys	3-28-06
John C. Nickel	3-28-06
Richard W. Peterson	3-28-06
Jill Ertola Shustoff	3-28-06
Mike and Shirley Traynor	3-28-06
Ethel A. Walsh	3-28-06
Barrett Weber	3-28-06
Elise Weber	3-28-08
Douglas Barth	3-29-06
Helene Cahen	3-29-06
Flower Fraser	3-29-06
Mark Fraser	3-29-06
Barbara Hancock	3-29-06
George T. Hasler	3-29-06
Barbara B. Kimball	3-29-06
David L. Kimball	3-29-06
Richard B. Madigan	3-29-06
Susan Marineau	3-29-06
Susan Martinelli	3-29-06
Sam McCullagh	3-29-06
Gene and Mary Metz	3-29-06
Donna Moffat	3-29-06
Sean Moffat	3-29-06
Gladys Moore	3-29-06
Tim Nevin	3-29-06
Ronald Pharis	3-29-06
Saul Robbins	3-29-06
Jeffrey Scutt	3-29-06
Nancy Boas	3-30-06
Roger Boas	3-30-06
George H. Hogle	3-30-06
Dan Janney	3-30-06
Richard C. Janson	3-30-06

John Beverly Jones	3-30-06
Richard S. Lowry	3-30-06
Alison Lufkin and Jamie Faber	3-30-06
Charles Raven	3-30-06
Patricia Raven	3-30-06
John J. Sullivan	3-30-06
Murray Waldman	3-30-06
Bill and Pat Barton	3-31-06
Ed Cluss	3-31-06
Allen P. Fields	3-31-06
Sarah Graham	3-31-06
Kenneth Hao	3-31-06
Justine Miner	3-31-06
George A. Tillotson	3-31-06
Maureen and Craig Sullivan	4-01-06
Susan Vickery	4-01-06
Brian Lurie	4-02-06
Dale Roush	4-02-06
Scott Tye	
Nicole Young	
Judy LeMarr	
Jim Fischer	

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**Second Batch**

Richard R. Volk	3-21-06
Sue Wright	3-23-06
James W. Peterson	3-24-06
Stephanie MacColl	3-25-06
L. C. (Tig) Tarlton	3-27-06
Marcus E. Nelsen	3-30-06
Marjell Trendell	3-31-06
Peter Trendell	3-31-06
Butch Hale	4-02-06
Annette Brands	4-03-06
Rony A. Ehrlich	4-03-06
Janet E. Hardiman	4-03-06
Ellen McElhinny	4-03-06
Peggy Seligman	4-03-06
Ronald A. Seltzer	4-03-06
Patricia Arrigoni	4-04-06
Nino and Debbie Kiraly	4-04-06
Randolph D. Rush	4-06-06
Kevin J. Murphy	4-07-06

Diana Bowes	4-08-06	
Carol Brosgart	4-10-06	
Joseph Gross	4-10-06	
Elly Drosihn	4-11-06	
Joe Drosihn	4-11-06	
Garrett Seligman	4-11-06	
Jesse M. Ellinger	4-22-06	
Edward Nicolaus	4-29-06	
Victoria Sebastiani	4-29-06	194

**Third Batch**

Alice P. Thomas	3-29-06	
George W. Pasha	3-31-06	
Elizabeth Hazard	4-11-06	
David Fenzl	5-03-06	
Jeff McPhail	5-03-06	
Jane Slack	5-04-06	
Philip Slack	5-05-06	
Marilyn Burns	5-05-06	
Linda C. Donahue	5-05-06	
Annie Crotts	5-08-06	
David Liebenstein	5-08-06	
Sheana W. Butler	5-09-06	
Mark Jacobsen	5-16-06	
Curtis and Veronica Fields	6-03-06	208

March 31, 2006

To Bill Carmen, MCOSD RE: Bolinas Lagoon Restoration Ecosystem Feasibility Study

Dear Bill:

Bolinas Lagoon is in the western coastal migratory bird flyway and was in the near past, as observed by many of us, an important feeding and resting stopover for large numbers of migrating birds. These bird numbers have fallen precipitously in the past twenty-five years. Along with the decline in the number of birds, there has also been a decline in invertebrate populations that had been a major food source for these migrating birds. Invertebrates have declined to a point that some species that prospered in the past may not now be present and many other species are now difficult to find. Some of these poorly represented invertebrate species hopefully remain in sufficient numbers that they will prosper once again following a lagoon restoration effort.

The information and projections in the COE and the PW draft studies are interesting but fail to adequately address core environmental problems caused by the loss of sub tidal and partially inertial habitat, this from a considerable loss of tidal prism. Tidal prism controls life in the lagoon. Adequate tidal volume delivers the organisms that nourish the invertebrates and baitfish that in turn attract and feed the birds. Restoration to conditions necessary to support a prosperous living lagoon begins with an adequate tidal exchange.

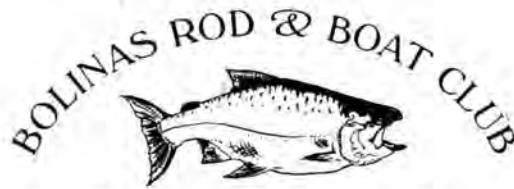
Bolinas Lagoon is not experiencing a natural ageing process. The accelerating loss of aquatic habitat is mostly human caused. The disruption of the natural lagoon process caused by the Dipsea housing development, the Bolinas groin and the Seadrift sea wall must be mitigated by restoring an adequate habitat enhancing tidal prism. Any lagoon habitat restoration project should be designed and guided by biologists and hydrologists familiar with Bolinas Lagoon and its environmental history and requirements.

We have only two options. To do nothing to the area studied and accept the salt marsh that will develop followed by the encroachment of tules and willows, or to restore the damaged tidal prism to a point that wildlife can reintroduce itself.

The choices comedown to the lagoon becoming a beautiful meadow or being restored to more closely resemble the truly living lagoon it has been in the past. We believe the MCOSD should choose the latter and there should be no further delay to initiate the planning process for a project to move in this direction.

John O'Connor,

President,  
Bolinas Lagoon Watershed Team  
P.O. Box 116 Bolinas, CA 94924  
[oconnor@linex.com](mailto:oconnor@linex.com)



83 Wharf Road • Post Office Box 248 • Bolinas, California 94924 • (415) 868-0427

March 23, 2006

William Carmen, Project Manager  
Bolinas Lagoon Ecosystem Restoration Feasibility Study  
MCOSD  
3501 Civic Center Drive  
Suite 415  
San Rafael, Ca. 94903

Dear Mr. Carmen:

The Bolinas Rod and Boat Club, a 200 member non-profit corporation dedicated to boating and fishing, safety of water recreation and the conservation of fish and game, wishes to comment on the February 2006 Bolinas Lagoon Ecosystem Restoration Feasibility Project report prepared by Philip Williams & Associates and Wetland Research Associates.

The report is predicated upon a 50 year projection of the lagoon's future where no action or intervention is taken to preserve the lagoon or its habitats. The membership of The Bolinas Rod and Boat Club strongly believes that some intervention is needed to preserve this unique environmental asset.

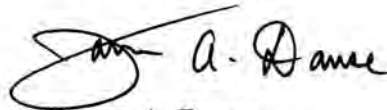
Man has intervened over the years to alter the lagoon's ability to sustain itself. Logging, grazing, farming, placement of fill, construction of the Seadrift lagoon and the rip rap along Seadrift near the inlet channel and the Stinson Beach State Park's construction have all contributed to the alteration of the tidal prism and the hydrologic flushing action necessary to maintain a healthy estuary. It is simply unacceptable to do nothing. Man has altered the lagoon's natural ability to sustain itself and now man, as the steward of the lagoon, is compelled to take remedial action to correct the declining health of the lagoon.

Alarming conditions are already evident to the simplest of observers and those with historic perspective of the last 40 years; witness the decline of the Wharf Road channel, the growth of Kent Island from a tidal sand bar to a forested island, an expanding Pine Gulch Creek delta with riparian woodland and the disappearance of eelgrass beds. The report does not believe the Lagoon's channel mouth is likely to close in the next 50 years, however it does say that it is possible every 10 years given a deteriorating tidal prism. We must be proactive in our efforts to revitalize the lagoon and vigilant in our efforts to ensure that the lagoon's ecosystem is not jeopardized by closure of the channel mouth.

Human modifications of the lagoon's equilibrium require some form of corrective action, preferably one which involves at least minimal efforts to increase the tidal prism and sediment removal. This could be in the form of modest dredging at the lagoon's channel mouth , the Wharf Road channel and in the northwest section of the lagoon and the breakup of Kent Island . This would not be a wholesale correction of the problem, but one which could be easily studied for its impact on the lagoon's overall restoration.

On behalf of the entire membership of the Bolinas Road and Boat Club I wish to thank you for the opportunity to comment on the report.

Yours very truly,

A handwritten signature in black ink, appearing to read "James A. Danse". The signature is written in a cursive style with a large, looping initial "J".

James A. Danse,  
President,  
Bolinas Rod and Boat Club

JAD/tbl



BUCKY MACE  
P.O. Box 306  
Bolinás, California 94924  
March 29, 2006

William Carmen, Project Manager  
Bolinás Lagoon Ecosystem Restoration Feasibility Study  
Marin County Open Space District  
3501 Civic Center Drive, Suite 415  
San Rafael, CA 94903

Dear Bill:

In response to your invitation to comment on the February 10 consultants' report concerning the future of Bolinás Lagoon, let me start by saying that I wholeheartedly and enthusiastically endorse and support the letter to you from Bolinás Lagoon Foundation's Board members dated March 19.

Speaking as a private citizen, I would like add some personal comments:

- The time has come for action, not more studies. Bolinás Lagoon has been studied exhaustively for more than 20 years, while its value as critically important wildlife habitat has steadily deteriorated during that time.
- The time has come to temper the voices of "the experts" with the voices of the local citizens who have observed the gradual, and at times not so gradual, deterioration of Bolinás Lagoon during those 20+ years. Anecdotal observations have value, and the anecdotal data suggests very strongly that Bolinás Lagoon is slowly and steadily deteriorating.
- We all agree that Bolinás Lagoon has significant value as wildlife habitat: for local and migratory birds, fishes, marine mammals, benthic organisms, plant life, and even humans, for recreation and enjoyment. A controlled, limited restoration program, including some dredging, will enhance those values, not destroy them. Restoring lost plant and animal communities will further enhance the value of Bolinás Lagoon.
- We have an opportunity to help our fisheries by restoring important habitats in Bolinás Lagoon. Fisheries have suffered terrible exploitation throughout the world, even though they are vital to the continued health of our planet and its peoples.

William Carmen  
March 29, 2006  
Page 2

We must not waste our opportunity to prolong the life of a healthy Bolinas Lagoon. In my opinion, it would be tragic to walk away from the public interest and support that has been developed during the Bolinas Lagoon Ecosystem Restoration Feasibility Study, and return to "more studies." We have momentum, and support from elected representatives, government agencies, philanthropic organizations, and literally hundreds of private citizens.

A decision not to help Bolinas Lagoon at this time would truly be an opportunity lost, and a sad heritage to leave to future generations.

Sincerely,

A handwritten signature in cursive script that reads "Bucky Mass". The signature is written in black ink and is positioned to the right of the word "Sincerely,".



April 10, 2006

William Carmen, Project Manager  
Bolinas Lagoon Ecosystem Restoration Feasibility Study  
MCOSD  
3501 Civic Center Drive, Suite 415  
San Rafael, CA 94903

**RE: Revised Draft Bolinas Lagoon Ecosystem Restoration Feasibility Study**

Dear Mr. Carmen:

The California Waterfowl Association – a 21,000 member conservation organization dedicated to the preservation of California's waterfowl, wetlands and our outdoor heritage – has reviewed the Revised Draft Bolinas Lagoon Ecosystem Restoration Feasibility Study which details the possible evolution of the lagoon over the next 50 years under the “no action” plan. We believe that the revised draft feasibility study has clearly demonstrated the need to restore and enhance the lagoon in order to achieve a productive and healthy ecosystem.

Over the course of the past century, California has lost over 90% of its historic wetland and waterfowl habitat – by far the largest percentage loss of any state in the nation. Yet, three-quarters of Pacific Flyway waterfowl, representing over 20% of the North American continental population, must still depend on our few remaining wetlands and associated uplands for nesting, wintering and staging habitat. In addition, experts estimate that over 50% of California's threatened or endangered species are, in some way, wetland dependent. Clearly, we must make every effort to preserve and enhance the few wetlands which remain to maximize their habitat values for these species, and Bolinas Lagoon is no exception.

If the goal of the Marin County Open Space District is to manage the 1,200 acre lagoon to provide adequate habitat for a diversity of species, including waterfowl, restoration efforts should be undertaken in the very near future. Most importantly, any restoration plan for Bolinas Lagoon should include additional deep sub-tidal habitat, expanded eelgrass beds, and increased tidal flow and connection with Pine Gulch Creek.



**California  
Waterfowl  
Association**

4630 Northgate Blvd.  
Suite 150  
Sacramento, CA 95834

TEL: (916) 648-1406  
FAX: (916) 648-1665

It is our hope that the Marin County Open Space District will use the Bolinas Lagoon Ecosystem Restoration Feasibility Study as a document that will ultimately lead to a restored and healthy lagoon. Should you have any additional questions or comments, please feel free to contact me at (916) 643-4607.

Sincerely,

Bill Gaines, Director  
Government Affairs

March 31, 2006

Bill Carmen, Project Manager  
Bolinás Lagoon Ecosystem Restoration Feasibility Study  
Marin County Open Space District  
3501 Civic Center Drive  
Suite 415  
San Rafael, CA 94903

RE: Draft Reports Regarding the Evolution of Bolinas Lagoon

Dear Bill,

I support the comment in the March 19th letter from the Bolinas Lagoon Foundation sent to you to initiate a restoration project now. An exception to their suggestion is that the reintroduction of any native species not be done concurrent with a project, but left to a decision making process after careful monitoring of the project that would evaluate the pros and cons of such introductions and the probability of success.

Bolinas Lagoon is dependent upon a certain tidal exchange to sustain the creatures that exist at this time in the lagoon. The Draft Reports make clear that there will be a continual decline in the tidal prism into the future unless there is intervention. If a no project alternative is adopted we will continually observe the decline of marine organisms and the result of that decline due to further tidal prism loss. I have observed this ongoing dynamic from first hand experience.

The loss of plankton as the tidal prism continues to diminish and the resulting effect on the food chain all the way up to and including the birds is unacceptable. The closure of the mouth of the lagoon, no matter when it closes should not be the benchmark for intervention. Preservation and abundance of estuarine species should be our goal.

A discussion of how this can come about is needed immediately. I realize that intervention may cause unintended consequences, however I see from the dated maps that what is missing at this time is a functioning Bolinas Channel. This has come about in the most recent past of just a few years. I would imagine this is not the result of natural processes, but from the effect of human projects changing the course of the natural processes. The maps clearly show the Bolinas Channel has continued to be present through the time line of the maps. It would seem prudent and beneficial to approach re-establishing a circular flow in the lagoon by re-establishing the Bolinas Channel in such a way as to positively slow down the diminishing tidal prism. Adaptive management and monitoring would follow to achieve desired goals.

The Draft Reports demonstrate that the abundance of sediments delivered to the lagoon are ocean born as opposed to watershed sources at this time. The effects of the Bolinas

Groin and the Seadrift seawall are not made clear in the Draft Report III, Conceptual Littoral Sediment Budget. For example: are either of these projects accelerating the filling of the lagoon and just what is the net effect of one on the other at the mouth of the lagoon regarding the littoral sediment budget. Left out of the report: it is important to note that the first large major repair to the wall occurred in the winter of 1998/99 with approximately 3 times the number of tons of rock that was used to repair the seawall in 2004. The 1998/99 ran the entire length of development on the sandspit, whereas the 2004 repair was at the upcoast and downcoast sections of the seawall and not the midsection. There is another necessary repair to be scheduled this year. Continued and further hardening of the sandspit may be accelerating the transport of lateral sediments upcoast absent the dunes that if present over all of the sandspit, would accrete and store the sand until violent sea storms with high wave action would move the sand offshore. Conclusions reached in Future Condition # 24 (Page 7 Draft Report I) may need to be revisited as sea level rise will result in constant re-armoring of the Seadrift seawall to protect the Seadrift homes.

It has not been considered, but is there a possible project that could be designed at the mouth of the channel that would slow or neutralize the net littoral transport of sediments into the lagoon from either upcoast or downcoast. Another question, will the analyses of the corings be completed at some time?

I have enjoyed reading the Draft Reports. After living here so long and experiencing the lagoon both above and below the water, the Report seemed quite familiar. The past several years of study has produced enough information to act conservatively to initiate a project that would be most beneficial to the lagoon habitat. The lagoon is changing too fast to delay initiating a project. Thank you for providing the Draft Reports and the opportunity to comment.

Sincerely,

Cela O'Connor  
P.O. Box 116  
Bollinas, CA 94924  
oconnor@linex.com

Dear Bolinas Lagoon Committee,

Thank you for all your efforts for so many years to protect and preverve the great natural beauty and ecosystem of Bolinas Lagoon. I am writing to express my support for using methods that disturb the ecosystem to the least degree possible and to suggest the following as ways to encourage the critical tidal flow that feeds the ecosystem:

Easkoot Creek is clearly a major contributor to siltation of the lagoon. This winter, we have seen first-hand how great amounts of rock and silt made its way through our property on Calle del Pinos in Stinson Beach filling the stream bed tremendously and increasing the volume of silt going into the South end of the lagoon.

It would seem logical for your group to encourage GGNRA to create and alternative stream flow out through the Stinson Beach Park parking lot during heavy rains, mud slides etc. This strategy both helps reduce the amount of silt coming into the lagoon and eases the flood concerns of people living in Stinson Beach (many of whom were inundated on Dec. 31, 2005).

Separately, there have been numerous violations reported in regard to the current work going on in the Sea Drift Lagoon to repair the bulkhead and replace toxic-soaked pilings. I would suggest that the water and mud from the artificial lagoon be carefully tested before it is allowed to flow into the Bolinas Lagoon.

Charles Higgins  
850 Baker Street  
San Francisco, CA 94115

chiggins@ehss.org  
(415) 392-7600 x306



Dr. David Schneider  
OPTOMETRIST

(510) 848-6733 • ds6956@earthlink.net

3/06

1736 HEARST AVENUE • BERKELEY, CA 94703

DEAR PROJECT MANAGER CARMEN -

I urge the DISTRICT to ADOPT

an EASILY UNDERSTANDABLE STATEMENT,

to be prominently FEATURED at the

FRONT of the ADMINISTRATIVE RECORD,

THAT NO INTERCESSION in the

EVOLUTION of the LAGOON TO PREVENT

its CLOSURE is WARRANTED.

Sincerely -

DR SCHNEIDER

RECEIVED  
MAR 9 2 11 PM  
MARINE POLICE OFFICE  
1736 HEARST AVENUE

I have read the recommendations the draft report. I was very pleased with the conclusions and the recommendations and agree with them.

David A. Chenoweth  
Mill Valley, CA



Mr. Carmen,

I am writing on behalf of my family regarding restoration of the Bolinas Lagoon. My family has been part time resident for 4 generations dating back to 1921. My grand parents found the lagoon a very special unique inlet environment and in those days arrived in Bolinas on the Owl. My sister and I, growing up, fished from the dock and wharf beach, and actually caught bullheads and perch. My sister and I would watch the small fishing boats go out from the dock and come back with salmon and crabs. Some times if we were lucky a friend would take us with them to enjoy the experience. I would explore the lagoon by canoe and look over the side at the tiger sharks. My Dad would take myself and friends in a row boat from the Stinson side of the lagoon. Our family would watch literally thousands of pelicans come (the sky would be darkened with numbers before the DDT devastation) and go on a daily basis from the lagoon. We would fish from the lagoon mouth and beach for sea bass during the runs. On special occasions a number of local families would go for a short row from the dock to Kent island (you could not walk across like today) where we would have a picnic and BBQ hot dogs and marshmallows. It was a special time and more, an environmentally special place.

Well, the above says a lot for what my family thinks has been lost to future generations if man continues to mismanage the Lagoon which includes doing nothing. Doing nothing is wrong. We would recommend that whatever it takes to restore the lagoon is what should be accomplished and lets not continue to disagree, but instead start agreeing on a formative plan which will restore the lagoon as described above for generations to follow. My parents said my generation was the future and it would appear from looking at the current lagoon quality of life that we have not done more than the prior and present study. Now that we have the reports lets get going with the financing and resulting physical work so that restoration will take place now.

Sincerely,

Dean Remick Hart  
14 Terrace Avenue  
Bolinas  
2473 Deer Valley Lane  
Walnut Creek, CA 94598

Hello, I don't know if this will help or not, but I have just realized that I have missed the deadline to comment on the consultants' report. I tried to download the report but it seems to be so large that my computer couldn't handle it. Therefore I am unable to speak to its specifics.

I would, however, like to register my endorsement of the letter from the Board of the Bolinas Lagoon Foundation. I have had a life-long interest in the health and vitality of the eco-system of the lagoon and the entire West Marin area. My extended family and I are long-time supporters of the Audubon Canyon Ranch, we have owned various properties in Stinson Beach for over 50 years - and in Central Marin for longer than that. I know I speak for all of us when I say that the preservation and thoughtful, sensitive restoration of the Bolinas Lagoon and it's varied and extensive habitat are of great importance to us.

I will send my endorsement by mail tomorrow but in the meantime I am hoping that you will forward it to the appropriate recipients.

Thank you for your involvement and help.

Sincerely, Delanie Borden

Delanie Borden  
Design Coordinator  
San Francisco Decorator Showcase  
415.831.5678 (tel)  
415.302.6802 (cell)  
415.447.3175 (VM)

To:

Bill Carmen

following is article I handed you at BLTAC meeting - Thanks, Don  
3/3/06

from :

Don Slack

PO Box 517

Stinson Beach, CA 94970

home - 415 868 1921

days 415 453 8157 fax 453 0688

slackjd@sbcglobal.net

Bolinas Lagoon Ecosystem Restoration Project Public comments to Marin  
County Open Space District from Don Slack

#### SUMMARY

The Philip Williams Associate (PWA) report of 2/10/06 (pg. 91) shows a map of the predicted lagoon condition in 2050. It shows an unhealthy and dried up condition. Most of the subtidal and intertidal areas are lost to marsh and uplands.

The PWA report appears to be a good report having much useful data. However, it is limited in scope since it was commissioned to predict a future lagoon condition with no intervention and completed in a relatively short time compared to the extensive studies done previously. The PWA concludes that closure is not likely within 60 years. However, statements within the report imply closure could occur earlier.

Closure will have large negative impacts on lagoon plant and animal life since most depend on healthy functioning of an estuary system. (Much greater than the limited dredging proposed by the Army Corp. of Engineers (ACE) to maintain the lagoon)

One thing all the studies seem to indicate is that this is not an exact science. Scientist disagree on how to preserve the lagoon. Also some study conclusions are at odds with actual observations. Experimentation is needed to learn how to preserve the lagoon. Ample studies now exist. We should take actions now such as limited dredging in parallel with on-going studies to prevent further deterioration. Opening and deepening the Bolinas Channel and improving water flow to the north basin would have the immediate advantage of supporting local fishing activity as well as providing real data about what can be done to preserve to lagoon for generations to come.

#### COMMENTS, RECOMMENDATIONS, AND QUESTIONS

##### 1. Regarding Input for Decision Making

a. The ACE report completed in 2002 should be given equal weight with other studies. ACE representatives should have equal time in future meetings to present their views regarding needed actions to preserve the lagoon and to address criticism. Without this balanced input intelligent decisions cannot be made. The ACE report is extensive costing the taxpayer over two million dollars. It contains more

imperial data, eye witness data, and documentation of earlier studies describing lagoon conditions over the past 130 years than does the PWA report. Earlier surveying and measurement techniques were not as accurate as available to PWA but still provide valuable insight. John Winkleman was a key technical person writing the ACE report and should be part of the response team.

b. The ACE and PWA reports predict similar results in terms of lagoon specifics and the lagoon's future, (present and predicted tidal volumes, siltation rates, effect on habitat, and closure time) (pg. 105 PWA report). However, recommended actions differed. The ACE recommended dredging. PWA recommended monitoring. Why the difference? What does PWA consider the down side of dredging? Why does the ACE consider it important to start soon? What are the realities of time required to get a project started, funding, paperwork etc., compared to lagoon deterioration or closure.

2. Regarding time to lagoon closure from the sea:

a. The PWA report predicts 60 or more years to closure. It seems we can expect closure earlier. The ACE predicted 40 years as did PWA in earlier statements. (Marin Civic Center meeting PWA presentations Aug. 2, 2005)

b. The PWA prediction is based on global warming causing rise in sea level of 0.4 feet (pg. 7 para. 25) This is not likely due to the internationally recognized dangers of global warming, the rapidly developing technologies for ample renewable energy sources, and depletion of fossil fuels.

c. The PWA prediction is based on the O'Brian parameter, (pg. 84 of the PWA report) a relatively simple formula comparing wave and tide energy. Closure occurs when waves overpower tides. The PWA report states (pg. 87) closure can occur earlier under unusually high wave and low tide conditions. It seems these conditions are likely to occur a number of times over the next 60 years. Probabilities of early closure should be determined based on historical storm and tide conditions.

d. The PWA report (pg. 87) stated closure could be earlier than predicted by the O'Brian parameter due to shifting sands outside the lagoon mouth. Early closure probabilities due to this effect should be determined.

3. Regarding the ability of the lagoon to reopen after closure:

a. The PWA report referred to "periodic closure" (pg. 84 ). Is there any imperial evidence of estuaries similar to Bolinas reopening or not reopening after closure? If so where?

b. PWA report (pg. 87) refers to the Russian River closing and reopening. However, this does not appear relevant since the Russian River is a much larger water source than streams supplying the lagoon.

c, Don Danmeier of PWA commented that "it wouldn't reopen easily - probably intervention would be required" (Pt. Reyes Light article 2/16 by Alex Parsons).

4. Regarding imperial & eye witness history:

a. Earlier pictures of the lagoon such as shown in the PWA report pg. 22 show deep draft sailing vessels (seen at the south end of the wharf) drawing typically 8 or more feet of water. Numerous other photos in the Bolinas and Stinson historical archives show similar deep draft lumber schooners in the lagoon. Statements by captains of 19th century lumber schooners say a 10 foot draft ship could enter the lagoon at low tide. (ACE report)

b. In 1975 I helped a friend launch a boat drawing 4 feet of water which floated in the Bolinas Channel. The report does not attempt to understand or explain why the Bolinas Channel (the channel between Kent Island and Wharf road) went from several feet deep 30 years ago to closure today. A PWA representative stated (Nov. 7, 2005 lagoon meeting at Bolinas Elementary School) that this was beyond the scope of their study. An explanation of why the channel closed is needed.

c. These observations are not consistent with the PWA report that the lagoon depths have not changed much since 1854. An explanation is needed.

