California Water Research

Part 2 Surrebuttal Testimony of Dr. Clyde Thomas Williams

I, Clyde Thomas Williams, have previously testified in this matter. My Statement of Qualifications has previously been submitted as Exhibit DDJ-162. The following Part 2 surrebuttal testimony is submitted at the request of Deirdre Des Jardins, principal at California Water Research, in the public interest.

I. Summary of Testimony

A. Seismic Engineering and Design

In the Seismic Engineering and Design section, I cover the following.

New Seismic Design Criteria

The July 2018 Conceptual Engineering Report documents that the Department of Water Resources is now designing the Delta tunnels to withstand a Maximum Considered Earthquake, as defined by the American Society of Civil Engineers. This is consistent with my recommendations in my testimony in Part 1.

Since the CER states that the seismic criteria are still subject to change, I still recommend that the Board put this requirement in the permit.

New Seismic Review of Tunnel Liner Performance

Appendix M, the seismic review of the tunnel liner performance, assumes the tunnels are bored in soils that are very dense to rock. The Delta soils at the tunnel depths are softer than "very dense to rock." So this assumption appears to invalidate the entire analysis.

Geotechnical Data

The CER states that Delta soils below 60 feet are "very stiff to hard." The geotechnical data referred to in the Admin Draft Supplemental EIR/EIS shows that the soils at the depth of the tunnels are only soft to stiff.

New Liquefaction Analysis

The new liquefaction analysis in Appendix M concludes that liquefaction risk is low. A previous analysis assuming higher peak ground acceleration found that there could be "substantial, continuous liquefaction" down to 100 feet.

Site Specific Seismic Responses

Because the soils in the Delta are liquefiable and the clays may be plastic, an ASCE Site Class F seismic analysis with site specific seismic responses is likely required.

The liquefiable soils will also pose significant challenges for engineering the new Byron Tract Forebay embankments. To ensure that the dam is not a hazard to nearby residents, the Board should require an external peer review of both the geotechnical analysis and the seismic analysis for Byron Tract Forebay.

Seepage at Byron Tract Forebay

Given the known geotechnical issues and seepage problems in the vicinity of Byron Tract Forebay, the Board should require a peer review of the proposed methods for seepage control.

Boring the South Tunnels

The South Tunnels pass near the Clifton Court Forebay embankments. If a loss of ground happened while tunneling near the Clifton Court Forebay embankments, it could affect the integrity of the embankments, causing an uncontrolled release of water.

The geotechnical data shows silts or silty clays. Silts are difficult to tunnel in, and are known to be subject to running during tunnel boring. Plastic clays can exhibit squeezing during tunnel boring. Both can be causes of loss of ground. I recommend permit terms and conditions to reduce the risk of tunnel boring.

B. Changes to Project, Increased Borrow Fill, Water Quality, Hazardous Materials, and Traffic/AQ Impacts

In the section of my testimony Changes to Project, Increased Borrow Fill, Water Quality, Hazardous Materials, and Traffic/AQ Impacts I cover the changes to the project in Appendix 3 to the Admin Draft Supplemental EIR/EIS, and deficiencies in analyses in other sections of the Admin Draft Supplemental EIR/EIS.

Changes to the project include constructing a new regulating reservoir, Byron Tract Forebay, instead of expanding and reconstructing Clifton Court Forebay. The Admin Draft Supplemental EIR/EIS states:

> **Forebays**: A new forebay located on Byron Tract would be constructed instead of dividing, 35 dredging, and expanding Clifton Court Forebay. The Byron Tract Forebay would be constructed 36 on the area that was proposed for RTM storage under the approved project.

(Exhibit SWRCB-113, Chapter 3, p. 3-1.)

The Draft Supplemental EIR/EIS does not quantify the amount of borrow fill that will be needed for the embankments for the new Byron Tract Forebay.   This is buried in the 2018 Conceptual Engineering Report. The failure to quantify borrow fill for the revised project disguises the fact that the revised project requires increased amounts of borrow fill for the Byron Tract Forebay embankments. The 2018 Conceptual Engineering Report also changes the units for measuring borrow fill to “bank yards,” and does not explain why there is a reduction in the estimation of borrow fill needed for the three North Delta Diversion intake sites or the Byron Tract Forebay pumping plant.