5. Regarding present lagoon use:

a. The PWA report does not attempt to address local fisherman's concerns regarding the loss of navigable waters over the past 30 years and their ability to continue fishing.

6. Regarding source of lagoon fill

a. Eye witness accounts report of large masses of the Bolinas cliffs falling into the sea during the 1906 quake. This event could substantially effect the amount of fill coming from the sea in subsequent years. Has this been considered in determining past and future fill from the sea?

b. Dr. Byrne, UC Berkeley (meeting Marin Civic Ctr Aug. 2, 2005) said he would make better determination of tidal sediment by measuring barium content - was this done?

c. Dr. Byrne (meeting Marin Civic Ctr Aug. 2, 2005) suggested a large part of the lagoon siltation was coming from the Bolinas cliffs. However, the total mass coming from the cliffs per year is about 40,000 cu meters (assuming 2000 m to Duxberry x 30 m high cliffs x 0.6 m/yr erosion) The fill in the lagoon is about 50,000 cu meter/yr (based on 1100 acre x 1 cm/yr fill). Since it is likely only a small fraction of Bolinas cliffs would find their way into the lagoon, it seems this would contribute at most a few percent. What is the PWA basis for determining this source of fill.

7. The loss of lagoon depth was reported by Dr. Byrne, UC Berkeley (meeting Marin Civic Ctr Aug. 2, 2005) as about one cm/year over the past 90 years. Does PWA or others have rates over the last 10, 20, and 30 yr. time frames? From casual observation loss of lagoon depth seems greater than this over the past 30 years.

8. The PWA report contains lagoon photos showing conditions then and now. However tidal conditions at the time the photos were taken is not known (per PWA statement Nov. 7, 2005 lagoon meeting at Bolinas Elementary School ). It seems that to determine historical water

levels tide conditions must be known since even today the lagoon can appear empty or full depending on tide.

9. Morro Bay estuary is very similar to Bolinas having similar sand spit and reef structures north of the opening as well as similar watershed stream input. The ACE dredges this for a month or two every 5 years or so to prevent closure and retain the estuary properties. A comparison to the Morro Bay model would be informative.

end

Don Slack  
PO Box 517  
Stinson Beach, CA 94970  
home - 415 868 1921  
days 415 453 8157 fax 453 0688  
slackjd@sbcglobal.net

March 24, 2006

William Carmen, Project Manager  
Bolinás Lagoon Ecosystem Restoration Feasibility Study  
Marin County Open Space District  
3501 Civic Center Drive, Suite 415  
San Rafael, CA 94903

Dear Mr. Carmen:

I fully support the position of the Bolinas Lagoon Foundation in its March 19<sup>th</sup> response to the Phil Williams Associates report of Feb. 10. A limited restoration project would preserve the diversity and extent of marine and seabird habitat with minimum disturbance and large net positive impact on the overall ecosystem. The Army Corps of Engineers plan was excessive, but doing nothing is irresponsible.

Local residents who have been observing the Lagoon over the past few decades are practically unanimous in their assertion that there have been dramatic changes during that period, including reduction in water depth and area, and increase in height and extent of mudflats and their vegetation. Just in the last decade, the Kent Island forest has at least doubled in volume. Even if PWA is correct in concluding that the Lagoon is unlikely to close within 50 years, during that period there will certainly be a substantial, and to me unacceptable, reduction in marine and seabird habitat and diversity. Moreover, if closure does occur, "intervention" (dredging) will definitely be required anyway to re-open the channel to the sea.

Human activity has created this problem, and we should now do our best to undo the damage. Even now, the repeated and possibly illegal addition of thousands of tons of rock to the Seadrift beach wall is adding to the problem. The sea hits the wall, the wall sinks and pushes sand out into the sea, and the sand gets carried into the Lagoon. This is an easily avoidable source of human-induced siltation that continues only for political reasons at the expense of the Lagoon.

We have been studying and debating this precious Lagoon's demise for over three decades. It's time now to do what needs to be done before it is too late.

Sincerely,



Don Smith, Ph.D.  
Member, Board of Directors, Bolinas Community Public Utility District  
PO Box 67  
Bolinás, CA 94924

Hi Bill

I am concerned that the recent report on the Bolinas Estuary downplays the potential devastation that closure will produce.

Some species will be negatively impacted is an understatement at best. The clear assumption that the mouth will re-open at some time is ... an assumption.

The public needs to see a clearer picture of what this area will look like one day after closure, one week after and so on to the possibility of permanent closure and its consequences.

If one ounce of prevention is worth a pound of cure then perhaps mechanical means should be used to



die in the first twenty four hours of being denied fresh ocean water. They also feel that within a few days the marine mammals will leave, as will the herons, egrets and all other fish eating birds. The fish will be very unhappy as well.

In a cost-benefit analysis<sup>3P</sup> preventing closure is clearly the right choice.

JOSH CHURCHMAN  
Box 5 of.  
BOLINAS CA 94924  
415-868-0987

To: Bill Carmen  
Open Space District  
March 30, 2006

Dear Bill,

As a busy working person, and not a scientist, I have strived to understand the issues regarding the Bolinas Lagoon Ecosystem Restoration Project. I believe that the consulting team of W. Phillips and the participating technical advisory groups have compiled an excellent study of the history and issues of sedimentation and lagoon species and biology. From this study and continued research, an adaptive management plan can hopefully be realized.

\*I do not believe that the closing of the lagoon's channel mouth within the next 50 years is the only red flag for concern. Access by boat (as tidal levels allow) to the wharf across from Kent Island is also very important. In an emergency, those who can not walk far, the very young and old and the disabled, would rely on boat transport to leave the area.

\*Would it be of any use to project the consequences of what the original dredging project by the Army Corps of Engineers would have done to the lagoon's food chain?

\*Can a more simple draft for the average citizen be formulated that explains the importance of the tidal prisms and how there can be a significant improvement?

Thank you, Janine Aroyan, PO Box 1004, Stinson Beach, CA

Feb. 20. 2006

Dear Mr. Carmen

I am writing to urge The District to adopt an easily understandable statement on dredging The Bolinas Lagoon, & why it would be futile to do so.

This statement should be prominently featured at the front of The Administrative Record.

It should plainly state: No intercession in the evolution of the lagoon to prevent its closure is warranted.

Sincerely yours,  
Joan Hansenman Robbins  
Box 61 Overlook Dr.  
Bolinas, Ca 94924

MARIN COUNTY  
PARKS & OPEN SPACE  
FEB 24 2006  
RECEIVED

Hello,

I am a Bolinas resident. Please restore the lagoon. I believe it is clear that the lagoon has been altered due to the actions of mankind. We must use the means at our disposal to restore the lagoon.

Thank you,

Joe Straton

Dear Mr. Carmen,

We have spent over ten million dollars studying the lagoon over the last ten years.

Had we spent those millions excavating the lagoon, we would have made significant progress towards the restoration of this national treasure.

I fear we may simply be caught now spending more money on lawyers and experts of all sorts. At the end of the day (or decade) we will have done nothing to better the state of the lagoon, but the "professionals" will be able to retire comfortably.

In short: Stop the bureaucracy, start the excavation!

Thank you,

John C. Nickel  
Stinson Beach Resident.

Mr Carmen,

I have been a part-time resident of Bolinas for the past almost 33 years. I was lucky enough to marry into a family that had been part of your community since 1921. I am a California native and had never been to this beautiful place.

Over the years it has been our refuge. Our permanent residence and place of work is Walnut Creek, so it's a couple of hours away - and at the same time, another planet. Over these many years we have and continue to look forward to getting to Bolinas to walk on the beach and get our priorities straight again. Our three children have memories of being there with their Grandmother when they were little, and throughout their years growing up. Two now live in Seattle, but whenever they come home a trip to Bolinas is always part of their plan.

I have watched the lagoon slowly fill up with sediment over these past years. Now it's down to almost a trickle at low tide. How sad for the fisherman who rely on the access to the ocean for their livelihood. The years and years of study and talk, what to do or not - have bogged us all down to a position of being stuck in the mud - almost literally. If we wait not very much longer and talk with no action, there will be no lagoon, no place for the fishermen, no refuge for the marine life.

We need a definitive plan and we need to get started. The studies are complete and say pretty much what the rest of us can see with our naked eyes. It's time to stop studying and start acting.

Sincerely,

Kathleen Hart

14 Terrace Avenue

Bolinas



# MARIN CONSERVATION LEAGUE

1623A Fifth Avenue • San Rafael, CA 94901

(415) 485-6257 • Fax (415) 485-6259

e-mail: [mcl@marinconservationleague.org](mailto:mcl@marinconservationleague.org) • website: [www.marinconservationleague.org](http://www.marinconservationleague.org)

March 24, 2006

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William Carmen, Project Manager  
Bolinas Lagoon Ecosystem Restoration Feasibility Study  
MCOSD - 3501 Civic Center Drive, Suite 415  
San Rafael CA 94903

## Re: Projecting the Future Evolution of Bolinas Lagoon

Dear Mr. Carmen:

Thank you for allowing public comment on these documents. We are writing for the Creeks, Wetlands and Watersheds Committee of Marin Conservation League (MCL). MCL, as you know, has a seventy-year history of being involved in stewardship of Marin County's lands and in helping to plan for human use of the land with the smallest amount of impact on the natural systems of the County.

We have read the *Bolinas Lagoon Management Plan Update* (1996) and the DEIS/R and Draft Feasibility Report (2002) on the Bolinas Lagoon Ecosystem Restoration Project. We found the DEIS/R to be a grossly inadequate rationalization for a large USACOE dredging project.

The Creeks, Wetlands and Watersheds Committee would like to complement you, MCOSD Assistant General Manager Ron Miska, the District, and the consultants for preparing *Projecting the Future Evolution of Bolinas Lagoon* and its accompanying supporting documents. While the peer review comments indicate a few areas of concern, this document seems very thorough and complete. The conclusion that the Lagoon will likely not close in the next fifty years is one that we certainly hope is true. It may not be accurate, however, and we feel that there are several factors in the dynamics of the lagoon that have not been adequately addressed. These include: 1) study of the impacts of the revetment, Seadrift lagoon and groin on the lagoon's tidal flushing action; 2) the lack of hard data to determine the sedimentation rate in the south end of the lagoon; and 3) *Spartina alternifolia* which is present in San Francisco Bay and has the potential of swiftly establishing on frequently exposed mudflats destroying the habitat value for native species and cross pollinating with California cord grass. The growth of this large grass on the mudflats would also drastically change the sedimentation rate.

The Committee makes the following requests:

We request that the study include the present day (1960 to 2006) patterns of sedimentation that are influenced by the physical construction of Seadrift.

We ask that the study include the measure of actual sedimentation rate of the south end of the lagoon and the degree of confidence with which the sedimentation rate was calculated.

We request that the District add the monitoring for the invasive species of eastern cord grass.

We feel that in the absence of any negative findings in the above sedimentation studies, close monitoring of significant indicators by predetermined agencies or parties and carefully designed management interventions (if the indicators show a potential problem) will be the best solutions for protecting the long-term ecological health of Bolinas Lagoon.

Yours sincerely,

Jana Haehl  
President

Kathy Cuneo, Ph.D.  
Chair of MCL's Creeks, Wetlands and Watersheds Committee

CC: Marin County Board of Supervisors  
Marin County Planning Commission  
Sharon McNamee, Director, Marin County Parks and Open Space District

APR 11 2006  
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*Marin County's Environmental Watchdog*

A nonprofit corporation founded in 1934 to preserve, protect and enhance the natural assets of Marin County

Bill,

Suzanne is correct regarding the historical use of groins. One needs only ask Louise Pepper the where and how they were constructed. As I recall her telling me once, there were somewhere in the neighborhood of 4-5 small wooden structures that stretched pretty much from the present day groin up to roughly the "potato patch". They were built and maintained by the towns people, but, fell into disrepair during WWII.

Also, its my understanding, at the time of the Coastal Act going into effect a window was open permitting residents to install rip-rap. You will find rip-rap at the base of Bill/Pat Barton's house (Paul Kafetz at the time) and Ralph Garside's house. It wasn't installed correctly in some spots. Other residents at the time did not install rip-rap mostly due to cost.

Rip-rap is still being permitted today. The Gannis' (who live on the Little Mesa and are roughly next door to the Nunn's retreat) were given approval by the County about two years ago. However, they've not been able to install it due to issues with right of access with the Bolinas Rod & Boat Club.

The seawalls at various points along the beach are, so I'm told, not permitted. Regardless, the net effect of the patchwork system of seawalls and rip-rap increases the wave energy in those areas that are not protected. This likely increases the amount of wash-off from the bluff.

I would imagine that all the proper studies have been done. However, if additional evidence is needed as to the cause of the lagoon sedimentation, the various soils engineers in the area (many of whom have been serving the area for decades) can be an invaluable resource of information. They would validate that bluff soil is what creates the wide brown strip just off the beach that ultimately finds its way into the lagoon.

Suzanne says we should write to you as part of the "public comment". Please let me know if there something else that can be done in this period.

Kind Regards,

Mark.

---

**From:** SEVWAVE@aol.com [mailto:SEVWAVE@aol.com]  
**Sent:** Wednesday, March 15, 2006 12:35 PM  
**To:** scrubjay@sbcglobal.net; jeciani@svn.net  
**Cc:** joeldiana@msn.com; biobill@pacbell.net; byohn@olympus.net; campmw@earthlink.net; Mark Dempster; donsmith@microweb.com; joniharding@earthlink.net; Pmisty316@earthlink.net; Susiebuell@aol.com  
**Subject:** Bolinas Lagoon. Bill Carmen Open Space District



Dear Bill ,

It was a pleasure to meet you at the Bolinas Lagoon Technical Advisory Committee meeting in Stinson on March 3.

I just want to reiterate what I said there so that you will be able to include this in your upcoming report.

Based on the new knowledge that much of the sediment filling the lagoon is coming from the ocean cliffs,

and

Based on the past practice in Bolinas of using small groins very widely spaced along the beach to keep the ocean from attacking the cliffs directly and thus minimizing ocean erosion,

I would like to propose that a simple groin system be considered to help allay the cliff erosion and the resultant filling in of the lagoon.

Thank you for preparing the community feedback report.

I understand that you need to collect all feedback by March 31.

Best regards,  
Suzanne Ciani

Tel: (415) 868-2239  
Cell: (415) 307-8867

May 1, 2006

William Carmen

Bolinas Lagoon Project Manager  
3501 Civic Center Drive #415  
San Rafael, CA 94903

Dear William Carmen,


I am writing as a concerned citizen who is against the dredging of the Bolinas lagoon or the mouth of the Bolinas Lagoon.

I am writing to urge the District to adopt an easily understandable statement, to be prominently featured at the front of the Administrative Record, that no intercession in the evolution of the lagoon to prevent its closure is warranted.

As citizens and municipalities we have allowed the Army Corps of Engineers to do many great projects, and to make many mistakes. The environment has paid a high price for these mistakes and so will we. Please make a wise decision.

Thank You!

Sincerely,

  
Maya O. Carson

Maya O. Carson  
510 62nd Street  
Oakland CA 94609

William Carmen  
Project Manager  
Bolinás Lagoon Ecosystem Restoration Feasibility Study  
MCOSD  
3501 Civic Center Drive, Suite 415  
San Rafael, CA 94903

March 21, 2006

Dear Mr. Carmen:

We have been interested in the health and preservation of the Bolinas Lagoon for more than twenty years, and have been actively engaged in the ongoing evaluation of the Lagoon for the last five years. We've attended several public meetings sponsored by Marin County to update the public on the study project, and heard from many of the consultants and more vocal members of the community on this topic.

The central themes at these public meetings have revolved around a few basic questions:

- Are the changes in tidal prism in the lagoon due to natural or "man-made" causes? Should the answer to this question dictate our response to the filling in of the Lagoon?
- Is a meadow as "valuable" a natural resource as a lagoon? Specifically, would a meadow be as valuable as the tidal estuary that now exists? If the Bolinas Lagoon evolves slowly into a marsh and mud flat with little or no deep water, will it be as "valuable" a resource as it is now, or was fifty years ago?
- What determines value as far as the Lagoon is concerned? Should the Lagoon be able to support the diversity of species that now live there (or lived there within the last fifty years, prior to the current silt accumulation trend)? What about aesthetics and the value of tourism to the area? What about the economic value of the lagoon acting as a fish nursery, as it has done historically?

After listening to and participating in the study process for these last few years, we believe that the answers to these questions are all very clear. It is obvious that man-made changes to the watershed, to the area around the mouth of Pine Gulch Creek and elsewhere, along with other human intrusions, have seriously compromised the Lagoon's ability to flush sediment out to sea. Even if there were no human causes for the Lagoon filling in, it is unassailably true that due to increased development along our coastline, the Lagoon is an exceedingly rare resource along the western coast of the Americas. California's wetlands have been drastically reduced, with disastrous effects on a wide variety of migratory fish, bird, marine mammal and other species. The idea that the Lagoon would be equally valuable as a meadow is absurd to the point of offense.

The current study being presented by the consultant group is very short on biological data, which is a critical oversight. There is very little reference to the animals that have historically lived and currently live in the Lagoon. Without these data it's impossible to truly assess what is at risk, locally and regionally, in allowing the Lagoon to continue to fill in. We need to understand what we are losing in order to determine whether and how to avoid that loss.

In summary, the Lagoon must be preserved as an open water tidal estuary. This was a criterion established when the State transferred responsibility for stewardship of the Lagoon to the County of Marin. Failure to do so will be a breach of this responsibility, a breach of trust of the people of California, and an enormous resource management policy failure with permanent environmental consequences. All of this will be a black mark on the government of the County of Marin, where of all places, we should be able to preserve a resource of such clear and unique value as the Bolinas Lagoon.

Respectfully,

Nicole Lederer and Larry Orr



(415) 310-5109

**Peter R. Baye, Ph.D.**  
*Botanist, Coastal Plant Ecologist*  
**P. O. Box 65, 33660 Annapolis Road**  
**Annapolis, California 95412**



[baye@earthlink.net](mailto:baye@earthlink.net)

William Carmen, Project Manager  
Bolinás Lagoon Ecosystem Restoration Feasibility Study  
Marin County Open Space District  
3501 Civic Center Drive, Suite 415  
San Rafael, CA 94903  
[scrubjay@sbcglobal.net](mailto:scrubjay@sbcglobal.net)

**SUBJECT:** Comments on Bolinas Lagoon Restoration Project re-scoping documents: “Projecting the Future of Bolinas Lagoon”, “Recent (1850-2005) and Late Holocene (400-1850) Sedimentation Rates at Bolinas Lagoon”, PWA Conceptual Littoral Sediment Budget memorandum, and Peer review comments

Dr. Carmen:

Please consider my comments below on the subject documents concerning the environmental analyses for re-scoping of the Bolinas Lagoon Restoration Project (BLRP). I previously submitted detailed technical comments on the BLRP EIR/S and Feasibility Study in 2002 (Attachment A; incorporated here by reference).

My 2002 comments were highly critical of the premises for the BLRP and its analyses, as well as the analyses themselves. My technical criticisms focused on the original report’s negligence of seismic subsidence cycles as a primary natural driver of the geomorphic and ecological development of the backbarrier lagoon; its exaggerated and erroneous claims of logging-induced fluvial deltaic sedimentation as a primary cause of lagoon degradation; and misidentification of natural flood tidal delta sedimentation rates and patterns as symptoms of artificial, anthropogenic disturbance. I also stressed the inadequacy of the original report’s analyses of sea level rise influence on backbarrier lagoon sedimentation, and potential dredging impacts on flood tidal delta sedimentation, barrier beach erosion, and tidal marsh ecology. I was one original source (and perhaps the original source) of recommending a scientific peer review system for the entire project.

Peter R. Baye Ph.D.  
Coastal Plant Ecologist  
[baye@earthlink.net](mailto:baye@earthlink.net)

(415) 310-5109

P.O. Box 65, 33660 Annapolis Road  
Annapolis, California  
95412

In addition to my technical criticisms of the original BLRP documents, I was (and remain) concerned about the appearance of systematic bias in the presentation of technical information to the general public, and biases in the analysis and interpretation of scientific data.

The report of Byrne and Reidy (2006) and the Peer Review Team comments (Collins, general ed. 2006) substantiate my original technical criticisms, and at least partially support my concerns about biases in public presentation and analysis. The PWA/WRA report on projecting the future of Bolinas Lagoon (PWA and WRA 2006) has largely reversed the principal findings and conclusions of the BLRP EIR/S and Feasibility study, and has partially adopted the principal conclusions of Byrne and Reidy (2002) in the face of overwhelming, authoritative stratigraphic evidence regarding the late Holocene sedimentation patterns and paleoecology of Bolinas Lagoon (consistent with the conclusions my 2002 comment letter).

The PWA and WRA (2006) document, however, still exhibits some significant appearances of bias that must be identified and corrected to prevent biased interpretation by the general public, regulatory agencies, and decisionmakers who rely on these technical documents for their understanding. The Peer Review group did identify some of these problems with misleading or biased treatment in the PWA & WRA report, but the responses to these comments are still inadequate. The PWA & WRA (2006) report also includes some incorrect information on the ecology of Bolinas Lagoon, and some significant deficiencies in analysis. Generally, the PWA & WRA report still overstates the risks and threats of lagoon sedimentation, understates the risks of accelerated sea level rise and estuarine submergence, and understates the composition and biogeographic significance of the Bolinas Lagoon tidal wetlands. These deficiencies are discussed in comments below.

### **Lack of context: omission of comparison with 2002 Bolinas Lagoon “Restoration” Project documents**

Perhaps the most disorienting and misleading aspect of the 2006 reports for public understanding is the outstanding lack of context with the 2002 Bolinas Lagoon Restoration Project EIR/S and Feasibility Report. The current documents fail to contrast and compare the specific, fundamental original findings and recommendations of the 2002 documents with those of the 2006 documents. In failing to do so, the reports as a whole obscure rather than illuminate the fundamental purpose of this exercise. The lack of explicit point-for-point reference to the original basic findings and recommendations of the BLRP, and the specific scientific reasoning for changing them (or in most cases, reversing them), erases the project’s history of error. Given the magnitude of public funding and potential impacts of the original proposal, correcting these errors, and

emphasizing the causes of error, are significant to both public interest and scientific interest.

As indicated in my 2002 comment letter (Attachment A), the 2002 EIR/S and Feasibility Report asserted that Bolinas Lagoon was at an unacceptable, predictable, imminent risk of infilling with sediment to become a “meadow” and suffer catastrophic inlet closure. The original proposal recommended correcting a supposed pathological lagoon condition of reduced tidal prism and excess residual, persistent sediment that were attributed to artificial sources, logging and agriculture in the 19<sup>th</sup> century. This account was entirely incorrect. The current, corrected account, following the definitive study of Byrne and Reidy *et al.* (2006), confirms that the lagoon sedimentation is mostly natural flood tidal delta deposition, with relatively insignificant long-term reduction of tidal prism due to logging/agricultural sediment, relative to littoral (beach/flood tidal delta) sources of sediment. The revised 2006 reports confirm that the loss of tidal prism due to 19<sup>th</sup> century sedimentation was more than compensated by seismic subsidence of the lagoon in 1906, a recurrent process. The Byrne and Reidy *et al.* research confirms that the lagoon’s accelerated flood tidal delta sedimentation during the 20<sup>th</sup> century was a natural response to the natural deepening of the lagoon following the 1906 earthquake. The original project’s argument that artificial deepening of the lagoon (dredging) would be needed to rid the lagoon of artificial (logging-related) sediment deposits, and compensate for persistent artificial reduction of tidal prism, is entirely contradicted by fact. As the peer review team noted, this point is obscured in the PWA & WRA 2006 report:

We think the Administrative Report should state this message more clearly....lack of clarity....unduly complicated.... narrative about the evolution of Bolinas Lagoon....story gets lost in the details of the data and their analyses.

The “story”, the fundamental message about the reversal of the original project premises, is not so much “lost” as misdirected. The Peer Review group, in contrast with the obfuscation of the PWA & WRA report, communicates in plain and accurate language, to the benefit of public understanding, the fundamental revisions based on the best available scientific data and analyses:

We especially welcome the study’s emphasis on gaining basic understanding about the *relative roles of natural history and human history in shaping the lagoon’s existing condition....* two major conclusions can be drawn: *the lagoon mouth is unlikely to close and the overall ecology of the lagoon is unlikely to change in significant ways during the foreseeable future... empirical measurements of sedimentation patterns and sources of sediment....indicating that the shallow lagoon has not closed in the past, even when land use practices and earthquakes yielded sediment loads much greater than occur now....* Secondly, but perhaps equally important....*the bulk of the sediments in the major basins of the lagoon originate from the near-shore ocean (i.e., littoral) environment and from the bluffs just outside the lagoon, rather than from the local watersheds....* since the lagoon is unlikely to close in the foreseeable future, *no*

*intercession in the evolution of the lagoon to prevent its closure is warranted... one major dredging event...would increase tidal flood flow and thus bring more sediment into the estuary...lead[ing] only to more dredging.... There is an absence of ecological problems that would be mitigated by such apparently unnecessary preventive actions....* [italics added for emphasis, not in original]

It should be abundantly clear why these Peer Review criticisms require emphasis in the final report. The original project proposal claimed to be “restoration”, and pursued federal funding on that premise. This fundamental “restoration” premise is clearly invalid. Any intervention in the lagoon’s development would be environmental engineering unrelated to any accepted scientific or popular concept of “restoration”.

### **Sea level rise, “equilibrium”, and sedimentation.**

Even the Byrne and Reidy *et al.* (2006) and Peer Review group comments somewhat understate the reversal of one of the most important contrasts between original argument of the BLRP EIR/S and the current report. This regards the nature of vertical marsh accretion in relation to the tidal frame during sea level rise. EIR/S previously asserted that marshes would emerge above the tidal frame and become terrestrial “uplands” or “meadows”. This conclusion is reversed by Byrne and Reidy *et al.* stratigraphic evidence, amplifying the earlier conclusions of Rowntree. There is no scientific literature supporting a credible threat of imminent spontaneous conversion of tidal flats and tidal marshes to “uplands” during marine transgressions (sea level rise) even where sediment budgets support significant net tidal sedimentation (Allen 1994, Chmura *et al.* 2001, French 1993, French *et al.* 1994, Haslett *et al.* 1993, Nielsen and Nielsen 2002). Indeed, in estuaries where significant net sedimentation occurs, it generally causes net elevation change in lower intertidal zones rather than upper intertidal zones (Chmura *et al.* 2001, Nielsen and Nielsen 2002). Tidal marsh “drowning” (submergence; conversion to unvegetated flats, subtidal shallows, or conversion of high marsh to low marsh) is recognized nationally as a significant threat to tidal marshes of the U.S., including the Pacific Coast (Reed 1990, Reed 1995, Kennish 2001). The reports do not discuss how a positive sediment budget at Bolinas may be an environmental benefit for the marsh and flat ability to keep pace with accelerated sea level rise, given high uncertainty about secular rates of submergence.

The Peer Review group, however, failed to provide a rigorous critique of the misleading assumptions about sea level rise used in the PWA & WRA report. The PWA & WRA report applied an assumption of 0.4 ft sea level rise over 50 years without assessing the probability (confidence estimate) of this value, its underlying uncertainties, or the range of likely sea-level rise rates with equal or similar probability. The Peer Review group merely noted that this value “is a moderate estimate for the future rate of sea level rise” and instead emphasized uncertainty about benchmarks and elevation accuracy. In fact,

the estimated rate of 0.4 ft sea level rise is a highly conservative to low estimate that does not reflect the enormous (and growing) uncertainty about forecast accelerated sea level rise within the 50 to 100 year time frame (on the order of meters, not centimeters; Ekstrom *et al.* 2006; Otto-Bleisner *et al.* 2006; Overpeck *et al.* 2006) when climate change dynamics and ice sheet retreat are considered. The report should utilize the best available international scientific data and methods for risk assessment pertaining to coastal change forecasting related to accelerated sea level rise (Cowell *et al.* 2006, IPCC 1995, Paskoff 2004, Walsh *et al.* 2004). As Cowell *et al.* (2006) state regarding impacts of sea level rise on sand beach coastlines:

Predictions about these impacts are subject to intrinsic uncertainty...Transparency issues arise if deterministic models convey a false sense of confidence because of the predictive precision with which the results are stated, especially if the rated accuracy is not specified. The problem...is not so much with the models but with the way they are applied...The first step to managing uncertainty is to admit the key sources of uncertainty into models of long-term coastal change....In this respect, probabilistic forecasts provide a more transparent basis than deterministic predictions for coastal management decisions.

Addressing the uncertainties of sea level rise rates is significant because PWA concludes that sedimentation in the 50 year planning time frame will exceed sea level rise. This conclusion would not be supported if a probabilistic approach to sea-level rise, consistent with the best available scientific evidence regarding climate change and ice sheet retreat, is considered.

I fully agree with the Peer Review team's assessment of PWA's misuse and overuse of the concept of "equilibrium" which is applied rather indiscriminately as a rhetorical, non-scientific equivalent or surrogate for the concept of "natural". There is simply no empirical evidence for actual (as opposed to dogmatic or purely idealized, theoretical) "equilibrium" geomorphologic or ecologic conditions in Bolinas Lagoon. As Byrne and Reidy *et al.* (2006) state:

Perhaps the most important conclusion to be drawn from this part of the study is that prior to the period of American settlement Bolinas Lagoon was not a deep water lagoon persisting in equilibrium with slowly rising sea level. On the contrary, natural disturbances in the form of earthquakes, and possibly even a major tsunami, have repeatedly disturbed what was a relatively shallow lagoon throughout the period of record. The earthquakes in particular were important in that they caused the tectonic subsidence responsible for the continued existence of the lagoon.

The Peer Review consensus also supports this view, and stresses how misleading its use or misuse can be for public comprehension of the basic environmental issues, especially in a "restoration" context:

...dynamic equilibrium" is overly applied.... The consultants need to be clearer about how they use the term.... We do not think the concept is usefully applied to the whole lagoon.... the overall abundance of



each geomorphic unit continues to either decrease or increase, without a “leveling-off” or asymptote being achieved.... in the aggregate they do not exhibit equilibrium.... The concept of dynamic equilibrium is least applicable to the lagoon as an ecosystem.... The over-use *and perhaps misuse* of equilibrium concepts for the lagoon system as a whole affects the overall tone of the Administrative Draft report, *which in turn can foster unrealistic public expectations*. There is a *psychological element* associated with equilibrium and restoring equilibrium; equilibrium is easily interpreted as the natural state threatened by human activity.... The scientific evidence points to Bolinas Lagoon being a variable system, well adapted ecologically to respond to changes in sediment accumulation or erosion. By contrast, the equilibrium concept suggests a management or governance responsibility to reduce this variability by fighting nature: e.g., if the estuary is filling-in because of human actions, then we should be prepared to restore it to its natural state to compensate for our activities. To do so would ignore the evidence that human actions have had rather minor effects on the lagoon as a whole, and could cause ignorance of the negative consequences of the “restorative” actions themselves....it ought to be stated that the expansion of tidal flats and marshes will continue to slow until the next major earthquake... 6. Remove reference to dynamic equilibrium (see general comments above); 9. De-emphasize the notion of environmental or system “balance.” 17. Omit reference to equilibrium....; 18. Remove reference to dynamic equilibrium....; 24. Remove reference to dynamic equilibrium (see general comments above)...

[italics added for emphasis, not in original]

The Peer Review’s team’s astute concern for public perception and understanding of successional trends in the lagoon in light of artificial “equilibrium” rhetoric is laudable, and I concur emphatically:

...most visible recent changes in lagoon condition are the increases in tidal marshes and tidal flats on the west side of the fault line, near the town of Bolinas.... Their effect has also been negligible on the distribution and abundance of most species of plants, fishes, and other wildlife that occur in the lagoon. However, the high visibility of these changes can nurture a public concern that exceeds what is warranted by their actual effect on the lagoon ecosystem...

The PWA analysis repeats dogmatically, without empirical data or appropriate citation of the relevant contemporary scientific literature, that wind-wave and fetch relationships within the lagoon are significant factors for maintaining an “equilibrium” condition of unvegetated tidal flats, and that the fluvial delta progradation of Pine Gulch Creek disturbs this “equilibrium”. There exist appropriate, accurate methods of predicting shallow-water and intertidal wave energy (Cooper 2005, Johnson 1998) and reciprocal wind-wave/fetch and tidal marsh vegetation interactions (Moeller *et al.* 1996, Roland and Douglass 2005). The analysis of wind-wave effects on tidal flat/marsh sediment transport and ecological succession must account for the fact that much of the southern lagoon is sandy, and swash bar accretion, rather than silt resuspension, is a potential mechanism of shoreface response to wind-waves or refracted swell in the lagoon. Tidal marsh succession in sandy reaches of Drakes Estero and Limantour Estero occurs on and in the lee of irregular swash bars generated by lagoon wind-waves. This constructive process evidently occurs annually on portions of the Kent Island flood tidal delta as well (P. Baye, pers. observ. 1996-present). Moreover, tidal flats and especially vegetated marsh

are well-known for their ability to attenuate wind-wave energy (Moeller *et al.* 1996); without field studies in marsh plant colonization, there is no justification for assuming that wind-waves *per se* in Bolinas Lagoon are the primary ecological factor for maintaining unvegetated tidal flats, let alone “equilibrium” conditions.

### **Assessment of earthquake potential in 50 year planning frame**

The PWA and WRA report makes non-probabilistic assumptions about San Andreas earthquake/seismic subsidence events “Because large earthquakes ...occur every few hundred years, their effects were not considered in 50 year project” . This is not consistent with the empirical stratigraphic record reported by Byrne and Reidy *et al.* (2006): “ mean [earthquake] recurrence interval is ca. 300 years, although the time between the second and third earthquakes was only 130 years!”, which does not support the concept of a minimum multi-century threshold interval between major earthquakes. More significantly, it does not cite or apply any probabilistic models for San Andreas Fault activity recognized by the U.S. Geological Survey. The all-or-nothing “no quake in 50 years” assumption should be modified in a probabilistic framework.

### **Ecological assessments**

The assessment of the ecological conditions and forecast conditions of Bolinas Lagoon in the PWA and WRA (2006) report is based on a superficial and incomplete inventory, mostly species lists. The report does not provide any regional conservation biology context for the communities or populations in Bolinas Lagoon (see technical corrections, below, for a few selected examples). An outstanding example is Pine Gulch Creek delta. There are almost no natural ecotones between fluvial deltas and tidal marshes in the San Francisco Estuary, and most of the examples in Point Reyes are degraded by cattle grazing and trampling. The fluvial delta-tidal marsh ecotones of Bolinas Lagoon, southwestern Tomales Bay, and the Los Osos Creek delta are the outstanding examples (reference sites) of this ecotone in Central California. The PWA &WRA report, however, emphasizes the origin of the Pine Gulch Creek delta as a product of artificial channelization and excessive historic watershed sedimentation. This environmental perspective is quite inverted. The intact community structure and biological diversity of the ecotonal deltas of northern Bolinas Lagoon have substantial scientific, educational and esthetic value as biological resources.

### **Tidal inlet dynamics**

The conceptual littoral sediment transport budget should be based on a spatially explicit, morphodynamic model of tidal inlet behavior (Cleary and Fitzgerald 2003, Fitzgerald 1996, Kana *et al.* 1999, Mann 1993) and fully consider the limiting effect of foredune

armoring on Stinson Beach as it affects long-term sand budget for the flood tidal delta when sea level rises over 50 years, and the beach profile retreats (Young and Ashford 2006). The model should quantify actual net longshore drift (not “potential”) along Stinson Beach, and rigorously review whether the modern barrier beach has a swash-aligned (refracted wave orthogonal adjusted) or drift-aligned tidal inlet (Davies 1979, Hume and Herendorf 1992). The proportion of (mudstone) cliff-eroded sediment that is sand-sized and relevant to flood tidal delta accretion should be quantified. The effect of sea level rise (reasonable range of rates), shoreline retreat, and beach profile adjustment on the longshore transport of sand into the inlet should be re-assessed.

### **Technical corrections**

The PWA & WRA report misidentifies the shoreline populations of *Leymus mollis* on Kent Island (and Stinson Beach). These are a mixed population of *Leymus x vancouveriensis* (a natural introgressant between *L. mollis* and *L. triticoides*) and a minority of pure *L. mollis*, if any persists at all. *L. x vancouveriensis* is the dominant *Leymus* species throughout west Marin tidal shores.

The PWA & WRA report failed to identify the persistent annual brackish tidal marsh population of *Castilleja ambigua* that occurs in the high marsh grassland transition zone and high brackish marsh pans north of the Pine Gulch Creek delta. This seasonal (annual) population has been in evidence each year since at least 1997, and is conspicuous for approximately 6 to 8 weeks each year in mid-late spring.

The PWA & WRA report did not disclose the regional and range-wide conservation biology significance of the large population of *Cordylanthus maritimus* ssp. *palustris* on the salt marsh formed on the north side of the Kent Island flood tidal delta sheet. This is one of the largest single populations in California, comparable with the Walker Creek delta.

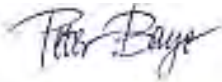
The PWA & WRA report did not identify the potential long-term consequences of tidal marsh succession in Bolinas Lagoon for range re-expansion of the California clapper rail. The report should note that soon after Pacific cordgrass established in southern Tomales Bay, the first clapper rails were detected after decades of absence. Bolinas Lagoon may function as a stepping-stone population between Richardson Bay and Point Reyes clapper rail populations, and could be significant for its recovery.

Note multiple typographic/spelling errors in plant nomenclature.

## Concluding remarks

I recommend that a revised final report be produced. The final report should explicitly compare the findings and conclusions of the original project reports and the recent (2006) reports. The findings and conclusions of the Peer Review and Byrne et al. reports, as well as public scientific/technical comments, should be rigorously applied, without bias, to the revised final report. Thank you for considering these comments.

Sincerely,



Peter R. Baye, Ph.D.

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## ATTACHMENT A

2002 Comment letter by Peter R. Baye on  
Bolinás Lagoon Restoration Project EIR/S and Draft Feasibility Report  
(reformatted with reduced font)

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September 24, 2002

SUBJECT: Comments on Draft Environmental Impact Statement/Report and Draft Feasibility Report:  
Bolinás Lagoon Restoration Project, June 2002

Dear Mr. Golden and Mr. Haddad:

I am submitting comments on the Draft Environmental Impact Statement/Report (DEIS/R) for the Bolinás Lagoon "Restoration Project", dated June 2002, within the extended comment period.

My comments cover the following subjects: (1) compliance with policy and regulations of the National Environment al Policy Act (NEPA) and California Environmental Quality Act (CEQA) regulations, and related environmental laws; (2) technical and scientific analysis of estuarine geomorphology and ecology, with emphasis on those aspects essential to stated project purpose, need, and project design; (3) recommendations for modifying the project design, technical analyses, and especially scientific peer review.

I am commenting because of my professional interest in backbarrier estuarine ecosystems such as Bolinás Lagoon, coastal restoration ecology, and NEPA and CEQA. My qualifications include over 25 years of

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surveys and field studies of barrier beach ecosystems (coastal dunes, beaches, estuaries, lagoons, and tidal marshes) and applied restoration ecology of coastal ecosystems, including the coasts of California, northeastern U.S., Canada, and Britain. My professional background also includes 6 years of work in environmental regulatory analysis and compliance with the U.S. Army Corps of Engineers, San Francisco District, and 5 years of endangered species and ecosystem planning and regulations with the U.S. Fish and Wildlife Service, Sacramento Office. Bolinas Lagoon is one of the many central California estuaries I regularly visit as part of my field investigations in coastal vegetation and landform development.

I would preface my comments with an acknowledgement that the Corps and Marin County are faced with a particularly difficult challenge in objectively evaluating the Bolinas Lagoon project. The popular belief (“folk myth”) that Bolinas Lagoon is threatened with imminent destruction by sediment filling has persisted (without empirical verification) for at least 70 years, as Rowan Rowntree documented in the 1970s (Rowntree 1973, Rowntree 1975). This popular belief, transmitted over generations, has reinforced political and institutional will to act on it, circumventing independent scientific peer review, and ignoring established global evidence and theory about tidal inlet and backbarrier lagoon development. Nostalgia and natural sciences are not equivalent, and valid ecological restoration depends on scientific understanding of natural processes in appropriate time-scales. The many inconsistencies between the conclusions of the DEIS/R and feasibility report, and their analyses, reflect this tension between wishful ecological engineering and scientific analysis.

Because of the length and technical detail of the comments, I am providing a brief executive summary, and a somewhat expanded narrative overview of the full comments, highlighting key points in less technical detail. These condense and reorganize highlighted points in the technical comments which generally follow the sequence of discussion topics in the text of the DEIS/R.

### I. Executive Summary

- Unsound analysis of purpose, need, and perceived threat to Bolinas Lagoon. The arguments for purpose and need of the project are basically flawed. The stated premise of need for the project is the claim that the estuary is threatened by overfilling with sediment, causing it to convert to “uplands”. This threat does not in fact exist. Infilling of tidal lagoons with fluvial and marine-transported sediment results in growth of estuarine mudflats and tidal marsh, not conversion to “upland”, or non-wetland environments. Accelerating sea level rise (an ongoing, progressive trend) and periodic seismic subsidence (an intermittent, recurrent event) are more likely to maintain or submerge Bolinas Lagoon, and most California estuaries. Sedimentation itself, and associated changes in wetland habitats, are not real ecological threats to Bolinas Lagoon’s long-term development. On the contrary, they are essential to its long-term development. Perceived ecological threats to the lagoon are based on basic misinterpretation of *inevitable, benign, and predominantly natural cycles* of ecological changes in the backbarrier lagoon system. No California estuaries have been converted to uplands in the last 10,000 years, and none are poised to do so.
- The proposed project is fundamentally artificial coastal engineering, not “ecosystem restoration”. The proposed project *eliminates mostly natural tidal (marine origin) sediment deposits* as well as mostly man-made 19<sup>th</sup> century sediment deposits, in about equal measure. *The project’s objective in effect is not restoration, but selection and artificial maintenance of a preferred stage in (cyclic) estuary development.* The project imposes an artificial condition *against* existing, ongoing natural processes. By definition, this is coastal engineering, not coastal restoration. It proposes to destroy the majority of the naturally formed tidal marsh in the estuary for the sake of submerged tidelands, without mitigation.

This is the opposite of ecosystem restoration, and is *typical of coastal engineering of harbors prior to the 1960s*.

- Deficient, flawed scientific analysis of tidal lagoon geomorphology and ecology. The DEIS/R contains many contradictions of its own data and analyses regarding historic development of the tidal lagoon habitats, particularly the relative influence of seismic subsidence (earthquake-related depth increases), watershed sedimentation, and natural processes of tidal inlets. The basic models of geomorphic and ecological development of estuaries are inconsistent, and often incorrectly applied.
- Destruction of unique and essentially natural tidal sediment bodies. The project's second largest targeted dredging area, around Kent Island, is a natural flood tidal delta, an inherent feature of sandy tidal inlets. It is not an artifact of watershed degradation and erosion. Its marine origin is unrelated to the stated purpose of correcting artificially increased fluvial sedimentation from the watershed. Kent Island (a large, persistent, emergent dune-capped flood tidal delta) itself is a *unique geomorphic feature in California*, and is not identified as such in the DEIS/R.
- Unprecedented and unjustified destruction of wetlands for "restoration". The project represents the *largest single-project destruction of combined tidal marsh and mudflat acreage in California since the passage of the Clean Water Act, and the only modern large-scale unmitigated loss of tidal marsh and mudflats proposed by government agencies*. It is ironically proposed under the purpose of "ecosystem restoration". This is unprecedented, unmitigated, unmitigable, and unjustified. It contradicts state and federal policies regarding the protection and conservation of wetlands, contradicts decades of commitment of state and federal resources towards the conservation of tidal marsh and mudflats.
- Significant underestimation of "significant" impacts. The scope, severity and magnitude of environmental *impacts of the project have been substantially underestimated*. Many significant species impacts have been omitted or severely underreported. Sediment budget deficits caused by dredging near the tidal inlet will likely cause severe beach erosion along the Stinson Beach sand spit, as the flood tidal delta regenerates in the proposed Kent Island dredging pit. Rare and endangered species impacts are woefully underestimated and understated.
- Unsound alternatives analysis (NEPA), failed compliance with national environmental law and policy. The analysis of alternatives (the heart of the EIS) fails to comply with NEPA. The proposed project is not substantially different from the single alternative, and it only trivially reduces project impacts, contrary to NEPA policy. The proposal itself fails to comply with the Clean Water Act's Section 404(b)(1) guidelines and policies for habitat development, sacrificing a more valuable natural aquatic habitat for an artificial one of lower value.
- Need for adequate independent scientific peer review. The proposed project and alternatives require critical review by an independent *qualified national or international scientific peer review panel*. The current project proposal lacks adequate and authoritative interdisciplinary expertise in estuarine ecology, geomorphology of tidal lagoon and inlet systems.

## II. Narrative Overview of Comments

The project's basic premise that Bolinas Lagoon is a degraded estuary in rapid decline, and at risk of becoming an "upland" in the foreseeable future, is simply incorrect. The DEIS/R misrepresents evidence of predominantly natural cyclic and progressive geomorphic and ecological change in the lagoon as

symptoms of artificially induced ecosystem degradation. The purpose and need of the proposed estuarine “restoration” (dredging) project is not supported by the majority of the scientific analysis presented, and is not supported by the global scientific literature on Holocene (post-ice age) development of estuarine lagoons behind barrier beaches (backbarrier lagoons).

The premise of progressive artificial degradation is in fact contradicted by the historic data presented on geomorphic development of Bolinas Lagoon. The purpose and need reflect instead popular beliefs derived from visual impressions of natural changes in the lagoon, informed by local folklore rather than geomorphic and ecological sciences. The DEIS/R exaggerates the long-term historic influence of human modifications of the estuary relative to natural processes. Reconstructed maps of the lagoon (presented in figures 1-3 and 3.4 in the DEIS/R, Fig. 3.2 in the feasibility report), clearly show *greater* area of subtidal waters in 1929 *after the 1906 earthquake*, more than in 1854, despite reported peak sedimentation in the late 19<sup>th</sup> century. This is not consistent with the premise that post-logging and agricultural sedimentation caused rapid, irreversible infilling of the lagoon that persisted to modern times.

The Bolinas Lagoon is *naturally maintained as an estuary* by sea level rise (now accelerating), periodic earthquakes which cause rapid subsidence (lowering) of the lagoon bottom, and natural sediment inputs from the tidal inlet (flood tidal delta crowned by Kent Island) and stream deltas. These processes are acknowledged in some portions of the DEIS/R (e.g. p. 3-48), but are understated or obscured in “promotional” descriptions of the project purpose and need. In fact, *estuaries do not become “uplands” during periods of sea level rise*, and there is no evidence that any estuary in central California has done so during the last 10,000 years (including the last 3000 years of relative stability in sea level, until recently), even during periods of peak artificial 19<sup>th</sup> century sedimentation.

Tidal lagoons that are infilled with sediment generally become complexes of tidal mudflat and marsh, not uplands. This is because tidal sedimentation is limited to the elevation of the higher daily tides, and stream delta sedimentation is limited to the height of floodwaters at the stream mouth, which depends on the simultaneous tidal elevation. Local waves and winds can raise sediment deposits above tide elevations only on a very local scale, as on Kent Island. Even coasts of seismic uplift and copious sedimentation, such as Northern California (especially along the Cascadia fault, e.g., Humboldt Bay) have maintained their estuaries in historic times.

The DEIS/R repeatedly and erroneously asserts, without reference to any scientific literature, that conversion to uplands is the general geomorphic destiny of tidal lagoons and estuaries. This is incorrect and inconsistent with the worldwide scientific literature on Holocene backbarrier estuary evolution (Borrego et al. 1993, Davies 1980, Carter 1980). It establishes a false premise that the lagoon is threatened rather than maintained by sedimentation during a marine transgression (sea level rise). With the minor exception of alluvial riparian *wetlands* (not “uplands” by the Corps standard definition) prograding over tidal marsh (Pine Gulch Creek delta), nearly all tidal have been maintained within the lagoon in historic times. The residential development along the backbarrier shore of the Stinson sandspit (Seadrift) is the only major source of outright tidal habitat loss in the estuary.

The lack of focus on modern sea level rise as a factor in maintaining and predicting the condition of Bolinas Lagoon is a serious, basic deficiency of the DEIS/R and feasibility study. Sea level rise is fundamental to any ecological or engineering study of coastal wetlands, yet it is marginally treated in the DEIS/R and feasibility report. This is significant because contemporary acceleration of global rise in sea level tends to compensate for past or present sediment accretion, maintaining intertidal elevations – thus undermining the justification for the proposed project. It is extraordinary that a Corps of Engineers study would neglect full consideration of the impact on sea level rise.

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The accelerated sedimentation of Bolinas Lagoon during the late 19<sup>th</sup> century due to artificial watershed erosion is a *history shared by all California estuaries*, especially the San Francisco Estuary's massive deposition of hydraulic gold mining debris (Atwater 1979) and agricultural sedimentation of Tomales Bay (Niemi and Hall 1996). The artificial increase in sediment deposition in the Bolinas estuary ceased long ago in the 20<sup>th</sup> century when the watershed reforested. Modern sedimentation in the estuary from streams and especially from the marine tidal inlet is natural, and changes it causes are *no threat* to the long-term health of the estuary. Continued sedimentation will result in a natural stabilization or increase of highly valuable riparian wetland and estuarine tidal marsh and mudflat habitat during marine transgression (sea level rise), *not conversion to uplands or persistent non-tidal conditions*.

The majority of the proposed dredging area is not 19<sup>th</sup> century stream delta sediment, but is part of the large and obvious *naturally formed flood tidal delta* (the Kent Island complex). The flood tidal delta complex is derived from natural marine processes and sediment sources, not artificially increased watershed sedimentation. The Kent Island complex re-formed after the 1906 earthquake by deposition of marine (Stinson Beach) sediments transported by tidal inlet currents. Its modern post-quake regeneration is shown in aerial photographs of figures 4.3 – 4.7 in the feasibility report. Sediment grain size analysis consistent with tidal marine sand origin is presented in the feasibility report (fig. 3.7): it shows that the *majority of the area around Kent Island matches Stinson Beach in fine sand grain size and composition*. Proposed dredging of this *essentially natural marine tidal sand deposit* is the second largest volume of dredged sediment in the project. The DEIS/R and feasibility report fail to analyze appropriately the relevance and nature of this deposit. Dredging out the Kent Island flood tidal delta complex is an *exercise in opposing natural estuarine maturation*, and *contradicts the stated project purpose of "restoring" the estuary*. It merely destroys the central feature of Bolinas Lagoon, one that has formed and re-formed through geologic cycles (see figure 3.4). This constitutes *artificial engineering*, not "ecosystem restoration" of the lagoon. Kent Island itself is a *geomorphically unique feature in California*, an emergent (dune-capped) flood tidal delta island, and it would be destroyed by the project.

The DEIS/R fails to provide a regional geographic context for Bolinas Lagoon's sedimentation history and ecological development. A *comparative geographic analysis* would indicate that *all other California backbarrier lagoon estuaries*, including those of comparable shape and size (Morro Bay, Bodega Bay) *also experienced rapid sedimentation during the early historic period of intensive logging and agriculture*. They all developed rapid increases in tidal mudflat and marsh area as a result. Some backbarrier lagoons, prior to artificial stabilization of tidal inlets with jetties, naturally maintained cycles of intermittent choking of tidal flows (e.g. Elkhorn Slough, Morro Bay, Mugu Lagoon); none became uplands or permanent non-tidal lagoons. There are no actual examples of any backbarrier estuary in central California suffering anything resembling the predicted worst-case scenario for Bolinas Lagoon – not a surprising fact for a coastline undergoing general submergence. In no instance has any lagoon or estuary been managed for navigable capacity by dredging out intertidal mudflats or marsh because of unacceptable and unmitigable environmental impacts to wetlands.

The geographic significance of Bolinas Lagoon's tidal wetlands is also understated. *Bolinas Lagoon is among the most pristine tidal marsh systems in California*, and one of the very few in central California with an intact ecotone between tidal marsh and freshwater riparian habitat. The *extent (acreage) of salt marsh habitat mapped* and quantitatively estimated in the DEIS/R *is severely underestimated (habitat maps do not match the color aerial photo of the Lagoon's salt marsh in figure 3-5)*. Wetland delineation methods used are entirely *inconsistent with the Corps' own standard methodology for wetland determination*. The DEIS/R also neglects to disclose that the unique high salt marsh vegetation at Kent Island would be destroyed by the project.