The July 2018 Conceptual Engineering Report still has no identified locations for where the borrow fill will come from, including borrow fill for Byron Tract Forebay. The 2018 Conceptual Engineering Report cites a lack of available geotechnical information. However, there is a large amount of relevant geotechnical information available, including soil maps in Chapters 10 and 17 of the Admin Draft Supplemental EIR/EIS which classify the soils in the Delta, and also show thickness of organic soils.

The soil maps show that most of the soil in the Central Delta has thick organic deposits, often consisting of deep peat and muck. The soil maps in the Admin Draft Supplemental EIR/EIS should have been cross-referenced with the specification of suitable borrow materials from the Conceptual Engineering Report. In addition the Department of Water Resources has available the WaterFix borings, the Delta Risk Management Strategy borings and the soil maps in the Delta Risk Management Strategy Risk Analysis Report, which are referred to in the 2018 Conceptual Engineering Report. DWR also has the Borrow Area Geotechnical Report from the In-Delta storage program, as well as many other sets of borings from the In-Delta Storage Program investigation, and many previous sets of borings.

All of the information points to borrow either being unavailable in the Central and South Delta or requiring removal and appropriate handling of significant amounts of overburden of organic soils. Use of borrow from these locations would conflict with the requirement in the 2015 and 2018 Conceptual Engineering Reports and the 2017 WaterFix Incidental Take Permit that borrow be obtained from locations which require removal of only no, or very limited amounts of overburden. (WaterFix Incidental Take Permit, p. 44.)

Nor has the process for reclamation of borrow pits been adequately defined. While it is proposed that the Tunnel Muck / Reusable Tunnel Material be put in the borrow pits, there has been no analysis of the how the toxic constituents in the Tunnel Muck / RTM will be insulated from groundwater if it is put in borrow pits that have depths below the groundwater table.   Since groundwater is 0 to 5 feet deep in much of the project area, this is a major omission in the analysis of of potential Water Quality Impacts Materials in the Admin Draft Supplemental EIR/EIS,

There are also major omissions in the discussion of Hazardous Materials in the Admin Draft Supplemental EIR/EIS. While there are tests for toxic constituents in the tunnel muck (Reusable Tunnel Material), there have been no tests for toxic materials in borrow fill or overburden. Tests of Delta channel sediments show toxic constituents including heavy metals, legacy pesticides including DDT and DDE, and PCBs. Nor has there been any analysis of emissions of hydrogen sulfide from organic soils moved as a result of the project.

Avoiding significant impacts from underseepage, borrow overburden, and toxic constituents would require trucking or barging in most of the borrow fill for the parts of the project in the Central Delta. This would mean that the barge and truck traffic analyses in the Admin Draft Supplemental EIR/EIS, and the associated air quality / emissions analyses likely have gross errors in the estimated amount of traffic for the project.

II. Detailed Testimony

A. Seismic Engineering and Design

New Seismic Design Criteria

DWR's July 2018 Conceptual Engineering Report has a substantial change in seismic design criteria, stating that the facilities will be designed to American Society of Civil Engineers ASCE-7 seismic standards for critical facilities. Under Section 4.2.1.4, Seismic Design Criteria, the 2018 CER states:

> For the purposes of developing seismic design criteria, the WaterFix facilities have been assigned a "critical" facility classification. Long delays in water delivery from the north to the south of the Delta could have a significant negative impact on human life and the California economy. The facilities will be designed as described in ASCE 7, which is often cited for the design of critical facilities. ASCE 7 does not specifically address the design of underground facilities like tunnels and shafts.