The DEIR/S substantially understates the scope of biological and geomorphic impacts of the proposed project. *Dredging out the huge flood tidal delta complex around Kent Island*, as proposed, would create a *strong sediment sink that would induce rapid shoreline retreat (beach erosion) along the west end of Stinson Beach*. This is neither discussed as a potential significant impact, nor is it studied at all in the feasibility report. This glaring omission is particularly ironic, because beach erosion and shoreline engineering is one of the Corps' traditional areas of specialization in coastal engineering. The beach erosion would significantly affect roosting and feeding habitat of the federally threatened western snowy plover.

The DEIS/R also significantly underestimates the scope and magnitude of the project's effect on special status species, mostly because the DEIS/R fails to provide any regional, cumulative impact perspective on the species abundance and distribution. The reversal of tidal marsh growth would impede the recovery of the federally endangered California clapper rail, which historically inhabited the lagoon. Dredging may adversely affect elusive federally listed tidewater gobies in subtidal channels and low-energy backwater areas. It would destroy the largest, southernmost population of the rare northern salt marsh bird's-beak on the coast, in the marshes surrounding Kent Island. One of the rare salt marsh ecotypes of an owl's-clover, a single population, grows in the marginal areas between the Pine Gulch delta and salt marsh pans. The type locality of one of California's rarest coastal plants, the marsh milkvetch, would be destroyed, as would its prospects for recovery there. Rare, refugial populations of invertebrates (native estuarine snails) occur in Bolinas Lagoon.

The suggestion that dredging intertidal mudflat, tidal marsh, and riparian woodland to become subtidal habitats would "restore" (or otherwise improve) the ecological health of the estuary is a conceit, and is unjustified from a scientific or coastal conservation perspective. There is no modern precedent in California for the proposed unmitigated destruction of hundreds of acres of tidal mudflats and marsh in order to increase subtidal habitat in any estuary, even for navigational purposes. The proposal is inconsistent with State and national policies and regulations for the protection of wetlands, particularly intertidal wetlands and riparian habitat. I believe the only reason the proposal has been seriously considered is uncritical reliance on the perceived, erroneous "threat" that without intervention, the estuary is at risk of becoming upland or non-tidal.

In the final analysis, the project's unacceptable impacts are due to the re-invention of a modest small-harbor navigational dredging project into an inflated, disproportionate, "ecological restoration" project. Re-casting the dredging project in the guise of "ecological restoration" circumvents conventional Corps cost-benefit analysis that would apply to harbor dredging projects. The proposal misapplies the concept of estuarine restoration at a huge and unacceptable environmental and economic cost, and risks regional and national damage to the credibility of ecological restoration in public works projects.

I am confident that a *qualified national or international scientific peer review panel* would largely confirm these conclusions. The current project proposal lacks adequate and authoritative interdisciplinary expertise in estuarine ecology, geomorphology of tidal lagoon and inlet systems.

### III. Text-specific comments: DEIS/R

#### Section 1.2. Purpose and Need.

**Omission of dredging proposal history.** The DEIS/R fails to disclose the *historic context* of dredging for navigational purposes in Bolinas Lagoon, and the Corps' earlier involvement in planning studies and cost-

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benefit analyses. These area explained in Rowntree (1973, 1975), which is cited by the DEIS/R only for less important information.

**Accelerated sedimentation:** The DEIS/R here introduces the oversimplified and incorrect claim that “Bolinás Lagoon has been filling in at an accelerated rate as a result of human activity since European colonization...For the past 150 years, tidal prism...declined at a noticeable rate”. This contradicts the more accurate account of the lagoon’s history on page 3-48, which correctly identifies the non-progressive, seismic subsidence cycle that governs the estuary’s tidal prism. It also contradicts the feasibility report, which accurately states on page 3-2 that “In 1998, the lagoon looked similar to the way it did in 1854”. Page 3-48 states that the 1906 earthquake restored about 50 million cubic feet of tidal prism lost because of 19<sup>th</sup> century fluvial sedimentation. Even this discussion, however, fails to note that increased depth of the lagoon after 1906 itself can induce temporary increased tidal sedimentation rates (“rebound” of the submerged flood tidal delta), just as sedimentation rates increase with depth following dredging. The idea that there is a constant or “normal” sedimentation rate in an estuary that undergoes periodic seismic subsidence makes little sense, and is highly misleading. The feasibility report adds that “there are many discrepancies” among reports of the sedimentation rate timeline of the lagoon, which may reflect the non-linear nature of sedimentation rate change in such a system. The DEIS/R and feasibility report fail to produce unambiguous evidence of excessive contemporary or recent fluvial sediment inputs to the lagoon, instead reasoning as though the massive, discrete 19<sup>th</sup> century fluvial deposition episodes never ended.

**“Disappearing” habitat equivocation.** The DEIS/R text is very misleading and ambiguous in stating that “Bolinás Lagoon is an example of an estuarine habitat that is rapidly disappearing along the Pacific Coast flyway”...(p. 1-3). The statement ambiguously suggests that the lagoon itself is disappearing as a tidal habitat, which is factually incorrect. It equivocates between the relatively pristine, protected Bolinás Lagoon wetlands, and estuarine wetlands in the region which have literally been converted to urban, agricultural, or industrial lands. This equivocation has no place in the statement of purpose and need, which must clarify, not obscure, matters of public interest.

**Accuracy of inlet closure prediction.** The DEIS/R uncritically raises the prediction that “the mouth of the lagoon is predicted to begin closing intermittently within the next 50 years”, without reference to the predictive accuracy, empirical verification, or statistical power of the model used to make the prediction. In fact, the model used to predict inlet closure (O’Brien 1971; feasibility report p. 5-6) is an older, outdated, crude, oversimplified model developed for large navigable tidal inlets. It has not been calibrated for fine-sand lagoons with complex inlet bedforms, tidal deltas, and sand spit interaction, which are key components to inlet choking and closure in small navigable or non-navigable inlets in California (Webb et al. 1991).

A notable recent failure of simplified models based on linear relationships between tidal prism, wave power, and inlet closure indices, is at Crissy Field, Presidio, San Francisco. The predicted time of probable or frequent inlet closure was more than two decades; the actual, observed time of repeated closures was less than one year. The modelling was performed by highly qualified regional expert hydrologists (Phil Williams and Associates). The point is not the source of error or its nature, but the *empirical limitations and inherently low predictive accuracy of older conventional tidal inlet models applied to smaller tidal inlets and lagoons*, which are relatively more responsive to feedback from depositional bedforms and sand bodies (shoals, bars, spits). Given the tremendous importance given to the alleged threat of inlet instability as a foundation of the need for the project, it requires far greater critical analysis. Casual reporting of a statistically insignificant model prediction as though it were a confident, foregone conclusion is both misleading and scientifically irresponsible.

Inlet closure or choking (partial closure) are not simply determined by two variables, wave power and tidal prism, the principal variables of the older tidal inlet models of Bruun (1968, 1978) and O'Brien (1971). Morphological controls (configuration and size of bedforms, sand bodies in the flood tidal delta complex), longshore transport rates, and sand grain size variation are highly significant factors for inlet closure and breaching. The fine sand grain size of Stinson Beach would favor low beach height, and inefficient lagoon seepage. The south-facing shoreline orientation, wide dissipative beach profile, and shelter from northwest swell (strong wave refraction) reduce the rates of longshore transport of sand and wave heights compared with most of the coast. Low beach height, low rates of seepage, and wave-sheltering of the tidal inlet all reduce the chances of persistent inlet closure. This is probably why there is no history of inlet closure at Bolinas, even prior to the 1906 earthquake. Other central California lagoons, prior to jetty construction (Morro Bay, Elkhorn Slough) were subject to tidal inlet choking and intermittent closure, but these are all west-facing, essentially unsheltered beaches. Southern California lagoons have coarser sand (greater beach height, steeper slopes) and greater wave energy and exposure, so their inlets are even less comparable with Bolinas.

Because of the importance attributed to the risk of inlet closure for perceived environmental threats and the stated purpose and need for the project, I suggest that the consequences and risks of inlet closure be delegated to coastal geomorphologists with recognized expertise (long research and publication history) to provide scientific peer review and independent authoritative, scientific opinion. More recent, comprehensive and realistic conceptual models of mesotidal inlets (e.g. Kana et al. 1999, for ebb tidal deltas) should be applied to the flood and ebb tidal delta system at Bolinas.

**Analysis of project purpose statement.** The statement of project purpose is excessively complex, circular, and unclear because it attempts to unify several incongruous, potentially incompatible aims. The first clause of the purpose, "increase tidal volume" is straightforward, but relates only indirectly and contingently (instrumental to) to the second major clause, "to restore intertidal and subtidal habitat in Bolinas Lagoon", and the subordinate clause, "in a manner that prevents the need for regular maintenance dredging during the project period". This fails as a statement of purpose pursuant to NEPA because it is *so narrowly constructed that it virtually defines the proposed project*, and excludes reasonable alternatives to the basic, underlying purpose of estuarine restoration. This is a type of vicious circularity in reasoning that courts have consistently ruled to be invalid in both NEPA and CWA documents.

If "increase tidal volume" is not an essential, underlying purpose, a virtue in itself, it does not belong in the statement of purpose. In effect, increasing tidal prism is the means proposed to achieve the end, which is habitat restoration. As a means, not an end, it belongs in the description of the project or alternatives, not in the statement of purpose. Including it in the statement of purpose biases the alternatives analysis, and establishes an arbitrary, exclusionary circularity between purpose, design, and alternatives.

"Restore intertidal and subtidal habitat" is problematic as a purpose for another basic reason: as the feasibility report states blithely (and correctly) on p. 3-2, "In 1998, the lagoon looked similar to the way it did in 1854...The size of Kent Island, the size and layout of the channels [subtidal habitat], and the extensive mudflats are all very much the same." . If the pattern and relative abundance of subtidal and intertidal habitats were roughly the same in 1854 and 1998, there is obviously little justification for "restoration", and less for massive ecological impacts to achieve it. Indeed, it is difficult to imagine what "restoration" would mean for an estuary which is structurally indistinguishable from its pre-settlement condition. This is only one of many glaring contradictions established by the project purpose and the large body of data on its geomorphic and ecological history.

### Section 1.3. Project Area

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**Estuarine lagoon fate as “uplands”.** The DEIS/R correctly states that “Estuarine lagoons generally have a relatively short life-span in geologic terms.” It then adds quite incorrectly, “The natural progression of such lagoons is to fill in and gradually become transformed, first into wetland habitat and *then into upland habitat.*” [emphasis added]. As indicated below, this is a fundamental error, and is not supported by any modern authoritative scientific texts or review papers in coastal geomorphology.

I can find no modern scientific text or credible scientific publication on estuarine geomorphology which supports the DEIS/R statement that the fate of lagoons is to accrete into uplands. On the contrary, the long-term development of tidal lagoons in marine transgressions (rising sea level), is normally a transition from subtidal shallows, intertidal mudflats, to tidal marsh and channel systems which may equilibrate with rising sea level (Carter 1980, Allen and Pye 1992, Pethick 1993). Even alluvial deposition associated with stream delta progradation on the California coast results in expansion of riparian *wetlands*, not “uplands”: this is evident throughout the riparian bottomlands of Tomales Bay and Drakes Estero valleys as they grade into historic tidelands. The worldwide phenomenon of estuarine lagoon filling is based on succession from subtidal shallows to tidal marsh creek and mudflat systems, not uplands (Borrego et al. 1993).

Given the importance of this “upland fate” premise as a justification of the project, it is essential that it be corrected. I am confident that such an egregious error could not survive scientific peer review.

*Tidal sedimentation alone cannot result in emergence of tidal marsh above the elevation of the highest tides.* Wave-reworking of estuarine sand (followed by dune accretion) can locally cause emergence above tidal elevation, as at Kent Island, but this is indeed exceptional on the California coast. Seismic uplift (not an issue at Bolinas, which intermittently subsides seismically) may cause temporary emergence of tidal marsh and temporary conversion to upland, but even this is soon reversed by aerobic decomposition of organic matter in drained marsh soil, which causes subsidence. *Tidal marsh soils tend to equilibrate with high tide elevations when sediment is available.* Under theoretical stable sea level, tidal marshes in backbarrier lagoons could reach equilibrium and long-term stability. In fact, sea level is not stable, but is rapidly rising.

A far more realistic concern for contemporary estuaries is failure of sedimentation and marsh peat accumulation to keep pace with *accelerating sea level rise*, resulting in submergence (drowning) of intertidal habitats. In this respect, tidal sedimentation in Bolinas Lagoon is a “healthy” indicator of its resilience to rapid sea level rise (Pethick 1993). Estuarine submergence and emergence during sea level fluctuations is the primary reasons lagoons are geologically ephemeral. The DEIS/R and feasibility report entirely lack balance in evaluation of the relative threats of historic watershed sedimentation and sea level rise (measured and forecast). The DEIS/R does, I concede, consider the cumulative impact of dredging and seismic subsidence, but sea level rise is equally significant, and somewhat more predictable. Nationally and internationally, sea level rise is among the foremost scientific concerns for long-term estuarine management, as indicated by the contemporary estuarine scientific literature.

## Section 2.2. **Development of Alternatives**

**Range of alternatives, screening of alternatives eliminated.** The range of alternatives selected for detailed analysis is unreasonably restricted by the unreasonably narrow, circular, overspecified project purpose. The project purpose is so narrowly matched to the proposed alternative that it allows only an essentially identical, minor variation of the project to be considered as a nominal “alternative”. As stated on p. 2-3, the two alternative “vary only with regard to excavation in Pine Gulch Creek delta”, which is essentially a single mitigation (avoidance) measure assigned to the proposed project. The difference is minor (86 versus 103 acres riparian wetland destroyed), and the *pro forma* “alternatives” are otherwise



indistinct twins. This is invalid in NEPA (40 CFR 1502.14; see also 46 Fed. Reg. 18026, March 1981, 1b; *Dubois v. U.S. Department of Agriculture*, 102 F.3d 1273 (1<sup>st</sup> Cir. 1996), cert. denied, 521 U.S. 1119 (1997)).

If the project purpose were more candidly and simply stated as a harbor improvement project aimed at keeping navigable access to a permanent tidal inlet and prescribed internal tidal channels, then options such as minimal maintenance dredging or even (rejected) jetties could be more fully and objectively compared with the massive dredging proposal on their merits. It is ironic that jetties were rejected because they “would not restore lost habitat” (in contrast with the proposed project, which would directly cause the loss of hundreds of acres of existing tidal wetland habitat), and because it would be “an eyesore” (in contrast with over 400 acres of dredging in a 1000+ acre lagoon over 10 years).

The fact that an alternative is locally unpopular prior to full NEPA evaluation (“It would not have public support”) is hardly a valid reason for eliminating a candidate alternative with reduced environmental impact. I am not advocating jetties as an environmentally preferable alternative, but it is instructive from a NEPA perspective that Bodega Harbor, Moss Landing, and Morro Bay (all small coastal lagoons like Bolinas) all have Corps of Engineers-constructed jetties to maintain open tidal inlets. It is unexplained why the Corps would presume the same to be beyond consideration at Bolinas. Overall, the selection and rejection criteria for candidate alternatives appear to have double-standards and bias in favor of the locally preferred project alternative.

#### **Disposal alternatives and conservation of marine sand in local sediment cells.**

All California beaches are subject to long-term retreat and erosion during marine transgression (sea level rise). Mining of beach sand (removal of sand from littoral sand transport cells) increases beach erosion. At the Golden Gate National Recreation Area’s Ocean Beach in San Francisco, even small amounts of wind-blown sand removed from the seawall and Great Highway are kept within the littoral cell by replacement at the updrift (south) end of the beach system, to avoid contributing to net sediment deficits. Any disposal of sand dredged from the flood tidal delta complex (tidal inlet vicinity, Kent Island area) at Bolinas Lagoon represents net export from the littoral cell, and *net deficits to the sediment budget of the beach system*. The *volume of sediment proposed for removal from the Kent Island compartment of the littoral cell is highly significant, nearly 400,000 cubic yards*.

Stinson Beach is a small littoral cell with finite source of sand resupply. The littoral cell of Stinson Beach includes shallow subtidal Bolinas Bay and the flood tidal delta complex of Kent Island (see fig. 3.7, feasibility study). Dredge removal of sand in the flood tidal delta complex (Kent Island and adjacent shoals, proposed 376,000 cubic yards) would be compensated among sediment compartments within the littoral cell by increased transport and trapping of beach sand to the lagoon. (see “cumulative impact of seismic subsidence, dredge-deepening, and beach erosion”, below). This indicates a major risk of significant net beach erosion, which is marginally addressed at all as a qualitative phenomenon (impact 4.4.1, p. 4-21). Beach erosion of this magnitude is not mitigable because there are no regionally available sources of suitably textured sand for beach nourishment (Dillon Beach sand quarry cannot mitigate a 400,000 cubic yard sediment deficit).

Because Stinson beach erosion affects a developed residential shoreline and includes valuable recreational and wildlife habitat, there is an urgent need to consider alternatives which would retain dredged sand within the littoral cell. This does not necessarily mean direct placement on the supratidal beach, the only option superficially considered and dismissed on page 2-26. The reasons for eliminating within-cell disposal of sand cited were undersized grain size and inappropriate color. Grain size gradients occur within littoral cells, with coarsest grains found in the surf zone and beach; smaller grains occur seaward of the surf zone

and in the lagoon. Sand color is a function of mineral films formed by iron reduction and oxidation, and these are subject to weathering under wave and current transport. Disposal of dewatered dredged sand in shallow subtidal or intertidal beach zones should be at least considered as mitigation for inducing large sediment budget deficits within the littoral cell of Stinson Beach. Placement of dredged sand on the supratidal beach would be inappropriate.

### Chapter 3 – Affected Environment.

#### Section 3.2.3. Circulation and Tidal Flows

Figure 3-4, the inferred, reconstructed “historic change in configuration of Bolinas Lagoon” carries heavy interpretive weight, and requires rigorous evaluation as well as careful, consistent interpretation. Neither is presented. Nothing in the DEIS/R reflects the basic and accurate statement in the feasibility report regarding net change to the tidal habitat distribution of the lagoon over the full cycle before and after the 1906 earthquake and 19<sup>th</sup> century pulse of fluvial sedimentation: “In 1998, the lagoon looked similar to the way it did in 1854...the size of Kent Island, the size and layout of the channels, and the extensive mudflats are all very much the same....Regular seismic events have continued this cycle of lowering the lagoon bottom after hundreds of years of sediment accretion [sic], keeping the lagoon open....”(feasibility report p. 3-2, emphasis added). Despite this graphic and narrative depiction of long-term, unsteady, dynamic near-equilibrium of the system, the preceding “purpose and need” discussion lapses back to the myths of persistent estuarine degradation, upland conversion, and imminent threats of inlet closure. It is as though there were multiple mutually incommunicative authors to the document, some focused on the true cyclic, dynamic geomorphic development of the estuary, and others focused on subjective local perceptions, with bias towards the proposed project..

*The acknowledged near-identical morphology of the lagoon in 1854 and 1998 highlights the self-contradiction of the project purpose as “ecosystem restoration”. All the reconstructed stages of the lagoon’s history are snapshots in cyclic estuarine development during a progressive marine transgression. No one stage is inherently “original” or “natural” in a sense of stable, ancient ecosystem structure. It clearly demonstrates that the project design is to force the estuary to an arbitrarily selected historical stage of development during historic times (not 1854, obviously) with deeper water conditions prevailing over larger areas than 1854 or today. The 1929 condition of the estuary is preferable from a navigational perspective, not an ecological perspective. There is no ecological reason to view natural geomorphic maturation after the 1906 earthquake, re-expanding valuable tidal mudflat and marsh, as an environmentally inferior stage of development.*

**Natural tidal sediment of marine origin versus watershed sediment.** This subject is perhaps the most important underlying scientific issue related to the project’s purpose and need, yet it is among the most superficially investigated. The discussion of sediment deposition omits (or avoids) the most basic questions about sedimentation: *what proportion of the historic sedimentation in the lagoon is derived from natural tidal transport of beach sand* (marine origin), and what proportion of historic sedimentation is fluvial? Of the fluvial component, what proportion of the net deposition since 1854 is “unnatural”, attributable to deforestation and agriculture in the watershed? In the absence of this inquiry, the DEIS/R lapses into an invalid tacit assumption (a bias related to local beliefs) that all sedimentation is bad or unnatural. The majority of available evidence indicates that about half of the area proposed for dredging to “restore” the estuary is *predominantly natural tidally transported sediment derived from the beach and nearshore* (marine origin). The feasibility report and DEIS/R circumvent this critically important distinction, an omission which favors the proposed project design.

The feasibility report essentially balks at these questions, acknowledging that only a “best guess” for the overall “average” or “normal” lagoon infilling rate is possible (a normative concept which has little scientific meaning over the late Holocene epoch [geologic time], and is laden with simplifying assumptions). The cursory treatment of the past attempts to discriminate among marine and fluvial sediment sources (p. 3-10, feasibility report) is inadequate and unacceptable for a purported “restoration” project which aims at correcting only human-caused degradation related to the watershed. The grain size distribution map (fig 3.7), and standard geomorphic interpretation of flood tidal delta patterning, indicate the overall pattern of marine-dominant sediment deposits in the lagoon, and provide a preponderance of available evidence for independent tidal transport and source of the flood tidal delta sediments. The distribution of near-surface fine sand *occupies about half of the lagoon bottom*. The match between sediment grain size of Stinson Beach and the flood tidal delta complex (both shown in yellow, fig. 3-7) is probably also matched by grain roundness/angularity patterns, which the report alleges (without reference to methodology or review) “were not as discernable as had been hoped”. This is probably a failure of the research effort, not the intrinsic limitations methods or their costs: powerful contemporary tools in sediment analysis are sufficient to address this question, and geomorphic analysis can corroborate such analyses.

**Weak and inconsistent evidence on modern sedimentation.** For all the weight given to the belief that the lagoon continues to suffer from undue sediment burdens, the evidence reviewed on p. 3-12 to 3-16 of the DEIS/R is remarkably equivocal and weak. It cites the short-term U.S. Geological Survey study (Ritter 1973) which found evidence of net export of sediment from the estuary, not net accretion of sediment – a conclusion which is inconsistent with the premise of the proposed project. No other evidence of net lagoon accretion due to watershed sedimentation is discussed in this section. Bathymetric (depth) surveys which indicate changes in lagoon volume do not discriminate clearly between stream and tidal (beach, nearshore) sources of sediment. Only long-term interpretations of the USGS study results are offered to support the belief that fluvial sedimentation is a significant contribution to modern bathymetric change. The arguments offered are valid, but imbalanced. They do not consider the more likely possibility that most of the bathymetric change recorded (especially beyond the North Basin) may be due to entirely natural tidal sand transport, which agrees with the grain size distribution map of figure 3.7 in the feasibility report.

The discussion on sedimentation also revealed how weak (or incredible) some of the sedimentation analysis has been. The unbelievable estimate of 40,000 cubic yards per year of wind-blown sand entering the lagoon is a case in point. This is contradicted by all field evidence: there are no dune deposits landward of the low, unstable foredune, and no dune transgressions across the modern spit because of obstacles (residential development) to dune movement. Suspended sand transport is a trivial source of sand compared with bedload (saltation) and creep. The spit terminus is capped by dune vegetation which traps and stabilizes most bedload transport of sand. Again, local beliefs cited by Ritter (1973) seem to be the only support for this mechanism, not scientific evidence. I am familiar with rates of foredune sand transport, and their field indicators, throughout the central and northern California coast, and I am confident that wind-transport of sand is negligible compared with tidal transport of sand through the inlet. Again, I am confident that this opinion would be confirmed by scientifically sound study and peer review.

If other estimates or assumptions about sediment transport and deposition in Bolinas Lagoon are as weak as those discussed in connection with wind-transport, the credibility of the analysis as a whole deserves great skepticism.

There is no doubt that streams discharging into Bolinas Lagoon deliver sediment and form deltas. What is doubtful is whether *contemporary* fluvial deposition of sediment occurs at a magnitude comparable to (natural) tidal inlet sediment transport, or historic post-logging rates. The DEIR/S fails to address this

adequately, and treats all sedimentation in the lagoon as though it were a pathologic condition. This implicit assumption is unjustified.

**Dynamics of the tidal inlet and flood tidal delta.** The discussion of tidal inlet dynamics (p. 3-16) is oversimplified and misleading, and discussion of the highly relevant nature and origin of the flood tidal delta (Kent Island flood tidal delta/shoal complex) is nearly lacking. Its nature is superficially but correctly identified on p. 3-42, yet is omitted from relevant context throughout the rest of the document. The Kent Island complex re-formed after the 1906 earthquake by deposition of marine (Stinson Beach) sediments transported by tidal inlet currents. Its modern post-quake regeneration is shown in aerial photographs of figures 4.3 – 4.7 in the feasibility report. Sediment grain size analysis consistent with tidal marine sand origin is presented in the feasibility report (fig. 3.7): it shows that the majority of the area around Kent Island *matches Stinson Beach in fine sand grain size*. Surficial tidal delta sands also match the beach in mineral composition (very high proportion quartz, well-sorted, rounded). Stratigraphic analysis could confirm whether the internal structure of the intertidal portions of the Kent Island complex are consistent with flood tidal delta deposition.

Proposed dredging of this *essentially natural marine tidal sand deposit* is the second largest volume of dredged sediment in the project. Its tidal origin and nature, however, are independent of the alleged source of estuarine degradation from the watershed. The DEIS/R and feasibility report fail to analyze the key nature of this deposit.

Dredging out the Kent Island flood tidal delta complex would be an *exercise in opposing natural estuarine maturation*. It attacks a predominantly marine-influenced tidal sediment deposit, not a (watershed) fluvial delta, and *contradicts the stated project purpose of “restoring” the estuary*. It merely destroys the central feature of Bolinas Lagoon, one that has formed and re-formed through geologic cycles (see figure 3.4). This constitutes *artificial engineering*, not “ecosystem restoration” of the lagoon. Kent Island itself is a *geomorphically unique feature in California*, an emergent (dune-capped) flood tidal delta island, and it would be destroyed by the project.

For critical analysis of the discussion on tidal inlets and inlet closure, please see discussion on “accuracy of inlet closure prediction” above.

**Regulatory considerations.** The discussion of the Clean Water Act omits reference to the most pertinent provisions of the Section 404(b)(1) guidelines, which govern discharges (including those incidental to dredging) in wetlands. The preamble of the Section 404(b)(1) regulations explicitly discusses “habitat development and restoration of water bodies”, precisely the purported purpose of the project. The policy recommendations here (p. 85344, Federal Register vol. 45, No 249, Dec. 24, 1980) are not reflected in the planning of the Bolinas Lagoon project, and are partly in conflict with them. Corps civil works projects involving dredging must substantively comply with the 404(b)(1) guidelines even though they are not subject to the Corps permit process, and Council on Environmental Quality guidance (CEQ, Nov. 17, 1980) establishes national policy for the Corps and EPA to evaluate all EIS dredge-related projects for compliance with the 404(b)(1) guidelines, even where projects are exempt from regulation under Section 404(r).

The 404(b)(1) guidelines preamble recommends “selecting the nearest similar natural ecosystem as the model in the implementation of the [habitat restoration] activity”. The project has entirely avoided any comparative geographic analysis of central coast estuaries. Perhaps this is because *Bolinas Lagoon is, by comparison, among the most pristine tidal lagoons in California*, equaled only by the small Big River estuary (Mendocino), Drakes Estero (which suffers from active cattle grazing and historic dams and

railroad berms) and Morro Bay (which has a tidal inlet stabilized by jetties and a massive delta formed by agricultural sedimentation a century ago). The lack of a better ecological model of tidal marsh and lagoon development than Bolinas Lagoon points to the self-contradiction of “restoring” an intact, viable estuary.

The 404(b)(1) guidelines preamble also warns, “*One viable habitat, however, should not be sacrificed in an attempt to create another...* when a significant ecological change in the aquatic environment is proposed...the permitting authority should consider the ecosystem that will be lost as well as the environmental benefits of the new system. [emphasis added]”, and “Where development and restoration techniques proposed for use have not yet advanced to the pilot demonstration stage, initiate their use on a small scale to allow corrective action if unanticipated adverse impacts occur”. These specific, pertinent Clean Water Act policy considerations are neither addressed in the DEIS/R, nor reflected in the development of alternatives. This is a major deficiency in the planning process. Although the Corps civil works program does not regulate its own activities with self-issued permits, it is obliged to comply substantively with the policies and provisions of its Clean Water Act regulatory authority.

**Biogeographic context** (Section 3.3.1.) The DEIS/R focuses on a mere listing of biological attributes of Bolinas Lagoon’s wetlands, and provides none of the essential geographic context for understanding of the “affected environment” and “environmental setting” recommended by the Council on Environmental Quality, which establishes national NEPA guidance (CEQ 1997).

The biogeographic significance of Bolinas Lagoon’s tidal wetlands is understated by lack of comparison with other estuaries along the California coast. *Bolinas Lagoon is among the most pristine tidal marsh systems in the state*, and one of the very few in central California with an intact ecotone between tidal marsh and freshwater riparian habitat. It includes rare intact ecotones (transition zones) between riparian and tidal marsh habitats, tidal marsh pans, estuarine beach-dune slacks, and some unique stands of high marsh vegetation. For example, the high marsh ecotone at Kent Island is the only location in California which includes a zonation from Vancouver wildrye (*Leymus x vanouveriensis*), red fescue (*Festuca rubra*) to saltgrass, pickleweed, and northern saltmarsh bird’s-beak (*Cordylanthus maritimus* ssp. *palustris*).

**Vegetation and habitat description, definition, and quantification are inconsistent and incorrect.** (section 3.3.2). The *extent (acreage) of salt marsh habitat mapped* and quantitatively estimated in the DEIS/R *is severely underestimated (habitat maps do not match the color aerial photo of the Lagoon’s salt marsh in figure 3-5)*. Wetland delineation methods used are entirely *inconsistent with the Corps own standard methodology for wetland determination*.

The DEIS/R states on p. 3-21 that “for the purposes of this EIS/EIR, habitats are defined by the Corps as follows: upland habitat is the area between 2.54 and 7.00 NGVD, intertidal habitat is from –1.36 to 2.54 feet NGVD...”. This conflicts with the document itself and with national Corps definition of wetlands. Table 3-1 (local tidal datums) shows that mean sea level at Bolinas Lagoon is slightly above that of the Golden Gate and Drakes Bay. The elevation of Mean Higher High Water, which is the approximate elevation of the pickleweed-jaumea-saltgrass salt marsh plain, is 2.7 NGVD at the Golden Gate and 2.92 NGVD at Drakes Bay. The lower elevation of “upland” applied to Bolinas is 2.54 NGVD, below both these reference MHHW elevations. *Therefore, the “local” definition of “upland” includes most tidal pickleweed salt marsh and all high salt marsh/ecotone. Calling a tidal salt marsh an “upland” is obviously incorrect and unacceptably misleading.* It causes the severe underestimation of salt marsh at Bolinas Lagoon.

This erroneous demarcation of marsh and upland is also inconsistent with both Corps wetlands determination methodology, and the definition of Waters of the United States in Corps regulations. The

legal upper boundary of tidal waters and tidal wetlands under the Clean Water Act, Section 404, the high tide line (33 CFR 328.3) is defined as "...the maximum height reached by a rising tide. The high tide line may be determined, in the absence of actual data, by ...a more or less continuous deposit of fine shell or debris on the foreshore....other physical markings or characteristics, vegetation lines...the line encompasses spring high tides and other high tides that occur with periodic frequency..." The high tide line is obviously above and includes the plane of MHHW. The Corps 1987 wetland delineation manual provides the national basis for a multiple-variable (vegetation, soil, hydrology) identification method of wetlands which is ignored by the DEIR/S. The DEIR/S also ignores the national Cowardin (U.S. Fish and Wildlife Service) classification system for wetlands.

This underestimation of salt marsh also appears in habitat maps, which are inconsistent with color aerial photographs in the DEIS/R (figs. 1-2, 3-5) and mapped habitats (figure 3-9). The obvious extensive salt marsh in the lee of Kent Island is entirely omitted from the map.

The consistent underestimation of tidal marsh by all methods (elevation boundaries, maps, and rejection of all legal and scientific federal definitions applied to tidal wetlands) gives the appearance of deliberate understatement of tidal marsh and tidal marsh impacts in Bolinas Lagoon. It is also tendentious, biased in support of the perceived threat used to justify the purpose and need of the project. *This is a very serious scientific and legal deficiency*, and must be corrected. All estimates of "Changes in Bolinas Lagoon Habitat Acreages over Time" presented in table 3-2, and all biological conclusions based on them, should be presumed to be incorrect until valid and accurate estimates of salt marsh and other wetland habitats are prepared. Standard methods of aerial photograph interpretation and mapping, combined with ground-truthing and reference of generally accepted wetland definitions and boundaries would provide this.

**Salt marsh vegetation errors and omissions (including environmental consequences).** The description and analysis of the salt marsh vegetation and plant community at Bolinas Lagoon is superficial, erroneous, and incomplete.

The DEIS/R fails to cite contemporary published peer-reviewed study of the marsh (Allison 1992), and omits key information. It incorrectly states that *Atriplex watsonii* occurs there, a species with a northern limit in San Luis Obispo, hundreds of miles south (the correct species is *A. semibaccata*, a non-native plant).

It omits the fact that Bolinas Lagoon supports the largest, southernmost population of the rare northern salt marsh bird's-beak on the coast (*Cordylanthus maritimus* ssp. *palustris*; cited in table 3-3, but not discussed in terms of significance or impact on p. 3-34), and that all population locations of this species would be destroyed by proposed dredging.

It similarly omits reference to the single population of the rare salt marsh population of *Castilleja ambigua* ssp. *ambigua* (salt marsh owl's-clover) at the north end of the Pine Gulch Creek delta/tidal marsh edge; the only other persistent salt marsh localities exist at Rodeo Lagoon, Limantour Estero and Point Pinole (San Pablo Bay).

Bolinas Lagoon is the type locality of the rare *Astragalus pycnostachyus* var. *pycnostachyus*, and dredging would destroy the only suitable habitat for reintroduction of this locally extinct species. This is omitted from the DEIS/R.

Other unique features such as the relict and active fluvial delta levees with red alder and willow "fingers" growing into salt marsh in series of wet years are omitted. The Pine Gulch Creek delta supports some of

the finest examples of riparian/salt marsh ecotones in California. None of these relevant aspects of Bolinas Lagoon's distinct tidal plant community is discussed.

**Wildlife community errors and omissions (including environmental consequences).** The federally endangered tidewater goby (*Eucyclogobius newberryi*) is not discussed in the context of estuarine wildlife communities (p. 3-24), though it appears in table 3.3.

The relationship between accreting sand spit and beach, and habitat for the federally threatened western snowy plover, is not discussed at all. This omission in turn avoids identifying the potential impact of dredging Kent Island on the significant erosion of the west end of Stinson Beach (see "cumulative impact of seismic subsidence, dredge-deepening, and beach erosion", below)

The discussion of habitat requirements of the federally threatened California red-legged frog is incorrect in stating that the species needs deep permanent sources of freshwater for breeding. The species actually competes as well or better in seasonal ponds and marshes with standing water that persists into summer, but not fall, and it tolerates brackish water at least below 4 parts per thousand. Because the frog can seasonally re-occupy and breed in quiet isolated summer scour pools of stream channels, it should be presumed to occur in Pine Gulch Creek and any backwater pools in its delta.

The superficial, trivial analysis of "no impact" to harbor seals neglects any consideration of the effect on habitat structure, specifically the dredging of high-intertidal haul-outs. The larger significant impact is not temporary disturbance due to the presence of the dredge, but the long-term elimination of traditional seal haul-out sites adjacent. Seals are not adversely affected by intermittent tidal inlet closure, as indicated by the large colony at the Russian River mouth; individuals feed up to a mile upstream of the mouth.

The DEIS/R fails to identify significant impacts to the recovery of the federally endangered California clapper rail, an historic inhabitant of Bolinas Lagoon (Table 3-3). Clapper rails are again vagrant inhabitants of Tomales Bay, where they are probably limited by poor high tide escape cover (J. Evens, pers. comm. 2001). Eliminating cordgrass and high salt marsh (especially thick gumplank cover around the Pine Gulch Creek delta) would be highly detrimental to the Clapper rail's prospects of recovery. Impairing the recovery of an endangered wildlife species is no less significant than "take" of mere individuals.

**Superficial and inconsistent discussion of seismic subsidence recurrence interval** (Section 3.4.2).

Since the lagoon deepens itself, without dredging, through seismic subsidence, the probable recurrence interval of this event is particularly relevant to (a) predictions about inlet closure with simplified models, and (b) purpose and need of the project. In sequential paragraphs of p. 3-43, the DEIS/R states "for the North Coast South segment of the San Andreas Fault the probability of a magnitude 6.7 quake is estimated to be 12 percent in the next 30 years", and "there is a 30 percent probability that within the next 30 years an earthquake similar in magnitude to the 1906 earthquake will occur on the northern segment of the San Andreas fault". These sequential statements appear to be quite inconsistent, with a nearly 3-fold error. They are also unreconciled with the statement on page 4-10 that "an earthquake of magnitude similar to the 1906 earthquake is estimated to occur on average about once every 300 years on the portion of the San Andreas Fault that lies north of Monterey County." These conflicting statements are serious deficiencies because of the importance of seismic subsidence to the natural long-term maintenance of the lagoon, and the analysis of project purpose and need. They also reflect deficient scientific review and editorial control of the DEIS/R.

Since the (doubtfully) projected risk of inlet closure is "due" by 2058, this is particularly important to the assessment of purpose and need, and to evaluation of the compound (cumulative) impact of dredging and

seismic subsidence. The subject requires clarity, rigor, and consistency. Conclusions depending on this analysis should be suspended in judgment. The relevance between the seismic recurrence interval and the project purpose and need should be made explicit.

### **Rigorous evaluation of Bolinas Lagoon Resource Management Plan policies.**

The requirement that "...dredging should be permitted only after documentation of need is established" and "...only as permitted under existing Coastal Act Policies", and the NEPA requirement for a "hard look" at environmental impacts, are not adequately met by the disjunct and inconsistent discussions of seismic subsidence cycles and historic sources of sedimentation (pp. ES-4, 3-40, 3-34, 4-47, 3-48, 4-3 to 4-5). The purpose and need for the dredging project should be rigorously reviewed by a qualified interdisciplinary scientific peer review panel, with expertise in coastal geomorphology and tidal marsh ecology.

## **Chapter 4 – Environmental Consequences**

**Need for consistent and expanded discussion of lagoon processes** (p. 4-3). Page 4-3 provides an illuminating, accurate, but exceptional discussion of lagoon geomorphology in the context of sedimentation, seismic subsidence, and sea level rise. These seminal perspectives (p. 4-3) are not carried through the text:

"within the recent geologic past the area that is now lagoon has probably experienced large fluctuations in its size and character...left alone the lagoon might survive the threat of closure of its inlet if the graben undergoes another episode of subsidence. It is *almost certain that the fault processes that have maintain the lagoon will continue to occur* [emphasis added].

What is missing is critical discussion of the subsequent statement that "But the risk that inlet channel will close...and that more habitat will be lost...is thought be unacceptable..." There is no reference to how this risk was judged to be "unacceptable", what values were compared and weighed, and whose judgment and authority was responsible. For an issue of ultimate importance for the purpose and need of the project such as this, such an omission of disclosure is unacceptable under CEQA and NEPA. The statement of "unacceptable risk" is not linked to the USGS forecast of seismic recurrence interval for the fault, nor is there internal reference to other chapters of the DEIS/R.

**Cumulative impact of seismic subsidence, dredge-deepening, and beach erosion.** The analysis of 4.2.2. fails to consider the cumulative effect of the compound deepening of the lagoon by dredging and seismic subsidence on erosion of the adjacent Stinson Beach (updrift littoral cell, east of the tidal inlet and proposed Kent Island "pit"). This is potentially highly significant for beach erosion, habitat loss of western snowy plovers, storm damage intensity and frequency for shorefront residences, and recreational use of GGNRA shoreline. The superficial and qualitative discussion of beach erosion under "erosion of tidal inlet channel and banks" (p. 4-21) describes only "minor loss of beach sand", not volumes of sand transport proportional with the volume lost (and demanded by) the removal of the flood tidal delta complex.

**Anoxic sediment chemistry of "turbidity".** The discussion of water quality impacts from "construction" (dredging) considers only turbidity in terms of suspended sediment concentration, not the inevitable chemistry of highly reduced, anoxic sediments below the lagoon surface. Reduced iron sulfide and free hydrogen sulfide are significantly more toxic in shallow tidal waters than mere aerobic suspended silt and colloidal clay. The concentrated dispersion of black (reduced iron) turbidity plumes would have much more severe impact on fish, marine mammals, and estuarine productivity than turbidity alone. This highly



probable and high-magnitude impact, as an aspect of deep dredging in organic estuarine sediment, is not adequately treated in the conditional language of page 4-5. Unlike most navigational dredging, the proposed dredging is targeted for very shallow or intertidal estuarine environments, which limits potential dispersion of an anoxic suspended sediment plume.

**Unstated hydrologic model accuracy or precision.** Mitigation measure 4.2.3. identifies sediment transport modelling to address potential impacts to circulation. The statistical power and accuracy of the model, its potential for calibration to local conditions, are not stated. If the model is merely heuristic (instructive but not empirically predictive with statistical significance), it is not acceptable as a substantive mitigation measure under NEPA or CEQA.

**Lagoon closure assessment.** The analysis and discussion of lagoon closure impacts (p. 4-8) is woefully inadequate, and inconsistent. See comments on “accuracy of inlet closure prediction” above. The assumption that “there will be no major subsidence of the lagoon...” contradicts the statement on page 4-3 that “It is almost certain that the fault processes that have maintain the lagoon will continue to occur...”. The omission of any explicit reference to the primary importance of sea level rise to lagoon closure, and the lack of sea level rise as a controlling variable for tidal prism, is a “fatal flaw” of the discussion and analysis. The deficiencies in accuracy of modern sedimentation rates (see comments on “accelerated sedimentation” and “natural tidal sediment of marine origin versus watershed sediment”, above) make this discussion misleading and unreliable.

**Inconsistent estimates of tidal prism changes due to compound impacts of seismic subsidence and dredging.** There is a huge gap between the amount of tidal prism estimated to have been regenerated in Bolinas Lagoon by the 1906 earthquake (50 million cubic feet (= 1,851,852 cubic yards; p. 3-48, citing Bergquist 1993) and the amount of tidal prism estimated to be caused by an equivalent seismic subsidence of one foot (p. 4-10: 720, 000 cubic yards, excluding 300,000 cubic yards of subtidal volume added). Even if the 300,000 cubic yards of subtidal volume were included in the estimate, there is a highly significant apparent discrepancy between the cited Bergquist estimate, the estimate on p. 4-10, and the feasibility report’s evaluation of historic bathymetry. The units used to express changes in tidal prism should be made consistent throughout the document, and estimated values should be consistent or at least commensurate.

**Inconsistent underestimation of “enhanced wave attack”** (p. 4-22). Failure to accurately predict sand spit erosion due to indirect sediment budget effects of dredging has resulted in a significant underestimate of the potential for increased wave energy in the tidal inlet. Retreat of the spit is highly likely as its sediment is transported to the major sediment sink of the excavated Kent Island flood tidal delta complex, as stated (understated) on page 4-21 (“most of the channel widening would come from erosion of the west end of the sand spit”). The distal end of the spit is the only significant wave barrier for the lagoon. Deeper water of the enlarged inlet would act as a lens to focus wave energy into the lagoon, allowing less wave energy dissipation from to bottom friction. The effects of former higher inlet wave energy are apparent in the historic photos of figures 4.3 and 4.4 of the feasibility report, which show wave-reworking of flood tidal delta shoals into an emergent “interior” barrier island beach, Kent Island (an emergent flood delta). The months of the photos are not given, but such extensive arcuate shoreline development on Kent Island would have occurred during earlier phases of spit retreat, probably in winter.

A recent example of significantly increased wave exposure due to inlet enlargement and migration is at the Mad River, Humboldt County, which had to be artificially stabilized in 1992.

## Concluding comments

Given the unprecedented magnitude of tidal marsh and mudflat destruction proposed as “restoration” of Bolinas Lagoon, the extraordinary stakes demand the most scientifically rigorous and consistent evaluation of purpose and need, alternatives, and environmental impacts under NEPA and CEQA. From both a regulatory and scientific standpoint, I regret to conclude that the DEIS/R is woefully deficient in both aspects, and even more importantly, contradicts itself and its feasibility report frequently. Some of the errors may be due to the difficulty in managing a large and complex body of information, but some errors appear to be exceptionally consistent and systematic (such as significant underestimation of tidal marsh). Other errors seem prejudiced in favor of the purported threats of “upland conversion” and lagoon closure used to justify the project’s purpose and need.

The scientific basis for the purpose and need of this “ecological restoration” project is weakly and inconsistently argued. The proposal itself, in my professional experience, is one of the least credible and most inflated “ecological restoration” concepts I have reviewed in the last 25 years, either in California or elsewhere. I have grave concerns that its poor scientific foundation for this “restoration” concept could undermine public and government support of valid coastal ecosystem restoration in the region for many years to come. I do not believe that his harsh evaluation is undue or unfair, especially given the magnitude of the project, and objective of “ecological restoration”.

Of all tasks needed to finalize the EIS/R, I recommend that an independent scientific peer review panel, with interdisciplinary expertise in coastal geomorphology (particularly in tidal inlets, beaches, and lagoons) and estuarine ecology (particularly paleoecology and community dynamics of tidal marshes) is the most essential. The local technical advisory panel does not and cannot fulfill this role. The U.S. Geological Survey, the University of California, and other academic institutions with internationally recognized scientific expertise would be appropriate sources for a scientific peer review panel.

Specific analytic tasks needed for an adequate final EIS/R include: (1) geographic comparative analysis of the sedimentation and ecological history of Bolinas Lagoon and other California estuaries; (2) focused study of the environmental consequences of tidal choking (partial or intermittent, unstable inlet closure); (3) realistic analysis of inlet stability and lagoon habitat change based on the best available data on sea level rise, seismic recurrence intervals, and accurate field data on tidal and fluvial sedimentation; (4) analysis of the project effect on the entire littoral cell’s sediment budget, with focused attention to the rate and magnitude of beach erosion following dredging of the Kent Island flood tidal delta complex; (5) comprehensive quantitative re-assessment of habitat types and distribution, using established, scientifically sound methods and definitions (based on ground truthing of current infrared aerial photographs); (6) re-assessment of biological impacts based on comprehensive regional biogeographic context, including regionally rare and declining species.

Adequate, complete, and accurate technical analysis is particularly important to support meaningful comments from federal and state resource agencies, whose staff rely on the accuracy and completeness of NEPA/CEQA documents. Resource agency staff usually do not have the time to fact-check basic information provided in an EIS/R.

If the purpose and need statement were appropriately recast more broadly, the alternatives analysis could include a reasonable, moderate-scale navigational dredging project which is specifically designed to improve recreational and commercial boat access to designated portions of the lagoon. This reduced project alternative could avoid most of the excessive, unacceptable, and unmitigable impacts of the proposed project. As a political outcome of the NEPA/CEQA process, such a downscaling of project

purpose and scope would better serve the general public interest in the lagoon, and the estuarine environment as well. Mitigation for a downscaled project could be proportionally reduced to removal of modern artificial fills at the edges of the lagoon, or other ecological enhancements that do not destroy more valuable existing habitats.

Sincerely,

[original signed]  
Peter R. Baye, Ph.D.  
Coastal Plant Ecologist

Attachment: Literature cited.

Copies:

Hon. Barbara Boxer

Agencies:

California Department of Fish and Game, Yountville (C. Wilcox)  
California Regional Water Quality Control Board, San Francisco Bay Region, Oakland  
California Coastal Commission, San Francisco  
U.S. Environmental Protection Agency, San Francisco (M. Monroe)  
U.S. Fish and Wildlife Service (M. Littlefield, C. Goude, W. White)  
U.S. Geological Survey, Biological Resources Division (K. Miller, J. Takekawa)  
U.S. National Park Service, Golden Gate National Recreation Area, San Francisco (B. O'Neill)  
U.S. National Park Service, Point Reyes National Seashore (D. Neubacher)  
Gulf of the Farallones National Marine Sanctuary, San Francisco (E. Ueber)

Organizations:

Marin Audubon Society, Larkspur (B. Salzman)  
Golden Gate Audubon Society, Oakland (A. Feinstein)  
Environmental Action Committee of West Marin (C. Caufield)  
Integrity in Natural Resources, Healdsburg (J. Hansen)  
Point Reyes Bird Observatory, Bolinas  
San Francisco Estuary Institute, San Leandro (J. Collins, R. Grossinger)  
Sierra Club, San Francisco Chapter, San Francisco (R. Gravanis)

Individuals

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Roger Byrne, University of California, Berkeley  
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LITERATURE CITED

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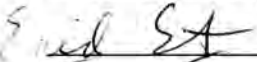
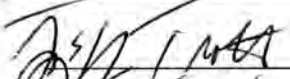
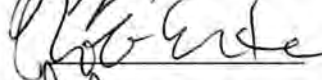
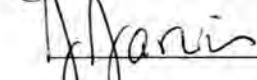
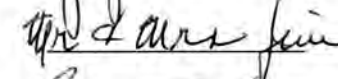

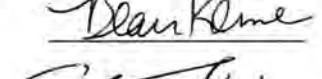
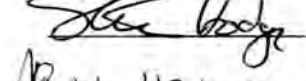
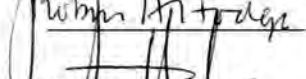
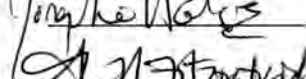

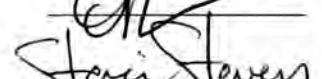
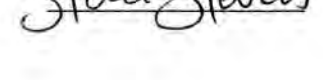
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To: Dr. Bill Carmen, Project Manager,  
Bolinas Lagoon Ecosystem Restoration Feasibility Study MCOSD  
3501 Civic Center Drive, Suite 415, San Rafael, CA 94903

Date: March 27, 2006

From: Residents of Stinson Beach and Bolinas

We urge your committee to pursue an intervention strategy to mitigate the silting in of Bolinas Lagoon. As stewards of this magnificent and precious estuary, it is time to take action to correct the impact of human intrusion. Expanding the tidal prism by restoring the Bolinas Channel and its connection to Pine Gulch Creek will help to restore the biodiversity and health of the lagoon and preserve the legacy we have inherited for many generations to come.

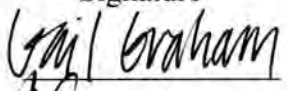
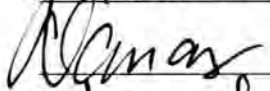
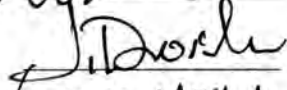
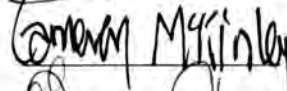
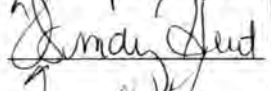




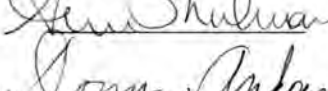
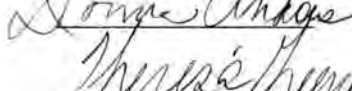
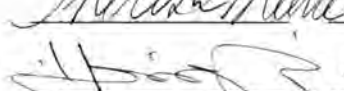
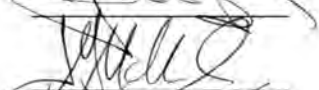
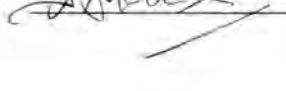
Signature	Print Name	Address
	MARK WHITE	407 CALLE DEL MAR STINSON 94970
	EMID STEVENS	122 CALLE DEL MAR 94970
	JEFFREY TROTTER	15 Calle de MAR 94970
	ROB ERTEMAN	24 AVENIDA Baulina 94970
	Jennifer Jarvis	PO. BOX 1009 SB 94970
	Sauri Fisher	PO Box 947 SB 94970
	SETH KLINE	1 calle del Embarcadero
	BEAU KLINE	1 Calle del Embarcadero
	STEVE HODGE	317 LARCH RD
	ROBIN HODGE	25 BELVEDERE AVE, STINSON BEACH
	JOSEPHINE HODGE	25 Belvedere Stinson Beach
	AMY FITZPATRICK	18 Avenida Favalora SB
	OSHER KLINK	125 BUENA VISTA S.B.
	Staci Stevens	15 Calle de Mar SB

To: Dr. Bill Carmen, Project Manager,  
 Bolinas Lagoon Ecosystem Restoration Feasibility Study MCOSD  
 3501 Civic Center Drive, Suite 415, San Rafael, CA 94903

Date: March 27, 2006

From: Residents of Stinson Beach and Bolinas

We urge your committee to pursue an intervention strategy to mitigate the silting in of Bolinas Lagoon. As stewards of this magnificent and precious estuary, it is time to take action to correct the impact of human intrusion. Expanding the tidal prism by restoring the Bolinas Channel and its connection to Pine Gulch Creek will help to restore the biodiversity and health of the lagoon and preserve the legacy we have inherited for many generations to come.