(Exhibit DWR-1304, p. 4-8, pdf p. 42)

As described in my Part 1 testimony, the ASCE-7-10 standards for critical facilities require the facilities to withstand an ASCE Maximum Considered Earthquake, which is defined as a 2% in 50 year event, with a return period of 1 in 2,475 years. The 2018 CER now states:

> The conveyance facilities, including pipelines, and tunnels, recommended seismic loading criteria are recommended to have a seismic loading criteria

> appropriate for a seismic event with a 2,475 year return period. Based on anticipated longer repair time, a higher seismic standard is recommended for pipelines and tunnels than for canals. Repair costs associated with tunnels and pipelines is also greater than repair costs for canals.

(Exhibit DWR-1304, p. 4-9, pdf p. 43.)

Given the depth of the tunnels, and the amount of water they will be carrying, these are more appropriate design criteria. However, the 2018 CER indicates that the seismic design criteria could be changed, stating

> Detailed seismic hazard analyses will be conducted in the early stages of preliminary design of WaterFix facilities. Based on the results of this analysis, the final seismic design criteria for the facilities will be established.

(Exhibit DWR-1304, p. 4-9, pdf p. 43.)

In Part 1, I recommended that the Board require that the WaterFix tunnels be designed to withstand an ASCE-10 Maximum Considered Earthquake without catastrophic failure. This is necessary to protect people, property, and critical structures on the surface. I continue to recommend that the Board put this requirement in the permit.

New Seismic Review of Liner Performance

The CER now states

> Under the performance criteria of MCE, the concrete segmental liner will be structurally intact without any collapse (see Appendix M: Seismic Review of Liner Performance). Uncontrolled discharge of water or ground loss induced by the tunnels will not occur because of the high-strength segmental liner that will resist the thrust, flexural and shear stresses associated with the maximum earthquakes.

(Exhibit DWR-1304, p. 4-10, pdf p. 44.)

However, when I reviewed the Seismic Review of Liner Performance in Appendix M, I discovered what appeared to be a major error in assumptions about geotechnical properties of the soils, which would result in an underestimate by almost a factor of 2 of the seismic ground motions used in the analysis of liner performance. The analysis in Appendix M assumes that the soils at the depth of the tunnels are Class B or Class C, which are rock, soft rock, and very dense/hard soils. Geotechnical testing for the project shows that the soils at the depth of the tunnels are NOT rock, soft rock, and very dense/hard soils.

DWR-1304, Appendix M, Section 4.2 states:

> InfraTerra reviewed the seismic hazard analyses and developed uniform hazard target spectra <u>based on spectral acceleration parameters from the DRMS report scaled to Site Class B/C conditions.</u> The target spectra were used to select eleven ground motions representative of the 975-year and 2,475-year hazards.

(DWR 1304, Appendix M, p. 22, pdf p. 503, underlining added.)

Table 20.3.1 below, is from Chapter 20 of the ASCE 7-10 Standards (Exhibit DDJ-148), on Site Classification Procedures. The Table below shows that Site Class B is rock, and Site Class C is very dense soils or soft rock, with average shear strengths (Sµ) of greater than 2000 pounds per square foot. (psf.)

Table 20.3-1 Site Classification

Site Class	$\bar{v}_s$	$\bar{N}$ or $\bar{N}_{ch}$	$\bar{s}_u$
A. Hard rock	>5,000 ft/s	NA	NA
B. Rock	2,500 to 5,000 ft/s	NA	NA
C. Very dense soil and soft rock	1,200 to 2,500 ft/s	>50	>2,000 psf
D. Stiff soil	600 to 1,200 ft/s	15 to 50	1,000 to 2,000 psf
E. Soft clay soil	<600 ft/s	<15	<1,000 psf
	Any profile with more than 10 ft of soil having the following characteristics: —Plasticity index $PI > 20$, —Moisture content $w \geq 40\%$, —Undrained shear strength $\bar{s}_u < 500$ psf		
F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1		

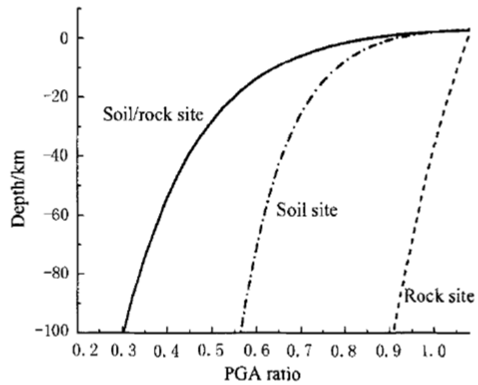
For SI: 1 ft/s = 0.3048 m/s; 1 lb/ft^2 = 0.0479 kN/m^2.