Signature	Print Name	Address
	GAIL GRAHAM	P.O. Box 7, Stinson Beach
	DAWN DUMAS	... .. 23 ... ..
	J. Drosich	✓ ✓ 403 ✓ ✓
	Cameron McKinley	P.O. Box 605, Stinson Beach
	Wendy Hunt	PO Box 318, Stinson
	Trudy Green	39 Brighton Ave Bolinas
	Annelise Beer	PO 428, Stinson Beach 94970
	ELLY DROSIAN	PO Box 403 Stinson Beach
	Tanni Meade	PO Box 513, Stinson Beach
	Ann Shulman	PO Box 1142, Stinson Beach
	Donna Andrews	P O Box 11 Stinson Beach
	Theresa Greene	P.O. Box 563 Stinson Bch. CA 94970
	Heidi Lundy	Star Route 609 # SB 94970
	Jeffrey G. McKinley	PO Box 605, Stinson Beach, CA 94970

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Bolinás Lagoon Ecosystem Restoration Feasibility Study MCOSD  
3501 Civic Center Drive, Suite 415, San Rafael, CA 94903

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Signature

Print Name

Address

Ewan Macdonald

A.E. MACDONALD

87 Wharf Rd, Bolinas

Robert A Balza

Robert A Balza

101 Wharf Rd, Bolinas

Lynnda J Balzan

LYNDA J BALZAN

101 Wharf Rd, Bolinas

Deane Frederick

ELAINE FREDERICK

103 Wharf Rd, Bolinas

Keith Hansen

Keith Hansen

99 Wharf Rd, Bolinas

Patricia

Patricia Briceño

99 Wharf Rd Bolinas

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March 24, 2006

Phil Binley  
39 Brighton Ave  
PO Box 627  
Bollinas, CA 94924

Bill Carmen  
145 Eldridge Ave  
Mill Valley, Ca 94941

RE: The restoration of the Bollinas Lagoon

Dear Bill, This letter is from a concerned citizen who lives (full time) in Bollinas and a citizen who doesn't need a study to reinforce my observations. This extremely valuable community asset and essential part of the local fish and fowl habitat **is on its way to extinction.** This doesn't surprise me, in fact it almost feels like a natural process but it also feels like something that can be prevented or at least slowed down.

I strongly support a process of small steps. Let's quite speculating and actually try something. Let's move from the study phase to a phase of experimentation.

Let's stop supporting the killing of innocent people around the world and start spending tax dollars in the place we live and earn our livings.

A handwritten signature in cursive script that reads "Phil Binley". The signature is written in black ink and is positioned below the main body of the letter.

CC: Bucky Mace, Bollinas Lagoon Foundation



ROBERT A. BALZAN  
P.O. Box 155  
Bollinas, CA 94924  
March 22, 2006

William Carmen, Project Manager  
Bollinas Lagoon Ecosystem Restoration Feasibility Study  
3501 Civic Center Drive, Suite 415  
San Rafael, CA 94903

Dear Mr. Carmen:

I am writing this letter to express my deepest concern about the Phillip Williams and Associates, LTD study of the Bollinas Lagoon and the concomitant inaction that could occur because of it.

As part of a family who has owned a home on the lagoon since the early 1900's, I have witnessed a drastic alteration of the lagoon's depth, composition, and marine life, particularly during the last 20 year period. Based on my observations, I believe that if limited dredging does not occur within the immediate future, this alteration will become irreversible.

Living on the lagoon provides an anecdotal perspective that studies do not. A view from my deck shows an incessant build up of sand banks throughout the lagoon's once open water. These banks have to have a negative effect on marine life. In years past I was able to catch a diversity of fish from my deck...bullheads, smelt, various variety of perch, shark, and rays. Today only shark and rays are available. Also, in the past I could gather horseneck and Washington clams on Kent Island. Today these are no longer in existence.

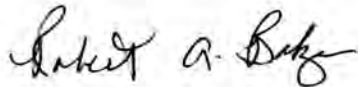
Of particular concern to me is the perilous movement of the channel in spring and early summer. During this time it surges directly under my house, undercutting the sand base around the pilings, and jeopardizing the house's very existence. In the past, this channel was situated much closer to Kent Island and not a major concern.

According to the study, if dredging were to occur, it could severely impair the food chain. From my perspective, the inaction has already impaired the food chain and will persist in doing so as long as the lagoon continues to close. A case in point is the change in the composition of sediment underneath and beyond my house. In years past, this area was composed primarily of sand. In recent years it has mutated into a mud/sand composite with an expanding algal growth. Such a change must inevitably

have some impact on the diversity of marine life as it presently exists.

In summation, I have been fortunate to have spent a major part of my life viewing the lagoon. I can still recall Kent Island being separated by a channel of water and waves washing over Seadrift. While I realize these are phenomena of the past, I hope that some remedial action will occur to preserve the lagoon and its status as a national treasure. This should not be in the form of ongoing studies, delays and inaction; but in a well thought out response that will return the main channel closer to its original location and preserve the overall integrity of this beautiful, very special habitat.

Sincerely,

A handwritten signature in cursive script, appearing to read "Robert A. Balzan". The ink is dark and the handwriting is fluid and personal.

Robert A. Balzan

**Robert D. Ekedahl**  
**2 Chateau Drive**  
**Menlo Park, Ca 94025**  
**Phone 650-324-2667**  
**Fax 650-324-2690**  
**Email: rde17@pacbell.net**

March 12, 2006

Mr. Bill Carmen, Project Manager  
Bollinas Lagoon Ecosystem Restoration Feasibility Study  
MCOSD  
3501 Civic Center Drive, Suite 315  
San Rafeal, CA 94903

Subj: Bollinas Lagoon

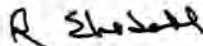
Dear Mr. Carmen,

We wish to express our support for a solution that would restore as much of the lagoon as financially feasible. We support the recommendations of the Bollinas Lagoon Foundation and the excellent work they have done for many years.

Of particular importance is the channel to the downtown area that services the small fishing boats that fish out of the Bollinas Lagoon

We have been homeowners in Bollinas since 1968 and have followed the changes to the lagoon since for some 38 years.

Sincerely,



Bob and Diana Ekedahl  
(47 Terrace Ave. Bollinas)



# SEADRIFT ASSOCIATION



March 29, 2006

Mr. Bill Carmen  
Project Manager  
Bolinás Lagoon Ecosystem Restoration Project  
M.C.O.S.D.  
3501 Civic Center Dr. #415  
San Rafael, Ca. 94903

RE: Bolinás Lagoon Ecosystem Restoration Feasibility Report

Dear Bill,

I am writing this letter on behalf of the Seadrift Association Board of Directors and its membership of some 300 Seadrift property owners. We are pleased to submit our comments on the February 10, 2006 Draft Bolinás Lagoon Ecosystem Report prepared by Phil Williams and Associates.

We view this report as another piece of the academic puzzle charged with projecting the ultimate fate of the Bolinás Lagoon, a subject of great interest and concern to our community. As you will see from our comments we are in disagreement with any "do nothing and hope" approach to this now ten year old project, and are of the opinion that now is the time to move forward and take positive steps to preserve/restore the Lagoon. We are therefore recommending the following:

1. That the County take steps to untangle the jurisdictional maize involved in overseeing the Lagoon and have it recognized and established that a Lagoon mouth closure be classified as an emergency. In addition, that it be agreed by all agencies involved that the County be permanently granted the authority and responsibility to open the Lagoon mouth in case of closure. In addition the County should develop a "plan" and be prepared, when and if closure occurs, to execute the closure opening.
2. That a list of "limited intervention" options be established and prioritized in order of importance.
3. That the County Initiate the planning and the ultimate construction of the first priority option and provide a program to monitor results.

4. Establish and maintain a schedule for continuing bathymetric surveys of the Lagoon to determine ongoing changes in the tidal prism.

It is our opinion that allowing the Lagoon to shrink over the years until equilibrium is reached would be an unfortunate decision and a regrettable environmental mistake. We are concerned that the current habitat balance and general health of the lagoon will continue to deteriorate needlessly unless there is some form of intervention. At the very least efforts should be made to maintain the current tidal prism. Increasing the tidal prism should be our goal.

We call on the County, as protector of the Lagoon, to step forward and initiate a program to keep this designated "Wetland of International Importance" a true wetland of international importance.

For the Board of Directors



Richard Kamieniecki  
General Manager

Cc Supervisor Kinsey

Mr. Carmen-

Re the Draft Report on the Bolinas Lagoon dated Feb 10, 2005

I am distressed by this report. I do not agree that we can I do nothing and let the lagoon die

To state that nothing needs to be done now to save the lagoon in the future is at variance with observable evidence over the past 5, 10 15, 20, 25, years or more of the lagoon. The lagoon has deteriorated over these years in terms of the eel grass, sub tidal habitat, birds leaving, the absence of fish, etc. and the enormous amount of silting that has taken place. The silt build up has been so visually and physically obvious and deeply threatens the environmental health of the lagoon. You don't need to be scientists to observe this fact. Drastic changes are taking place and they are taking place exponentially. Those of us who have observed this change can attest to that.

This tidal estuary is too great of environmental importance to do nothing about its on going destruction. We need restorative action to at least get some tidal waters circulating and washing in and out of the lagoon.

Otherwise, the Lagoon will be a meadow before we know it.

Thank you,  
Sherry Penzias



## SIERRA CLUB MARIN GROUP

Box 3058 San Rafael CA 94912 sanfranciscobay.sierraclub.org/marin  
/o Gordon Bennett 40 Sunnyside Dr Inverness CA 94937 415-663-1881/gbatmuirb@aol.com

March 31, 2006

William Carmen, Project Manager  
Bollinas Lagoon Ecosystem Feasibility Study  
MCOSD, 3501 Civic Center Drive Suite 415  
San Rafael, CA 94903

Dear Mr. Carmen:

On behalf of the Sierra Club's 7,000 Marin County members, our 205,000 California members, and our 750,000 national members, we offer the following comments on the four documents: Projecting the Future of Bollinas Lagoon ("PWA"), Recent and Late Sedimentations Rates ("RB"), Peer Review Comments ("TRG"), and Littoral Sediment Budget.

### General Tone

The Sierra Club is concerned that the February 2006 Draft Report on the Future of Bollinas Lagoon does not contain a clear, brief take-home message. That take-home message should be that the Report provides new and conclusive evidence that the sedimentation of Bollinas Lagoon is not a "problem" but rather a natural process that is virtually certain not to lead to the closure of the mouth of the Lagoon.

As a result of the Report's lack of clarity and brevity, the public is left to create its own mistaken take-home message. Public comments at the March 3 meeting of the Bollinas Lagoon Technical Advisory Committee can be paraphrased as:

*"The Draft Report and the Corps Report came to the same basic conclusion that the Lagoon is threatened by sedimentation. However, Corps Report claimed the problem was caused by sediment from the watershed and thus could be solved by dredging, while the Draft Report shows the problem is caused by sediment from the ocean and thus should be solved by armoring the bluffs and/or enlarging the groin."*

The above mistaken message is based on the incorrect assumption that a "problem" exists and thus requires a "solution" (replacing an old and discredited engineering project with a new and better engineering project). Problem-less solutions are futile at best and dangerous at worst.

Bluff armoring has been tried many times on our coastlines with consistently disastrous results. As the Coastal Commission's "Sample Policies for Planners" notes: *"Numerous studies...demonstrate that shoreline protective structures can have deleterious effects on beaches at their base and on more distant beaches due to interruption of sand supplies. ... Shoreline protective devices can and do substantially alter natural landforms by... accelerating erosion of the beach seaward of the device and of the bluffs on either side of the device."* Likewise, our understanding of the work of Professor Gary Griggs (UC Santa Cruz) leads us to believe that a large groin would not stop Lagoon sedimentation, because it would not affect the supply of ocean sand already stored in the vast reservoir of Bolinas Lagoon's tidal delta system. A large groin would, however, strip sand off adjacent beaches because the beach sands and the Lagoon sediments are part of the same system: any engineering "solution" that reduces one will reduce the other.

The PWA Report acknowledges that many local residents have made a logical but ultimately erroneous projection from their experience of localized sedimentation to arrive at an invalid "threat to the Lagoon." This erroneous projection has been supported by publicity intended to raise money and awareness to counter this "threat." The cumulative result is a public that is so intent on solving the sedimentation "problem", that any scrap of uncertainty in the Report (no matter how infinitesimal), any moment of hesitation in the Report (no matter how brief), and any mention of any possibility in the Report of Lagoon closure (no matter how remote)...is grabbed onto by the public as absolute proof that there is a imminent problem that needs an immediate solution.

Meanwhile, the Report's scientists are understandably reluctant to state in the Draft Report that their conclusions are absolutely totally 100% guaranteed certain (although the Report comes exceptionally close). Nonetheless the collision between the public's decades of logical but erroneous projection and the scientists' counter-intuitive new evidence underscores the importance of a clear take-home message that the sedimentation of Bolinas Lagoon is not a "problem" but rather a natural process that is virtually certain not to lead to the closure of the mouth of the Lagoon.

### **Sea Level Rise**

The Sierra Club takes issue with the single sea-level rise scenario upon which all analysis is based. Sea level rise and earthquakes are the two most important factors driving the future of the Lagoon. The IPCC model used as a basis in the PWA Report bases its prediction of sea level rise on thermal expansion only and fails to account for the melting of the polar icecaps that



will punctuate this "dynamic equilibrium (Science 3/24/06). The PWA model assumes ~0.4 feet of sea level rise by 2050 based on thermal expansion only, but we estimate that including the impact from polar melting would at least double that figure. Closure scenarios models were done for different Tidal Prisms and different Inlet Widths, but all based on the same thermal-expansion-only model for sea level rise. The graph of Potential Sea Level Rise (Figure 5-2) demonstrates PWA's choice of a mean sea level between two almost equal thermal projections. In the now discredited USACE report, there was great criticism that the choice of alternatives was between two almost identical dredging projects. We believe that the same criticisms apply here with a choice between two almost identical sea level rise projections. We urge that duplicate closure scenarios and habitat projections be run using a sea level rise projection that includes the melting of the polar ice caps.

### **Closure Prediction**

Given the public's long history of concern about the threat of closure of the mouth of the Lagoon and given the Reports' acknowledgment that extended periods of closure could bring about rapid changes in the ecology of the Lagoon, the Report's analysis of closure potential seems remarkably brief, several statements appear inconsistent, and the presentation is confusing.

The PWA Report assigns a numeric closure possibility (about once every decade) to a tidal prism of 2 MCY (pg 8 #32), but provides no data to back that statement. Table 5-2 (Results of Inlet Stability Analysis) shows three scenarios, none of which includes a 2 MCY scenario.

The PWA Report does not assign a numeric closure possibility for a tidal prism of 2.5 MCY, even though this is the projected 50-year condition. Instead, the report simply notes (pg 8 #26) that closure is possible "*under extreme conditions of strong El Nino Storms and weak neap tides.*" That same general statement could not only be made for the current tidal prism of 3.5 MCY, but also for virtually any tidal prism. This is not helpful. It is irrational to ascribe a numeric probability to a tidal prism of 2.0 MCY which will be reached well beyond the 50-year scope of this study, yet not assign a probability to the 50-year condition at 2.5 MCY. Is that possibly because the probability is so vanishingly remote that no reasonable/conceivable set of circumstances could come close? If so, then the "extreme combinations" statement leaves far too much to active imaginations in which every winter storm may be considered extreme. Is there any evidence to support the "extreme combinations" statement?

Pg 84 mentions, *"the first instance of predicted tidal prism closure over the simulation period occurred for a lagoon tidal prism of 2.0 MCY-slightly below the value predicted in 50 years-and an inlet width of 300 feet."* However, Table 5-2, which is supposed to represent "the results of this analysis" shows no data for 2 MCY and instead shows 2 closures for 2.5 MCY at the 300-foot width. Which is right? Assuming Scenario 2 is really meant to be for the 2.0 MCY tidal prism and the 300-foot inlet width, then does the "about once a decade" calculation come about by dividing 2 by 17? (because the data was *"simulated over a 17-year time series"*?) These points of key interest are inadequately discussed.

PWA page 84 states, *"smaller inlet widths produce larger values of tidal power."* Table 5-2 shows its 2 instances of closure at 2.5 MCY tidal prism and inlet width of 300 feet, yet also notes *"no closure was simulated (projected?) when the inlet width was reduced to its expected value of 200 feet."* If the expected inlet width is 200 feet and has no closures, then it is not clear how the 2 closures at 300 feet every 17 years can be said to equate to a closure possibility of ~once a decade for the 2.5 (2.0?) MCY scenario.

PWA page 84 notes, *"large winter creek flows into the Lagoon...would eventually lead to natural re-opening of the inlet."* We believe this circumstance would also significantly decrease the potential for closure, however the data analyzed to project the closure potential were wave and tide data only. Surely occasions where combinations over the 17-year study period of wave and tides that were likely to close the Lagoon but that also coincided with large winter creek flows should have a much lower closure probability weight assigned. Similarly PWA page 84 notes, *"erosion of the beach barrier by (winter?) ocean waves would eventually lead to natural re-opening of the inlet."* Likewise then, if the instances of wave power and tides suitable for closure occurred in the winter, then they should again be assigned a much lower closure probability, since any closure would likely be only until the next tide when the normal erosive power of the waves/tides would return from its unique closure conditions.

Figure 5-11's 10 days of data does not adequately represent 17-years worth of data. It does not show the two instances of predicted closure so that the public can see to what extent the potential for closure occurred in the winter when large creek flows would be expected nor how many tidal cycles the predicted closure value exceeded 12. There is also no discussion of what it means when the closure index spikes for one tide, as Figure 5-11 shows on 1/23/95, but then for the subsequent tide, the closure index drops dramatically. Was this the case for the two instances of closure? Does the closure index dropping from 12 back to 1 mean that the closure lasts for only one tide? These are the very issues that the public has expressed concern about, yet figure 5-11 does a very poor job at representing the data. Figure 5-11 also notes the *"current tidal prism (100 mcf) was used."* But elsewhere the Report indicates the current tidal prism is 3.5 mcy, which  $\neq$  100 mcf.

Pg 19 notes, "*Duxbury reef shelters this inlet from the prevailing northwesterly winds.*" For Figure 5-11, the wave power index uses "*waves from the Monterey Buoy (transformed to Bolinas Bay)*". Seemingly the wave power (one of the two determinants from which the closure potential was projected) is less at the inlet than in the more open ocean conditions at the Monterey Buoy, thus closure potential may be overstated depending on how the wave power is "transformed." But there is no discussion.

Lastly, Figure 5-11 attempts to do too much and the choice of the time period 1/20/95-1/30/95 is unfortunate not only because it does not include one of the two closure events, but also because the wave power graph exceeds the index threshold for closures, misleading the public into believing that this solid line rather than the circles represents the closure index.

### **Equilibrium Date**

Report says (PWA pg 8) "*The ultimate tidal prism of this projected long-term equilibrium form where net sedimentation keeps pace with sea level rise could be close to  $2 \pm 0.3$  MCY...*" However, the Report does not say when this equilibrium condition will be reached. There is a habitat map of the long-term equilibrium conditions, but the Tidal Prism Change Graph (Figure 3-14) is cut off at 1998. In our opinion, this Tidal Prism Graph should be extended out, not just to 2050, but also to and past the date that the ultimate equilibrium form is achieved. PWA certainly has this information: Response to TRG comment #3: "*In projecting an equilibrium form we have evaluated how the lagoon morphology would adjust over the next few centuries in response only to projected sea level rise. We find that this projected morphology and associated tidal prism – the asymptote of the evolutionary trajectory, does equilibrate as a full tidal system. In other words, the lagoon does not require another major earthquake within the next few centuries to persist as a tidal system.*" We also believe an extended (beyond 1998) tidal prism was presented as a power point screen in the November 7, 2005 public meeting.

If it takes 50 years to go from a tidal prism (based on sea level rise only from thermal expansion) of 3.5 in 1998 to 2.5 in 2050, and the rate of tidal prism change decreases as the tidal prism decreases, then this ultimate tidal prism must be beyond the date derived from a straight-line projection, which is 70 years from now. We would guess that a flattening-curve projection might reach this ultimate tidal prism closer to 100 years from now using only seal level rise based on thermal expansion. This date is important to reveal to the public.

These timeframes are far beyond the stated scope of the Report, but if the Report is going to mention this once-a-decade closure probability for the "ultimate equilibrium form" and map its habitats, then we believe it should also project a date when this ultimate form might be achieved. Given the 50-year scope for the Report and the public's high concern with the threat of closure, then we believe it is necessary to inform the public so they may know when the probability of once-in-a-decade closure is projected to begin. For example, if this once in a decade closure probability might begin, say, in 2051, just 1 year outside the scope of the study, then this would provide a completely different context to the Report than if the minimum 2.0 Tidal prism point would be reached in 2091, for example.

### **USACE Errors**

It would be helpful if the problems found with the USACE Report were collected together in one statement so that the public could better understand what went wrong. For example, the USACE EIR/S did not adequately distinguish that an increase in sedimentations does not result on an equal decrease in tidal prism...ie sedimentation below low water and above high water do not change the tidal prism. Also the USACE bathymetry surveys were not all tied to the same datum (RB pg 19) and the USACE used the wrong tidal benchmark (RB pg 19).

### **Bluffs and Groins Past and Future**

The PWA Report does not adequately distinguish between the littoral sources of the sediment directly after the earthquake (the destroyed bluffs) and the current littoral sources in which bluff erosion plays a minor role. This unclarity may have led the public to mistakenly believe that a groin would protect the current lagoon from littoral sedimentations. Furthermore, the Littoral Sediment Budget Report addresses the questions: *Have the Bolinas Groin and the armoring of Seadrift affected net sedimentation in the Lagoon? How have these structures changed the beaches adjacent to the inlet and the movement of sand?* However, these questions are for the past. There is no discussion of how these structures may or may not affect sedimentation over the 50-year scope of the report.

### **Possible Typos**

Suggested typos ~~struckthrough~~ and corrections underlined: PWA page 6 #16: *Although the Pine Gulch Creek delta and Kent Island have sheltered areas along the eastern western side...* PWA pg 28: *"UC Berkeley cores were limited to unvegetated mudflats and subtidal shallows and do not account for the delivery of coarse watershed sediments..."*

### **Choice of Words**

There is an uneasy tension between the PWA choice of words in 6.1 "*Managing in the Face of Uncertainty*" and the RB statement "*Is Bolinas Lagoon 'filling in' at a rate that will lead to its extinction and conversion to freshwater marsh within the next 50 years? The answer, almost certainly, is no.*" Again, this concern goes back to our first concern that these documents lack a clear and brief take-home message. We fully agree with the comments of the TRG in this regard and believe that the TRG comments have not been adequately addressed or incorporated into these documents.

The 8-page PWA "Conclusions and Recommendations" is an inadequate executive summary and, for a take-home message, is 7.9 pages too long. The clear take-home message that should be in the very first sentence of any executive summary should be: The sedimentation of Bolinas Lagoon is not a "problem" but rather a natural process that is virtually certain not to lead to the closure of the mouth of the Lagoon. Each word of each component of these 4 documents should be analyzed to make sure that they conform to or at least are not subject to misinterpretation that could undercut this clear take-home message. To obtain this level of clarity in these four Reports would be the most useful tool to manage in the face of public uncertainty.

Thank You for the Opportunity for Review and Comment,

Gordon Bennett, Chair  
Sierra Club Marin Group  
SF Bay Chapter Executive Committee

Stinson Beach Village community is pleased to submit our comments on the Draft Report prepared for Marin County by Wetlands Research and PWA associates that were released February 10, 2006.

- First a brief introduction: \*International Wetlands Treasure-Bolinas Lagoon was so named by the Ramsar Convention in 1991, receiving recognition of its unique natural treasures.
- The Crown Jewell of Marin County's estuary system
- "Pool at the Foot of the Mountain of Creation"-Pomo Indian legend

Referring back to the current operational management plan (June 1996 Certified Management Plan), Wetland Research and PWA presented a focus of the future conditions within the ecological changes forecast within the 1994-1996 analysis of tidal prism and lagoon evolution as follows

\* the anticipated gains and losses in fish and wildlife species as projected to 2008, as-well-as, with 1). closure of the lagoon mouth and 2). future increases in tidal marsh and loss of tidal flat and channels.

NOW that we have seen the Draft report of the Lagoon Reformation Study, the same consultants are continuing to forecast this same process of 'loss' of physical and biological values in the "evolutionary" process through the year 2054. With this in mind, the goals and objectives of the local stakeholders are TO: Preserve and resort the ecological values of the Bolinas Lagoon(primary goal);maintain the abundance and diversity of the Lagoon life(especially aquatic birds, marine mammals, fish, and marine plants and invertebrates);maintain, over the long-term, a balance among aquatic habitats that best maintain the abundance and diversity of intertidal lagoon life; restore water quality and hydraulic functions that will decrease sedimentation and prevent the loss of rich estuarine habitats.

- When we (the public) review the agreed-upon set of objectives in the 2002-2003 Contract with the PWA/Wetlands Research team with the County, we find these assignments:

Task#5: Predicting Habitats and Ecology-the goals of the Consultant team and the TRG review group in memo/March 25, 2003 states:"However, some populations of mobile species of wildlife including especially the Coho run in Pine Gulch and the migratory shorebirds and waterfowl that use the system are obviously important."

Unfortunately, the response of the Consultants to the comments/concerns of the PRAG members were less than competent with regards to the Study's evaluation of special status/indicator species change from the 2054 predicted conditions. The response to

PRAG members Page and Thomas concerns regarding the "lack" of detailed analysis of these indicator/special species and habitats were, [consultants comments]-"We agree that many fish species, which use habitats within the Lagoon at various life stages, will lose habitat over the next 50 years; however, species-specific impacts were not discussed due to the large-scale focus of the document."

With this in mind, we suggest that the Exhibit "A" Service to be provided by Contractor" Sep. 9, 2004, contract agreement (Subtask 5.2 Projected Future Lagoon Habitats & Ecology/ WRA will predict future shifts in abundance and distribution of different types related to changes in Lagoon elevation, inlet closure frequency and duration, and estuarine processes(Task # 3 and 4) . WRA will predict future shifts in abundance and distribution both of common fish and wildlife species And special status species related to change in habitat types. WRA will also predict future shifts in abundance and distribution of eelgrass beds in the Lagoon."

Thus, the contract agreement has NOT been completed by the Contractor and hence has left a huge hole in the research framework necessary to evaluate WHAT WE ARE TO LOSE AND WHAT WE ARE TO GAIN in the 50-year forecast! This is not a small matter; when you consider that our Public MUST know what they (the stakeholders) are losing before they can make an informed decision whether they are willing to accept these losses!

Just remember that the 1994-1996 Management Plan for Bolinas Lagoon (the current operating document) described the proposed Adaptive Management for Bolinas Lagoon and discussed its individual elements, including a dredging contingency plan if certain thresholds are exceeded. Indication that these three thresholds were (1) mouth closure (2) habitat changes, (3) navigation. PWA Associates original plan called for the possibility of dredging only after a 5-year monitoring period, during which time other management activities would be undertaken to reduce the amount of sediment entering the Lagoon.

Well, history has now painted the picture for the 50-year foreseeable future. And the picture of an ever-vanishing open-water estuary is NOT an acceptable alternative. Please respond to these concerns with your review process and written comment publications. Any detailed adaptive management plan for the future must take these issues (along with the many more you will receive) into careful consideration.

Scott Tye  
for the Stinson Beach Village  
Association

Dear Bill ,

I have just read the article in the Point Reyes Light and appreciate the opportunity to communicate about this issue.

I live on Ocean Avenue and have been here, on the cliff, for 14 years. I am not surprised that recent findings have targeted the cliff erosion as the major source of sediment that fills the lagoon.

Apparently, up until World War II, there was a system in place that controlled the cliff erosion- a series of "piers" ( or groins or whatever) going out from the beach that essentially kept the ocean back. Some of the remnants of this system still remain.

Louise Pepper remembers this, as do many others, and said that when the War came, the men were not available to "maintain" the piers.

Not only is the cliff erosion filling in the lagoon, but it is threatening the very infrastructure of the town now as Terrace Avenue shows slides in two places, at Overlook and at Surfer's Outlook.

We need to reinstitute this once trusted system to protect our lagoon, our roads, our homes.

Best wishes,  
Suzanne Ciani

Tel: (415) 868-2239

Cell: (415) 307-8867



Dear Bill ,

It was a pleasure to meet you at the Bolinas Lagoon Technical Advisory Committee meeting in Stinson on March 3.

I just want to reiterate what I said there so that you will be able to include this in your upcoming report.

Based on the new knowledge that much of the sediment filling the lagoon is coming from the ocean cliffs,

and

Based on the past practice in Bolinas of using small groins very widely spaced along the beach to keep the ocean from attacking the cliffs directly and thus minimizing ocean erosion,

I would like to propose that a simple groin system be considered to help allay the cliff erosion and the resultant filling in of the lagoon.

Thank you for preparing the community feedback report.

I understand that you need to collect all feedback by March 31.

Best regards,  
Suzanne Ciani

Tel: (415) 868-2239  
Cell: (415) 307-8867

P.O. Box 1005  
Stinson Beach, CA  
94970

March 29, 2006

William Carmen, Project Manager  
Bolinás Lagoon Ecosystem Restoration Feasibility Study  
MCOSD  
3501 Civic Center Drive  
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San Rafael, CA 94903

**Comments On Draft Reports on the Bolinas Lagoon Ecosystem Restoration Feasibility Project**

Dear Mr. Carmen:

As the owner of a home adjacent to Bolinas Lagoon, I am concerned about the Lagoon's deterioration. I submit the following comments on the reports released last month. I am providing these comments by e-mail today and also will mail a hard copy today.

**1. The Report "Projecting the Future of Bolinas Lagoon" ("Williams Report") does not plainly state its limited purpose. As a result, Section 6 can be and has been misread as a no-action recommendation. Its limits should be clarified.**

I understand the general issue facing the MCOSD to be whether the general public interest, or the legal obligations imposed by the state in Chapter 787 of the California statutes, sections 1(a)(1 through 5), require the MCOSD to take steps now to address the diminishing tidal prism in Bolinas lagoon. That state law provides in pertinent part that:

[T]he lands shall be used by the county, and its successors, for purposes in which there is a general statewide interest as follows:

\* \* \*

(5) For the establishment, preservation, restoration, improvement, or maintenance of intertidal and subtidal marine biological reserves, restoration and maintenance of shellfish and related fishery resources, development of nature study trails and areas, exhibits, research projects, preservation of areas of unique ocean phenomena for marine activities and water sports, and the natural beauty and biological resources and activities related thereto,

subject to the prior approval of the Fish and Game Commission as to those matters which are subject to the regulation by the commission pursuant to the Fish and Game Code.

I am aware that the Attorney General has informally opined that "not . . . each and every listed use" addressed in the five subsections of section 1, including subsection 5 quoted above, "need be implemented by the county." That does not mean, however, that MCOSD is free to ignore all the obligations imposed by Section 1. Since none of the "listed uses" in the preceding subsections -- essentially a boat harbor, public parks, fishing piers, marina -- have been constructed, section 5 governs and is in any event pertinent to the issue now facing the MCOSD.\* Quite aside from the law, observed changes in the lagoon suggest the need for some action.

In this context, the Introduction to the Williams Report (at 1) says its purpose is to "develop a 50-year 'no action' projection of the evolution of Bolinas Lagoon and its habitats" that assumes no "management intervention." The Introduction indicates that "the next steps of the planning process" the factual part of the report can be used as a guide "for a decision as to whether or not restoration actions are required."

The Williams Report should be limited to its purpose -- reporting on the physical condition and evolution of the lagoon. Sections 6.1 through 6.3 in particular are an ill-advised excursion into recommendations for some future actions. Unless read with extreme care they can be misinterpreted as a recommendation by the consultants that no action should be taken now to address the deteriorating condition of the lagoon.

To the extent that the discussion in Section 6 can be understood, the report's authors were **directed to assume** that no action would be taken now and make recommendations on what to do if that were the case. I have two problems with this. First, proposals based on a no-action assumption are not useful at this stage. A decision on whether to take action and what action to take now are for MCOSD, subject to review by the Board of Supervisors and, perhaps, the courts.

Second, the direction to the authors suggests a bias in the study design. If the authors are to make recommendations on future steps at all, then they should have been asked, as an alternative and in addition to the "no action" assumption, to assume that some limited action alternative to the Corps of Engineers most recent proposal would be taken now and make their best recommendations for actions that should be taken or considered.

Finally, in addition to this scope problem, sections 6.1 through 6.3 are largely incomprehensible consultant-speak. Figure 6.3 is wholly mystifying. This has

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\* Law governing the Gulf of the Farallones National Marine Sanctuary authorizes dredging without a permit for "ecological maintenance" and "mariculture" and for other purposes with a permit issued by the Director. 15 CFR § 922.82

the effect, among others, of masking the key "no action" assumption the authors were directed to make. To the extent I understand their recommendations, they just propose to study the problem, possibly forever.

These sections should simply be deleted from the final report as beyond its legitimate scope and an intrusion into the role of the decision maker responsible to the public.

## **2. Significant Local Impacts In the "South Arm" Are Not Clearly Presented.**

The only textual discussion of the South Arm (*i.e.*, the entire area south and east of the main channel) that I found is located on page 74. Based on the only core taken in that area, apparently in a prior study, the Report states about the South Arm:

Although the sediment accumulation based on the Macdonald and Byrne core is sufficient to fill all of the subtidal shallow and raise all mudflat elevations above the local mean sea level, our projection [nonetheless] retains a portion of the area in the South Arm exposed to prevailing winds as submerged mudflats.

Only by comparing Figure 4-7 at page 49 with Figure 5-9 at 82, over 30 pages later, does one begin to understand that this admittedly optimistic projection shows significant adverse impacts in the South Arm.

Virtually all of the "sub-tidal shallow" environment is shown to be concentrated south of the main channel along the angled part of Dipsea road, then trending north toward Highway 1, then twisting back to the south and east. This area will change to "frequently exposed mudflat." (Figure 5-9) In general, it appears that the entire area east south east of the main channel will convert to mudflat and marsh, with the exception of a narrow channel adjacent to Dipsea road.

With respect to the "sub-tidal shallow" in the South Arm, I can attest from personal observation that this area is a favorite with various bird species during periods when the surrounding mudflats begin to emerge. Those more familiar with the birds may be able to explain why. My assumption is that in their present condition, fish tend to congregate in these areas. The Williams Report projection of the loss of the entire 27 acres of this habitat throughout the lagoon is a serious matter that needs to be addressed now by the MCOSD.

In general, the Williams Report should present these localized changes in an understandable way, possibly with a shorter summary that shows Figures 4-7 and 5-9 on successive pages and comments on the changes.

Since the logic of the analysis is that more tidal prism loss occurs sooner rather than later in the 50 year period, as "dynamic equilibrium" approaches, it would be

useful to have intermediate term projections of the local impacts.

### **3. The Williams Report Ignores Easkoot Creek Impacts.**

In contrast to the detailed discussion of Pine Gulch Creek, the Williams Report offers no discussion of Easkoot Creek and its impacts on the lagoon.

According to the Bolinas Lagoon Management Plan Update 1996, changes to the configuration of the lagoon as it existed in 1854 included the fact that "Easkoot Creek was diverted into the southern end of the Lagoon whereas it naturally flowed directly into the ocean via a small wetland." (at 16) Local oral history on whether any part of the flow of Easkoot Creek reached the lagoon before its diversion is conflicting, but all seem to agree that any significant rainfall, and its accompanying sediment deposit, would normally flow from Easkoot Creek into "poison pond" and then the ocean.

The significance of the modern era diversion of this creek was underscored just this year during the New Year's day flood. The watershed of Easkoot creek is by far the steepest now emptying into the lagoon. Because of a significant mudslide high in the watershed, Easkoot creek filled with sediment and overflowed, flooding several houses and ultimately carrying substantial sediment into the lagoon. This is not the first time this creek has flooded since it was channelized. Its impacts on the lagoon are entirely man-caused.

Easkoot creek impacts are not mentioned in any of the reports. In substance, the diversion of Easkoot Creek added its substantial vertical watershed to the area draining into the lagoon. Given this impact, the William's Report assumption of 10,000 CY/yr net sedimentation fluvial deposits appears to underestimate future deposits from this source. If so, the South Arm would be particularly affected by the underestimation.

With regard to the 10,000 CY/yr net sedimentation estimate in the Report, the assumed watershed area (16.7 square miles), Appendix C at 1, seems small if the watershed of Pine Gulch Creek alone is 8 square miles, Appendix C at 3, Table C-1. Does the 16.7 mile assumed watershed size include the Easkoot Creek watershed?

It would be helpful to explain whether the Tetra-Tech sediment input study dealt with Easkoot Creek and how.

### **4. The Williams Report Tends To Overemphasizes the Importance of Inlet Closure.**

Few question that closure of the lagoon inlet would be a bad thing. The TRG suggests (TRG Comments at 3) that the Williams Report concludes that "no intercession in the evolution of the lagoon to prevent its closure is warranted." I don't find that conclusion in the Report itself. In any event, from a policy perspective, lagoon closure is not the only problem resulting from the loss of tidal prism detailed in the

Williams Report. The potential for deferring inlet closure further into the future may be a factor supporting intervention that addresses directly various other problems, such as the projected loss of certain bird habitat, disappearance of eel grass, and the projected loss of an entire 27 acre morphological unit (Table 5-1, subtidal shallow, at 83; and see 93). Alternatively, actions taken now to reduce the risk of inlet closure may be less invasive than would be required if MCOSD were to wait until closure has occurred or is imminent.

**5. The Williams Calculation of the Future Reduction in Tidal Prism Is Not Explained And Appears Inconsistent With Other Data, Including Byrne Report Data. The Other Data Indicates That The Report's Conclusions About Inlet Closure Are Overly Optimistic.**

Williams calculates that the tidal prism will be reduced by 1 million cubic yards over the next 50 years. So the projected future tidal prism loss is only 20,000 cubic yards per year. (7, 84)

The basis for this projection is simply not explained in the documents. The Report recognizes this projected tidal prism loss is "less than" the 20th Century rate and states it is "due to the projected changes in sediment budget and sediment dynamics discussed above." (84) Those sections, however, at 68-72, provide no explanation of the 20,000 CY/yr number or how it was reached. An explanation is called for. The 20,000 cubic yards per year appears to understate the probable rate of future tidal prism loss, particularly in the next quarter century.

The Williams Report itself recognizes that the average prism loss since 1906 has been about 34,000 cubic yards per year, but then states that "results from bathymetric surveys suggest that it has slowed to about 25,000 CY/yr during the late 20th century." (at 5 ¶ 10)

Even the derivation of the historic "late 20th Century" 25,000 CY/yr number is not disclosed. It understates other numbers provided in the Report and its Appendix.

The 25,000 CY/yr number conflicts with the 29,577 CY/yr prism loss provided for the period 1929 to 1998 shown in the last line of Table B-4 in Appendix B.

The 25,000 CY/yr number may reflect in some way the "Summary of Tidal Prism Calculations" Table B-4 statement that Tidal Prism change in 1968 to 1998, (possibly the "late 20th Century") based on "Corps TINs" was 0.8 MCY or about 26,666 CY/yr. If these are the "bathymetric surveys," Byrne states, discussing them: "These [recent slow] rates are not supported by the short core chronologies." (Byrne at 18).

The Williams Report projection about future tidal prism loss also appears inconsistent with the Report's sedimentation data. Sedimentation accumulation averaged 43,000 CY/yr during the 1906-2004 period, (e.g., 5). During this period, lost tidal prism was 34,000 CY/yr (Williams at 5) or about 80% of the net sedimentation. (80% is my

calculation) The Williams Report discussion of net sedimentation at 28 says it "used" 45,000 CY/yr as the net sedimentation rate for the "average 20th Century" rate. Somewhat inconsistent with that statement, Table 3-3 at 39 uses 43,000 CY/yr to calculate a recent historic tidal prism loss of 30,500 CY/yr, a number that should be 32,500/yr to be consistent. All of this appears to conflict with both the statement that the "late 20th Century" experience has been a tidal prism loss of 25,000 CY/yr and that a correct future tidal prism loss average would be 20,000 CY/yr.

At a minimum, the Williams calculation is based on an undisclosed, very time-limited base of data that is charged to be inaccurate by the Byrne Report and is inconsistent with other estimates.

These numbers matter. If the average tidal prism loss since 1906 of 34,000 cubic yards per year were to continue in the future, that would mean that the tidal prism loss Williams projects in 50 years would occur in only 30 years. The prism loss projected to cause inlet closure every 10 years (at 8, ¶ 32) would arrive in about 44 years. (These numbers have to be considered in the context of the Corps of Engineers proposal for about a 10 year dredging program after starting the process if that option were to be pursued.)

A concise explanation of why Williams reduced the projected prism loss number below the average loss since 1906, below all calculations of recent averages presented in the Report appendices, and appears to have extrapolated a result from bathymetric surveys Byrne says are inaccurate would be helpful to one assessing the Report.

In addition, to the extent Williams is projecting a gradually slowing rate of prism loss, there is no presentation of the rate of slowdown. In other words, how much of the next 50 year's tidal prism loss is assumed to occur in the next 5 to 25 years?

Finally, a short explanation of how different prism loss assumptions affect the conclusions on inlet closure probability is needed.

## **6. The Williams Report Calculation of the Future Reduction in Tidal Prism Appears Inconsistent With Byrne Report Data.**

The future projection of tidal prism loss of 20,000 CY/yr appears inconsistent with the current ratio of littoral and fluvial sources of sediment.

The Williams Report states that under "current conditions" there is 43,000 CY/yr of sediment accumulation in the lagoon, approximately 10,000 CY/yr of which is from local watershed and 33,000 CY/yr is brought in from the ocean. (¶ 12 at 5-6) My understanding is that this ratio is based on the Byrne Report. *See* Byrne at 12.

The 10,000 CY/yr "sediment accumulation" from local watershed is not going to diminish. Indeed, a correct global warming adjustment and other factors like

Easkoot Creek channelization may require an assumption that it will increase. At a minimum, therefore, the current sediment accumulation assumed in the Report from watershed sources implies a tidal prism loss from fluvial sediment deposits alone, based on the historic ratio of net sedimentation to prism loss, of 8000 CY/yr over the next 50 years.

Assuming something like the historic ratio of fluvial and littoral net sedimentation, an 8000 CY/yr tidal prism loss from fluvial sources suggests a loss due to littoral net sediment of about 26,400 CY/yr (80% of 33,000 CY/y) and a total tidal prism loss of about 34,400 CY/yr. Thus the Williams Report projection of only 20,000 CY/yr in the future assumes a very significant change in the ratio of fluvial and littoral net sedimentation that does not appear to be duplicated in any other era studied by Byrne. This apparent inconsistency between the two reports should be addressed.

**7. The Byrne Report Is Based On A Geographically Limited Data Sample. A brief statement of the implications of this would be appropriate.**

The core sites in the Byrne Report, shown on Figure 2, are all not only north of the main channel, they are all north of Pine Gulch Creek. The two "long core" sites are at H-3 and A-3, the latter at the far north-west end of the lagoon. Both the core location and Byrne's explanation of the unexpectedly high percentage of littoral-sourced sediment suggest that his conclusions may not be extrapolated correctly to the South Arm of the lagoon. This, in combination with the fact that no one has looked at the Easkoot creek impacts, suggests that any conclusions as to the future evolution of the South Arm are questionable.

If there are limits on the extent to which conclusions based on data from the Byrne core samples can be extrapolated to the entire lagoon, they should be clearly stated.

Byrne theorizes that the relatively high level of littoral sediment in his cores is explained by the "opening up of the Kent Island and Bolinas tidal channels along the west side of the lagoon as a direct result of the displacement along the fault trace." (at 20) Williams states that "Strong flood-dominance in tidal current velocities measured along the main channel suggests that beach sands swept through the inlet during [*sic.* presumably high tide] are preferentially transported to the north." (at 40) Both of these theories suggest a delivery of littoral based sediment to the area north of the main channel where the cores were taken. There is no analysis in either report suggesting a similar impact on the South Arm.

In Table 1 at page 9 of the Byrne Report the two far right columns have the same heading but different numbers. This needs to be corrected. It may be significant that the modern sedimentation rates shown in the far right column are highest at H4 and H5.



## **8. Both the Williams Report and the Byrne Report Underplay the Impact of Logging Prior to 1906.**

The Byrne Report documents the substantial "human-induced" sediment prior to 1906, but concludes that the increase in tidal prism from the 1906 earthquake "would have more than compensated for the nineteenth century reduction due to redwood logging and agricultural activity." The Williams Report estimates these "watershed disturbances" reduced the tidal prism by "about 0.5" million cubic yards, but does not attribute much significance to this loss, again because of the quake.

The half million cubic yards of material deposited by man prior to 1906 did not go away as a result of the quake. If it had not been there, the post-quake tidal prism would have been even larger and presumably the tidal prism today would be larger than it now is. Neither report provides any estimate of how much larger the tidal prism would be today absent the 0.5 million cubic yards of man-cause sediment prior to the quake.

## **9. Any Use In Calculations of the Byrne Report Calculation of Autocompaction Should Be Identified.**

There is a discussion in the Byrne Report of autocompaction, stating that this process will compress recent sedimentation layers by about 20%. (14-15) Any use of this factor should be identified and explained. For example, since autocompaction is a constant process, it would not affect yearly average net sedimentation rates or yearly average tidal prism loss over long periods.

## **10. Are There Consistent Global Warming Assumptions?**

The Williams Report assumes that global warming effects will increase the rate of sea level rise in future years. Assuming that is correct, are there other effects that should be considered for consistency? For example, the National Oceanic and Atmospheric Administration website notes that "[i]nstrumental records show that there has been a general increase in precipitation of about 0.5-1.0%/decade over land in northern mid-high latitudes." Would continued precipitation increases of this magnitude generate increased watershed sedimentation beyond that projected in the report? Are there local precipitation increase data that should be considered?

Thanks for considering these comments.

Sincerely,

/S/ Terry J. Houlihan

Terry J. Houlihan

# **Bolinas Lagoon Ecosystem Restoration Feasibility Project**

## **Final Public Reports**

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### **VI Peer Review and Public Comments on Previous Draft Reports with Responses**

Response to Public Comments

# **Bolinas Lagoon Ecosystem Restoration Project**

## **Response to Public Comments on the February, 2006 Draft Reports**

The following are responses to public comments prepared by the consultants and MCOSD. All letters received during the public comment period were posted on the MCOSD web site on April 18, 2006 and were carefully read and considered. Rather than providing a response to letters individually, the comments and responses were grouped by topic. The consultants will be discussing their responses to these public comments—and providing some additional responses based on further analyses suggested by the commentators— at the next public meeting to be held at 7 pm on May 2, 2006, at the Stinson Beach Community Center.

### **Contents: Topics and Responses**

1. The 50-year projection, the “No-Action Alternative” and the DEIR/S
2. The Report should/should not state that intervention is required.
3. The Report should specifically address differences with the DEIR/S
4. Goals, Objectives, Indicators and Thresholds
5. Monitoring and Adaptive Management Plan
6. Inlet Closure
7. Sea Level Rise & Climate Change
8. Dynamic Equilibrium
9. Wind-Waves and Mudflat Evolution
10. Earthquakes
11. The 1906 Earthquake and Logging Effects
12. Episodic Alluvial Events
13. Littoral Sediment Input / Bolinas Bluffs
14. Sediment Accumulation / Deposition / Tidal Prism Loss

15. Groins and Armoring

16. Easkoot Creek and the South Arm

17. Bolinas Channel

18. Wildlife/Habitat Projections

A. Declines in Birds and Invertebrates

B. Significance of Pine Gulch Creek Delta/Regional Conservation Context

C. Clapper rail habitat

D. The invasion of non native cord grass

E. Missed Populations of Plants and Animals/Nomenclature

19. Literature Cited

## **1. The 50-year projection, the “No-Action Alternative” and the DEIR/S**

It is evident from several letters that we have not clearly presented the context of the Report in the overall planning context.

The 1996 Bolinas Lagoon Management Update presented an analysis that suggested that the lagoon had lost significant tidal prism since 1968 and recommended that additional studies be conducted to corroborate this finding and to determine the future magnitude of tidal prism loss. A Reconnaissance Study conducted by the United States Army Corps of Engineers in 1997 concluded that corrective action – dredging and/or other means of removing accumulated sediment or minimizing its entry into the lagoon – was in the national interest. The Corps of Engineers, with financial support from the federal government, the State of California and the Marin County Open Space District (the project’s local sponsor), commenced a Feasibility Study in 1998 to develop a plan to restore the lagoon’s habitats. The Corps released its Draft Feasibility Report and Draft EIR/EIS for the Bolinas Lagoon Ecosystem Restoration Project in 2002 which proposed to dredge approximately 1.4 million cubic yards of sediment from the lagoon. Public comments on the Draft EIR/EIS focused on the lack of a clear, scientifically sound description of how the lagoon would evolve if no action was taken—without which purpose and need for intervention can not be determined.

The Open Space District contracted with a consulting team to provide a rigorous scientific review of the Draft Feasibility Report and Draft EIR/EIS assumptions and conclusions and to provide a 50-year projection of the lagoon’s hydrological and ecological evolution. This projection assumes that no management intervention will take place by definition—in regulatory terms it is the “No-action Alternative” that will be compared to other Action or Intervention Alternatives in the EIR/S. Hence, just because intervention is not discussed in the Report, this does not indicate that intervention is or is not warranted; the purpose and need for intervention will be assessed when the Draft Feasibility Report and Draft EIR/EIS are revised—with significant public input—in the next steps of the planning process.

## **2. The Report should/should not state that intervention is required.**

The Draft Report does not make any recommendations with regard to intervention as specifically directed by our Technical Review Group (TRG). The TRG recommended that the Report focus only on the 50-year projection of the lagoon’s evolution that includes past, current and future hydrological and ecological conditions.

Numerous letters suggested that the 50-year projection clearly shows the need for intervention. Other letters stated that the 50-year projection clearly shows that intervention is not warranted. All public comment letters concerning intervention will be considered during the next steps in the planning process where purpose and need for intervention will be determined.

### **3. The Report should specifically address differences with the DEIR/S**

As part of Phase I of the current project, the consultants reviewed all prior data and analyses, including the work done by Tetra Tech and ACOE for the DEIR/S. These reports, reviewed by the TRG, are posted on the Open Space District web-site. The consultants and the TRG identified data gaps and recommended new analyses—the new data and analyses resulted in some fundamental differences in the findings between the DEIR/S and the present study. These differences, and the underlying reasons for these differences, are discussed in these earlier reports.

### **4. Goals, Objectives, Indicators and Thresholds**

The Report refers to the general Goals and Objectives in the 1996 Bolinas Lagoon Management Plan Update. The Report suggests that it would be appropriate to revisit these broad Goals and Objectives in light of our new understanding of how the lagoon functions; on the page following the restatement of the 1996 Goals and Objectives, the Report adds that the management goals and objectives should be based on the concepts of ecological integrity—among these are that 1) coastal lagoons are dynamic, evolving systems, 2) as long as natural physical processes are allowed to occur, the lagoon system can be self-correcting, and 3) human induced changes may interfere with the natural development of the lagoon ecosystem.

The Report then states that these broad goals need to be translated into specific management objectives; the broad Goals and Objectives are not in of themselves appropriate for determining whether or not an ecosystem restoration project is needed. Specific objectives, indicators established to measure these objectives, and threshold values for the indicators will need to be established. It should also be noted that a range of intervention alternatives— including watershed practices and small projects—may be considered.

Clearly, our current knowledge of how the lagoon functions indicates that the majority of sediments are littoral and that the lagoon tends toward a shallow equilibrium state (albeit a dynamic equilibrium due to constantly changing influences such as sea level rise etc.), punctuated by periodic earthquakes that deepen the lagoon (average duration between earthquakes is 360 years with a range of between 140 and 630 years; data from Byrne's coring report). These results indicate that it is not possible to pick any particular lagoon form to manage for; if major intervention is justified, it should be on the basis that anthropogenic changes have significantly altered the natural trajectory of the lagoon's evolution with corresponding adverse ecological impacts.