Assuming the soil is class B or C, InfraTerra concludes that the median peak acceleration at Clifton Court Forebay at 100 feet depth is 0.24 g for 2,475 year ground motion – about 36% of the surface peak acceleration of 0.66g calculated in the Delta Risk Management Strategy Seismic Hazard Analysis. Appendix M states:

> Site response analyses were performed based on subsurface conditions near Clifton Court, and the results indicate the median peak accelerations a a depth of 100 ft are about 0.21 g and 0.24 g for 975-year and 2,475-year ground motions, respectively.

(Exhibit SWRCB-1304, Appendix M, p. 22, pdf p. 503.)

This assumption appears to be consistent with the attenuation for a soil/rock site (Treasure Island) in the analysis of downhole data in *Variation of Earthquake Ground Motion with Depth* (Exhibit DDJ-155), which I referenced in my analysis in Part 1. The graph for attenuation at depth of Treasure Island is shown on the next page. The downhole data for strong motion at the La Cienega site from the same paper, gave approximately 30% attenuation at 120-160 feet, which would give a median peak ground acceration of about 0.46 for 2,475 year ground motion at Clifton Court Forebay – almost double the 0.24g estimated using assumptions of very dense soils / soft rock or rock at the depth the tunnels.



If the mean peak ground acceleration is significantly greater than 0.24g, then the entire rest of the analysis in Appendix M is invalid, because all of the analyses use the peak ground acceleration as an input.

Geotechnical Data

The soils section of the Admin Draft Supplemental EIR/EIS refers to DWR's 2011 Draft Phase II Geotechnical Investigation-Geotechnical Data Report-Pipeline/Tunnel Option. (p. 10-9.)

Contradicting the assumptions in Appendix M of the 2018 Conceptual Engineering Report, the triaxial shear strength tests in the 2011 Draft Phase II Geotechnical Investigation-Geotechnical Data Report did NOT show very stiff soils. Table 3-5 in the report, reproduced below, shows the triaxial shear strength test data:

Table 3-5 Summary of Triaxial Test Results

Sample Source	Sample Depth (feet)	Liquid Limit,	Plastic Index	Classification	Confining Pressure σ_3, psf	Total Stress		Effective Stress		Remarks
						C, psf	Φ, degree	C′, psf	Φ′, degree	
DCR2-DH-006	112.5-114.5	44	16	ML	6000, 9000, 12000	1000	-	-	-	UU test
DCR4-DH-006	92.5-94.5	38	10	ML	5000, 7000, 10000	2000	-	-	-	UU test
DCRA-DH-008	80-82	42	11	ML	4500, 6000, 9000	1500	-	-	-	UU test
DCRA-DH-010	97.5-99.5	43	12	ML	5500, 8000, 11000	850	-	-	-	UU test
DCRA-DH-012	107.5-109.5	43	14	ML	6000, 9000, 12000	2800	-	-	-	UU test
DCRA-DH-014	109.5-111.5	60	19	MH	6000, 9000, 12000	3300	-	1000	17	CU test
DCRA-DH-017	139.5-141.5	61	18	MH	8000,12000, 16000	3550	-	600	27	CU test
DCRA-DH-022	120-121	37	15	CL	7000, 10500	900	-	-	-	UU test
DCRA-DH-022	136-138	65	27	MH	7500, 11000, 15000	3200	-	600	26	CU test
DCRA-DH-024	112.5-114.5	41	16	CL	6000, 9000, 12000	2000	-	-	-	UU test

(Exhibit DDJ-312, p. 3-31, pdf p. 42.)