## **5. Monitoring and Adaptive Management Plan**

The Report includes sections on monitoring and an outline of an Adaptive Management Plan. The Report recommends monitoring as an essential activity whether or not purpose and need for intervention is demonstrated in the next steps of the planning process. Several letters recommended specific physical and ecological parameters to monitor and these will be included in the revised Report. A detailed monitoring plan that identifies specific indicator species and monitoring methods has not been prepared. However, the report provides examples of species associated with each potentially affected habitat unit in Section 5.9.1 (Expected Shifts in Habitat Distribution and Abundance). For example, monitoring shifts in abundance of diving fish-eating birds, such as common loon, double-crested cormorant, brown pelican, western grebe, osprey, red-breasted merganser, and Forster's tern, would provide useful information to document whether or not a reduction in subtidal habitat is occurring as projected, along with the anticipated associated ecological response. Bolinas Lagoon population trends should be evaluated both locally and within a regional context to determine if population changes are associated with local conditions, or are the result of broader influences. The Draft Report was edited to more clearly address the significance of comparing results of local monitoring to other monitoring programs in the region.

The Adaptive Management Plan is presented only as an outline and includes a discussion about intervention generally, but as noted in the Report, this does not suggest that intervention is (or is not) recommended.

Monitoring can provide useful data to confirm the trajectory of the 50-year projection and will allow us to refine, reanalyze and readjust this projection. If intervention measures—large or small—are implemented, monitoring of the effects of these actions will also allow us to test our understanding of how the lagoon functions and the need and efficacy of additional intervention

The Adaptive Management Plan is presented only as an outline and includes a discussion about intervention generally, but as noted in the Report, this does not suggest that intervention is recommended.

## **6. Inlet Closure**

A number of comments were received involving the inlet closure analysis. These comments can be generally summarized as:

1. How was natural re-opening considered in the analysis?
2. Do creek flows affect inlet stability?
3. Can the probability of closure be quantified?
4. Are there reference sites of periodic inlet closure?

The following paragraphs attempt to clarify these questions, as well as resolve discrepancies in the report.

*1. How was natural re-opening considered in the analysis?*

Natural re-opening of a closed inlet occurs when the water level on one side of the beach barrier rises high enough to overflow its crest and long enough to scour a self-sustaining channel. This can occur on the ocean-side with spring tides and low swell conditions or on the inland-side when runoff fills the lagoon. In the case of Bolinas Lagoon, swell conditions would tend to create barrier beaches higher than spring tide levels. Therefore, the most likely natural re-opening mechanism would be filling the lagoon by creek runoff.

Due to differences in the onset of rainfall and the arrival of energetic ocean waves from the Pacific Ocean, prolonged closure potential is most likely during two parts of the year: late fall and late spring. If closure were induced during by large swells in the late fall prior to the onset of significant rainfall, a high beach barrier could form before impounded freshwater runoff raised lagoon water levels. If the succeeding winter were relatively dry, it would be possible for the lagoon not to fill because of the small watershed size. This means that closure could extend into the succeeding years until winter rainfall events are large enough to fill the lagoon. Similarly, a closure during the last spring would persist throughout the summer and fall, until the following winter season. In both cases, mechanical intervention may be required to re-open the inlet before large changes in water temperature, salinity and dissolved oxygen affected aquatic species.

*2. Do creek flows affect inlet stability?*

Although creek flows may play an important role in breaching a closed inlet, their scouring power is typically an order of magnitude smaller than that of tidal flow. For the application of the O'Brien analysis at Bolinas Lagoon, we confirmed this by calculating the contribution of tributary inflow to scour power of tidal flows over an entire water year. For example, typically a 1-day in 2-year flow event discharges approximately 0.4 MCY, compared to about 3.5 MCY of tidal water discharged through the inlet.

*3. Can the probability of closure be quantified?*

Assigning a numerical probability of closure is difficult and limited by the period of the data used to carry out simulations in this analysis. The 'once-a-decade' estimate referenced in the report and public meetings was developed from the two events in the 17-year simulation in which the O'Brien index exceeded the critical value established at the two reference sites for which extensive data were available, Crissy Field and Russian River. (Note that the Crissy Field inlet design anticipated frequent closures, using this type of analysis, because of its small tidal prism). Several more closures would need to be simulated over the 17-year period to provide enough data points to establish a probability of closure. Unfortunately, wave buoy data were not available for the 1983 swell conditions. This event is generally regarded as the historic record wave condition along Northern California.

*4. Are there reference sites of periodic inlet closure?*

Although the two reference sites used to establish the critical value of the O'Brien index differ from Bolinas Lagoon with respect to tidal prism and wave climate, these factors



have been considered in the analysis. In each application, local wave climate (transformed to nearshore values) and the respective tidal prism and inlet width of the system were used to quantify the O'Brien index. Although not quantified by the O'Brien analysis, there are several examples of coastal lagoons subject to inlet closure to varying degrees of duration and frequency. These include: Drake's Estero (always open); Tijuana Estuary (closes every couple of decades); Pescadero (historically open but now seasonally closed); and Abbot's Lagoon (opens for a short period every several years).

*Points of clarification*

In addition to the questions above, errors in Table 5-2 generated confusion; the second column incorrectly lists tidal prism values. The corrected table (shown below) is consistent with the narrative in Section 5 and key findings described in Section 2.1. Note that two inlet widths were considered for the 2.0 MCY scenarios since inlet width is expected to diminish with tidal prism. The analysis shows that the lagoon mouth is only expected to close under scenario 4 under the assumptions of the model (please see discussion in the Draft Report).

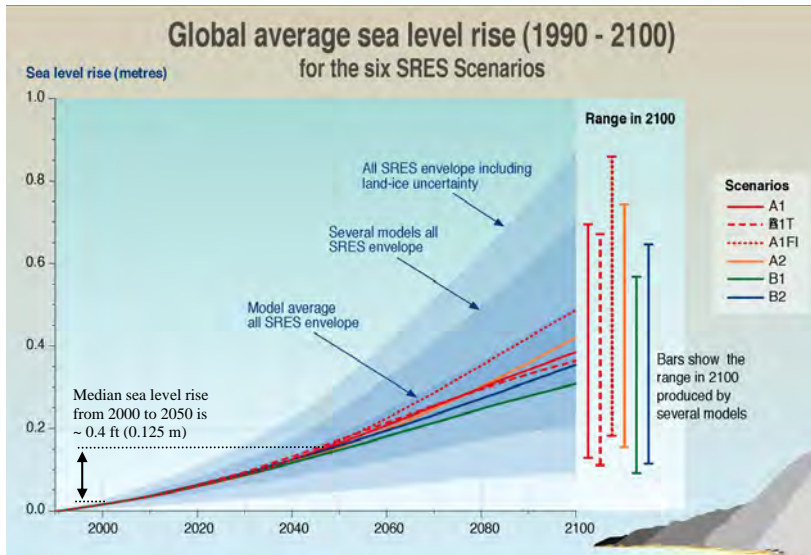
**Table 5-2. Results of Inlet Stability Analysis**

Scenario	Tidal Prism (MCY)	Inlet Width (ft at MSL)	Number of Closures (S > 12)	Maximum Value of Stability Index
1	3.5	300	0	6.9
2	2.5	300	0	9.2
3	2.0	200	0	9.4
4	2.0	300	2	13.8

We should also note that the other half of the O'Brien index – the wave power – was established by transforming offshore wave energy to nearshore values using coefficients that reflect the sheltering effect of Duxbury Reef. These 'transformation coefficients' are a function of wave direction and period, and were established by analysis of wave data collected in Bolinas Bay in support of the Corps study.

**7. Sea Level Rise & Climate Change**

Prediction of future sea level rise involves substantial uncertainty. The 0.4-ft increase in mean sea level applied in the 50-year projections of lagoon morphology is approximately the median value of all models used reported by IPCC (2001) (see figure below). Although the effects of thermal expansion are expected to account for the majority of future sea level rise (only 4-6 cm of the 10-90 cm of projected sea level rise over the 21<sup>st</sup> century is expected from melting arctic glaciers (Arctic Climate Impacts Assessment 2004)), results from very recent studies suggests that the median value of predicted future sea level rise may be revised upwards. (Note: Estimates of a new 21<sup>st</sup> century sea level study [Overpeck *et al.* 2004] were mistakenly reported in the March 24<sup>th</sup> edition of the *San Francisco Chronicle*. The actual projections were up to 3 ft by the end of this century, and this is consistent with prior IPCC projections.)



Source: Intergovernmental Panel on Climate Change (IPCC), 2001.

Sea level rise greater than the value used in our analysis would reduce the future potential of inlet closure and result in smaller habitat changes than projected. In particular, more rapid sea level rise would result in smaller shifts in frequently exposed / submerged mudflats. Projected changes to fluvial delta, salt marsh and subtidal shallow habitats are less sensitive to changes in sea level rise, although the distribution of these units could also be affected if 50-year sea level rise is very different from the 0.4 ft value assumed in our analysis.

Similar to future sea level rise, climatic changes are difficult to predict – especially changes in a particular locale. Although more frequent and intense rainstorms would produce more watershed material by hillslope erosion, a ~ 1% per decade increase in precipitation predicted by some climate changes models would not substantially affect the net sedimentation in the lagoon since the majority of the material is derived from littoral sources.

## 8. Dynamic Equilibrium

This criticism of the use of the concept of dynamic equilibrium is important as it relates to how we view – and manage – Bolinas Lagoon as a self-sustaining ecosystem. This concept underlies the methodology used in developing predictions of the physical evolution of the lagoon. It is described in Section 3.1 of the report and was the subject of extensive comments by the TRG on the administrative draft report that can be read in their entirety at <http://www.marinopenspace.org/pdf/Bolinas-LagoonBLERFP-Peer-Review-Comments.pdf>. We believe that this criticism is unjustified, and may be the result of a misunderstanding of how we view the self-organizing physical processes that determine the shape and ecologic integrity of the lagoon as it evolves.

We understand the persistence and sustainability of the physical lagoon over the last seven millennia to be explicable by what is termed in the geomorphic literature [Schumm

and Lichty 1965, Schumm 1977, Woodroffe 2004] as ‘punctuated dynamic equilibrium’ or ‘dynamic metastable equilibrium’ as illustrated conceptually in Figure 3-3. Within the lagoon individual geomorphic units, like mudflats, channels and marshes evolve towards ‘end states’ dictated by the balance between erosive and depositional forces. The aggregation and interaction of geomorphic units in their dynamic end states, or as they evolve, dictates the morphology and tidal prism of the whole lagoon.

Erosive and depositional processes vary over different time scales so the end state varies over time. For this reason we use the term ‘dynamic’ as opposed to static equilibrium. In the case of Bolinas Lagoon evolutionary trajectories can be disrupted and reset by catastrophic earthquakes. For this reason we use the term ‘punctuated’ to best describe the evolutionary trajectory.

The conceptual model described in the report [Section 3], provides a coherent explanation of the geomorphic and hydrodynamic response to changes in the lagoon over time and is consistent with data from coring of sediments within the lagoon [Byrne and Reidy 1996, Bergquist 1978]. These demonstrate the persistence of a tidally influenced lagoon dominated by intertidal mudflats over approximately the past seven thousand years, the dominance of littoral sediments in the seaward portion of the lagoon, and the absence of an extensive depositional delta at the mouth of Pine Gulch creek.

The implications of this conceptual model are:

1. We can postulate a dynamic ‘end state’ towards which the lagoon is evolving in response to the current values and variability of forcing mechanisms.
2. This end state will change in response to long term changes in forcing mechanisms like sea level rise.
3. Depending on the frequency of catastrophic events and rate of recovery of individual geomorphic units, for much of the time lagoon morphology will be evolving towards rather than achieving a dynamic equilibrium form.

The TRG commented “*while it is reasonable to state that the lagoon as a physical system exhibits equilibrium seeking behavior [i.e. tends towards a persistent average condition over time] it is not reasonable to imply that equilibrium will actually be achieved*”

Our analysis has developed a prediction of the ‘persistent average condition’ that could potentially be reached in approximately a hundred years. We recognize that this is a theoretical construct that assumes no catastrophic earthquakes will ‘punctuate’ and affect the evolution of the lagoon. We also recognize that projections beyond the 50-year planning horizon include considerably larger error bands. Our analysis shows that this end state is substantially different [a smaller lagoon] than the end state that might be inferred from pre-European settlement conditions, 200 years ago, because the forcing mechanisms that dictate how geomorphic units within the lagoon evolve, have changed. In addition our analysis projects 50 years in the future, 150 years after the 1906 earthquake, the lagoon is still evolving towards its end state.

We responded to the TRG's comments on this issue in the draft report as follows:

*'The concept of dynamic equilibrium is overly applied.'*

We have edited the report to emphasize geomorphic evolutionary trajectories and the role of major earthquakes in resetting the lagoons evolution. We agree that 'equilibrium seeking behavior' describes the evolution of individual geomorphic units and key attributes of the whole lagoon. However, use of this terminology inevitably poses the question in the publics mind –“what equilibrium?” We have therefore continued to describe 'dynamic equilibrium' as a conceptual end state while acknowledging that because of re-adjustment after major tectonic events the lagoon may have never achieved it.

We believe this discussion of the appropriateness of defining dynamic equilibrium to be very important in interpreting the future of the lagoon. Our conceptual model of the lagoon is that it is a self-organizing sedimentary estuarine form that persists due to the balance between sedimentation, and the creation of 'accommodation space', both from continual sea level rise and from infrequent episodic tectonic subsidence events. In projecting an equilibrium form we have evaluated how the lagoon morphology would adjust over the next few centuries in response only to projected sea level rise. We find that this projected morphology and associated tidal prism—the asymptote of the evolutionary trajectory, does equilibrate as a fully tidal system. In other words, the lagoon does not require another major earthquake within the next few centuries to persist as a tidal system. The role of these earthquakes is to punctuate the dynamic equilibrium state, reinitiating evolutionary trajectories that converge on a particular estuarine morphology, which is in turn changing over time.

We did not intend to imply that the ecosystem is in dynamic equilibrium. Our discussion above, and the use of dynamic equilibrium in the report, is restricted to physical morphology.

## **9. Wind-Waves and Mudflat Evolution**

Many references in coastal geomorphic literature describe the influence of wind-wave and evolution of mudflat profiles (Kirby 1992, Dyer 1998). The concept of equilibrium profiles is discussed by Woodroff (2004), and empirical evidence of how changes to internal wind-wave exposure inside a lagoon may shift mudflat slopes and elevations are presented in Kirby (2000). Observed marsh expansion in sheltered areas (see Figure 3-10) and relatively minor changes in mudflat elevation in exposed areas (Figure 4-5) suggest that these concepts can be applied to projections of future conditions at Bolinas Lagoon.

## **10. Earthquakes**

There was concern from some readers that our analysis did not account for the potential effects of future earthquakes in our 50-year projections. Although a major earthquake along the San Andreas Fault is expected sometime in the future [The USGS estimates earthquake probability along the San Andreas at approximately 20% over the next 30 years. See <http://quake.usgs.gov/research/seismology/wg99/index.html>], we have neglected such an event in our projections due to several uncertainties that make quantification of its effects extremely difficult. From Byrnes' coring study, average duration between earthquakes at Bolinas Lagoon is 360 years with a range of between 140 and 630 years. It should also be noted that each earthquake may result in very different effects on the lagoon as there may be differential north-south shifts, east-west differential in down-drop, overall magnitude of down drop, and therefore very different impacts on channel morphology and overall lagoon evolution. Magnitude, trace and other details of the next earthquake will all affect the amount of tidal prism increase and habitat change. Assumptions regarding these effects would include considerable uncertainty.

## **11. The 1906 Earthquake and Logging Effects**

As documented in the Byrne study and summarized in the PWA report, logging and other watershed disturbances accelerated the delivery alluvial sediment to the lagoon. It is difficult to predict the present-day tidal prism had 19<sup>th</sup> century watershed disturbances not occurred. We speculate that if natural watershed delivery rates persisted throughout the 19<sup>th</sup> century, the tidal prism of Bolinas Lagoon would have been larger immediately following the 1906 earthquake. However, dispersion of littoral material into the lagoon would have been greater and at least partially offset the hypothetical and incremental increase in tidal prism.

## **12. Episodic Alluvial Events**

We understand that NPS may be collecting flow data along Easkoot Creek and possibly Pine Gulch Creek. Although these data (if collected) could extend the data record through the recent New Year's storms, we do not believe they would substantially change the multi-decade average used in our analysis (which include the even large storms of 1982 and other El Nino years).

### **13. Littoral Sediment Input / Bolinas Bluffs**

Questions from the public concerning the littoral sediment and Bolinas Bluffs focused on the following issues:

- Discrepancies in the report between how much bluff-eroded silt is delivered to the lagoon.
- Changes in beach morphology and littoral drift due to armoring effects along Stinson Spit.

Under contemporary conditions, circulation patterns in Bolinas Bay limit the amount of bluff-eroded material transported through the tidal inlet. However, massive bluff failure *at the time of the 1906 earthquake* would have increased the supply of this material. It is reasonable to expect that the delivery of bluff-eroded material over the past one hundred years has changed. [Note that preliminary data presented at the August 2005 meeting at the Civic Center were revised. Data in the final Byrne and PWA reports are based on a 6.8 mm/yr average sedimentation rate in the North Basin – not the 10 mm/yr reported at the August 2005 meeting.]

Over the long term armoring at Stinson may affect the beach elevation, its planform shape, and possibly the amount of beach sand entering the lagoon. However, late-20<sup>th</sup> century aerial photographs show a stronger correlation to strong winter storms than armoring at Stinson. Note that the sand transport potential referenced in the report is probably much higher than actual sediment delivery. This is discussed qualitatively in the reports. However, the relevant implication is that the estimate of littoral sediments (beach sands plus bluff-eroded material) available for transport is an order of magnitude greater than observed sedimentation rates within the lagoon, and a more detailed analysis was not needed to confirm that the supply of nearshore sediment is adequate to fill the sediment budget.

### **14. Sediment Accumulation / Deposition / Tidal Prism Loss**

A large amount of information regarding historic and future sediment accumulation and tidal prism change was presented in the Byrne and PWA reports. Public comments involving these issues focused on the following questions:

- What was the basis of projecting tidal prism over the next 50 years, and why is the future rate of loss slower than historic values?
- Are there data to quantify how changes to sedimentation and tidal prism rates will vary within the 50-year planning horizon (e.g., in the next 5 to 25 years)?
- Are there discrepancies between the Byrne data and analysis carried out by PWA?

Future tidal prism loss and habitat change were projected by methodology described in Section 5.1. Generally speaking, this consisted of: (i) estimating changes to each of the geomorphic units to assess habitat distribution; and (ii) aggregating the cumulative effect to across the lagoon to assess tidal prism. While making our projections of each geomorphic unit, we reviewed the major terms of the sediment budget and significant processes affecting sediment dynamics to assess how sediment inputs and outputs are

likely to change. Results from this exercise led to our estimate of approximately 1 MCY loss in tidal prism over the next 50 years, or about 20,000 CY/yr on average.

This rate of future tidal prism loss is less than our estimates of historic change (~34,000 CY/yr from 1906-1998) and (~25,000 CY/yr from 1968-1998). This trend of a deceleration of tidal prism loss is consistent with changes in internal sediment dynamics (e.g., diminished strength of tidal dispersion, effects of wind-wave agitation) and accelerated sea level rise, as described in Sections 5.2 and 5.3. Please note that our projection of 50-year evolution does not assume diminished watershed delivery, although the lateral extension of Pine Gulch Creek will slow as its radius increases and a larger portion is captured on the supratidal 'cone'.

As described in Section 5.4, the projection of 50-year conditions is based on a variety of sources. In the North Basin, we directly applied the results from the Byrne study (6.8 mm/yr) to project changes in shallows, mudflat and marsh since sediment cores collected from this area provided the most reliable dataset. However, the projection of future geomorphic changes outside of the North Basin was based on other data due to the limited coverage of the Byrne dataset (see Figure 5-4). For example, expansion of the Pine Gulch Creek delta was based on the average rate of watershed delivery.

For the purposes of establishing a 20<sup>th</sup> century sediment budget for the lagoon, we have extrapolated the Byrne average (6.8 mm/yr) over the entire lagoon (~43,000 CY/yr) at the suggestion of the TRG. (The narrative on page 28 incorrectly states that we used 45,000 CY/yr. Results summarized in the Table 3-3 and findings described elsewhere are based on the correct value of 43,000 CY/yr.) Note that our estimate of the ratio of watershed to littoral sedimentation is not based on the stratigraphy results of Byrne; we simply calculated the difference between total sedimentation (43,000 CY/yr) and the average annual watershed delivery (10,000 CY/yr based on Tetra Tech's estimate of watershed yield and our analysis of transport capacity). We expect this ratio to change as watershed delivery continues at its present rate but tidal dispersion diminishes (see Section 5.2.1).

It is important to note that we have based our projection of future lagoon conditions on average annual sediment rates established over several decades. Actual year-to-year sedimentation and morphologic change will differ due to the climatic variability, such as the episodic nature of fluvial delivery and the occurrence of strong ocean storms.

## **15. Groins and Armoring**

Although construction of the Bolinas Groin has been effective at maintaining a wide and high Brighton Beach, it does not appear to restrict littoral delivery under existing conditions since the structure is buried during summer and winter months. At these times, wave action is effective at transporting beach sands along the active littoral zone. During times of energetic winter storms, the zone of active littoral transports further offshore – beyond the extent of the groin.

Aerial photography analyzed as part of this study suggest that sand transport and beach morphology along Stinson Spit over the past are strongly related to the occurrence of El Nino winters. Although the effects of armoring along Stinson Spit are less certain as sea level continues to rise, delivery of beach sand into the lagoon does not appear to be limited by supply or littoral drift along the beach. Rather, the sediment texture (coarse material near the inlet; finer material at the North Basin and South Arm) suggest that the strength of tidal dispersion is the primary factor affecting delivery of beach sands.

## **16. Easkoot Creek and the South Arm**

The 10,000 CY/yr estimate of watershed yield was established by Tetra Tech for the entire 16.7 square mile watershed, including the area tributary to Easkoot Creek. Delivery of alluvial from this creek, in addition to accumulation of littoral sediment in this area, has been included in the 'Macdonald and Byrne' core extracted from this South Arm.

Past changes to the South Arm (as well as other sub-areas) are in Section 3.5.1, with Figure 3-9 mapping the approximate extent in marsh vegetation over a series of four 'snapshots' from 1959 to 1998. Additionally, the placement of artificial fill in the South Arm during construction of Seadrift Lagoon is discussed in Section 3.5.2 and Figure 3-12. Unfortunately, very limited data from dated sediment cores are available to quantify the 20<sup>th</sup> century sedimentation rate in this area. Several cores taken by Byrne et al. for this study were not useable because of the large amount of disturbance from fill and dredging in the South Arm. However, the results from an older core were similar to the average of the cores recently extracted from the North Basin (both ~6 mm/yr).

## **17. Bolinas Channel**

The gradual and continued reduction in depth, width and cross-sectional area of the Bolinas Channel has been observed over the past several decades. We attribute this to reduction in channel size to accumulation of sediment at the head of the Bolinas Channel associated with progradation of Pine Gulch Creek delta (compare aerial photographs from 1959 and 1998 shown in Figure 3-10). We expect this trend to continue (see narrative at top of Page 74), with the ultimate size of Bolinas Channel dictated by the marsh area which it drains (a portion of the salt marshes on Kent Island and south of Pine Gulch Creek).

## **18. Wildlife/Habitat Projections**

### **Declines in Birds and Invertebrates:**

The Report identifies groups of birds, fish and invertebrates that are expected to decline, remain stable, or increase based on the predicted shifts in habitat (Section 5.9). It is recognized that Bolinas Lagoon is a site of international importance for migratory birds (designated such by RAMSAR) and waterbirds are of particular importance. Studies (1992, G. Chan; & 1993/4, A. Malino) of benthic invertebrates at the lagoon found a



diverse species composition and population numbers that are comparable to other northern/central California coastal lagoons and embayments. These surveys were not extensive, area wise of the entire lagoon, but were representative of the typical channels and mud flat areas in the lagoon. Surveys of benthic invertebrates in 2004 (W. Martin) found a slight shift in species composition compared to the earlier studies. This shift was to benthic invertebrates more tolerant of elevated nutrient levels. However, the overall number of species were not significantly different from the number of species found in earlier surveys. Population numbers are much more difficult to quantify given the vagaries of the lagoon environment and as such cannot be directly compared between the two sampling periods without longer term data sets.

### **Significance of Pine Gulch Creek Delta/Regional Conservation Context**

We agree that regional conservation context is important as reflected in the discussion of threatened and endangered wildlife and habitats. We agree that Pine Gulch Creek delta is of significant biological value, in particular for migratory land birds and that many rare species have been observed there. Nevertheless, Pine Gulch Creek delta is an artifact of the creeks channelization and excessive historic watershed sedimentation and contributes to decreased wind-wave effects and increased sediment deposition along the west shore.

### **Clapper rail habitat**

The Report identified several species of birds that are expected to increase in numbers with the expansion of tidal marsh. We did not however, mention that with tidal marsh succession, Bolinas Lagoon may function as a stepping-stone population between Richardson Bay and Point Reyes clapper rail populations. This will be added to the Report.

### **The invasion of non native cord grass**

Establishment of invasive Atlantic cordgrass (*Spartina alterniflora*) in Bolinas Lagoon would be a significant threat to native plant communities and habitats. It grows at higher and lower elevations than the native California cordgrass (*Spartina foliosa*), reducing mudflat and shorebird habitat and replacing pickleweed and other high marsh species. It can also alter tidal circulation by colonizing channel bottoms. In addition, it hybridizes with the native cordgrass and could lead to extirpation of the native species over time.

Invasive Atlantic cordgrass was identified in 2003 Bolinas Lagoon by the San Francisco Estuary Invasive *Spartina* Project (ISP), a project of the California State Coastal Conservancy and eradicated by Marin County Open Space District and ISP. Reliable morphological characters are not presently known that can be used to positively identify hybrids of *S. alterniflora* and *S. foliosa*. ISP collects samples of suspected invasive cordgrass and conducts genetic testing to determine presence of hybrids with native *S. foliosa*. Ongoing monitoring for Atlantic cordgrass in Bolinas Lagoon is conducted by Marin County Open Space District, Audubon Canyon Ranch and ISP. We agree that a

monitoring plan for Bolinas Lagoon should be developed that includes reporting on the ongoing Atlantic cordgrass monitoring and control efforts.

### **Missed Populations of Plants and Animals/Nomenclature**

Several commentators provided information on rare plants and animals that were not found during the surveys and otherwise were not mentioned as potential or known at the Lagoon. Similarly, mistakes in nomenclature were also pointed out. These will be added to the report and corrected, respectively.

### **19. Literature Cited**

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