The undrained shear strength (s) of the soil is given by

$$s = C/2$$

where C is the unconfined compressive strength, shown as C under the column "Total stress" in the table above. To get the shear strength from the above table, one divides the compressive strength, C, by 2. The following classifications for soils, originally defined by Terzaghi, are still widely used[1]:

Consistency	Terzaghi Unconfined Compressive Strength (psf)	Shear strength (psf)
Very soft	< 500	< 250
Soft	500 – 1,000	250-500
Firm	1,000 – 2,000	500-1,000
Stiff	2,000 – 4,000	1,000-2,000
Very stiff	4,000 – 8,000	2,000-4,000

ASCE-7-10 Class C sites that are classified as "very dense" have mean shear strengths greater than 2,000 psf, averaged over layers down to 100 feet below the surface. (Exhibit DDJ-148, p. 204, pdf p. 24.7.) ASCE 7-10 does not give a method for site classification for underground structures such as tunnels, but one can compare with the mean shear strength (averaged by depth) of the soil samples at the depth of the tunnel bore.

None of the soil samples in Table 3-5 are rock, so none would be Class B. Based on shear strengths of greater than 2,000 psf, Terzaghi's "very stiff" soils would be analogous to ASCE-7-10 class C sites. Terzaghi's "stiff soils" havie mean shear strengths between 1,000 psf and 2,000 psf, and so would be analogous to ASCE 7-10 Class D sites. None of the soil samples in Table 3-5 are "very stiff."

In addition, if one looks at the river crossings and Delta channel crossings in the above table, one finds that almost all of the river channels have undrained shear strengths of 1,000 psf or less. These range from 425 psf at Potato Slough (south of Bouldin Island) to 1000 psf at Old River. These soil samples would be classified as soft to firm under Terzaghi's categories. The single exception is the San Joaquin River channel (DCRA-DH-012), which has undrained shear strength of 1,400 cfs, and would be classified as stiff. None of the river or channel crossing samples could be characterized as very stiff.

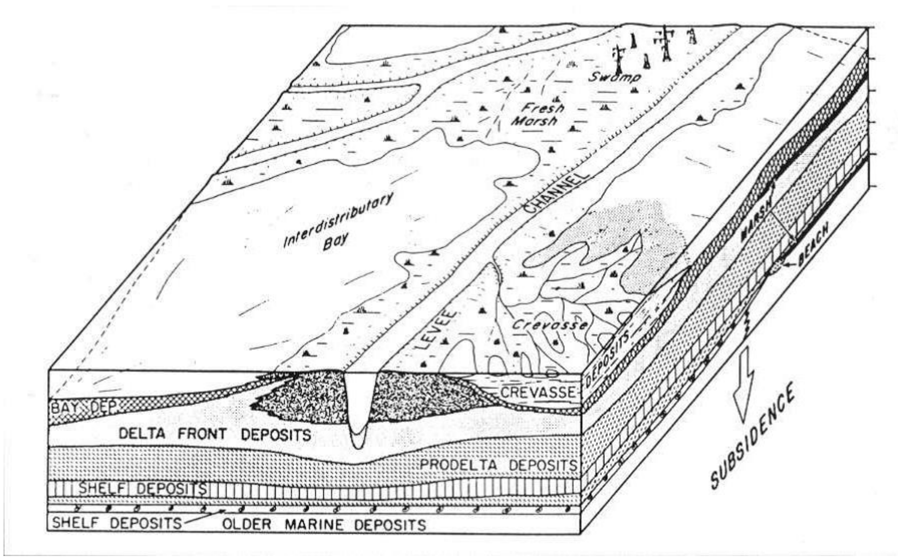
DCR2-DH-006 Intake 2 Sacramento R.
DCR4-DH-006 Intake 4 Sacramento R.
DCRA-DH-008 PTO Mokelumne R.
DCRA-DH-010 PTO Potato Slough
DCRA-DH-012 PTO San Joaquin R.

[1] Exhibit DDJ-342 is a true and correct copy of Terzaghi, Karl. Soil Mechanics in Engineering Practice, John Wiley and Sons, 1948.

DCRA-DH-014 PTO Connection Slough
DCRA-DH-017 PTO Railroad Cut
DCRA-DH-022 PTO Woodward Canal
DCRA-DH-024 PTO Old River

In sum, DWR's own boring data shows not only that the Delta alluvial deposits at the depths of the tunnels are NOT Class B or C, they may not even be Class D.

It is not unexpected that softer Holocene deposits would be deeper under Delta channels than under Delta Islands. The following diagram, from a powerpoint presentation by David Rogers and Rune Storesund on the Geologic Setting for the Sacramento San-Joaquin Delta[2], shows the geology of a natural Delta channel.



Chapter 4 of the 2018 CER recognizes that the Delta has Holocene alluvial channel deposits in active, historic, and prehistoric non-tidal channels. The CER states that

> Alluvial channel and natural-levee deposits are characterized by loose, poorly graded, sandy to clayey silt and silty sands.

[2] Exhibit DDJ-341 is a true and correct copy of Rogers, D., and Storesund, R., Geologic Setting for the Sacramento San-Joaquin Delta, Berkeley NSF RESIN Project Meeting, January 26, 2011. Obtained from http://web.mst.edu/~rogersda/levees/California/GeoSetting-Sacramento-San%20Joaquin-Delta.pdf

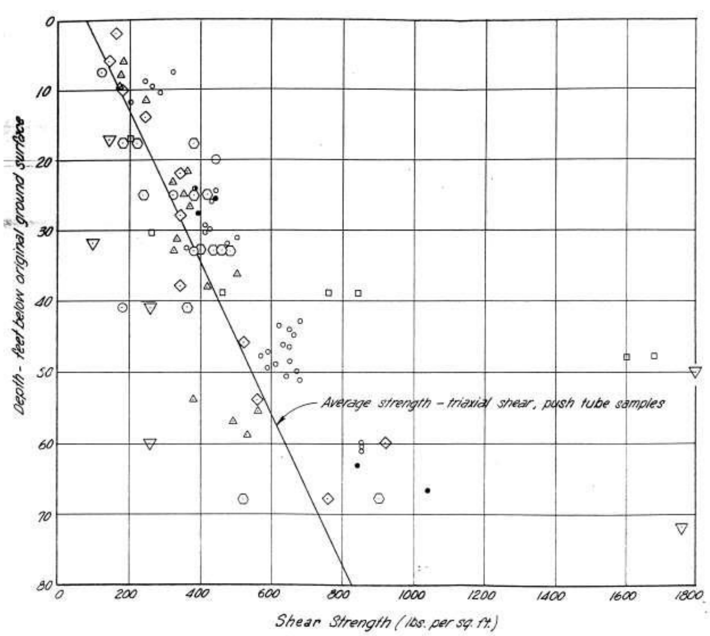
Chapter 4 also recognizes that bedrock is generally deeper than 1,000 feet in the project area. But it incorrectly classifies the soils at depths below 60 feet as “very stiff to hard,” stating

> In general, the Holocene deposits of soft mineral/organic soils and peaty material of the floodplain deposits and tidal marshes were encountered up to 60 feet below ground surface (bgs) within the Delta. The Holocene materials are generally characterized as organic soil or very soft to medium stiff silty clay with medium dense silty sand and poorly graded sand (Figures 4-2 through 4-6).
>
> The deeper alluvium of probable Upper and Middle Pleistocene age (11,700 to 781,000 years before AD 2000) are generally characterized by dense to very dense silty sand, poorly graded sand, and very stiff to hard silty clay and clayey silt.

(Exhibit DWR-1304, p. 4-3, pdf p. 37.)

This generalized description in the CER could be why InfraTerra assumed Class B or class C soils, since the tunnels are at depths of greater than 60 feet.

But in general, this description that the consolidated Pleistocene alluvium begins at 60 feet depths in the Delta appears incorrect. Geotechnical data shows that Delta alluvial deposits are much softer at 60 feet than “very stiff to hard.” The graph below, from the powerpoint on the Geologic Setting for the Sacramento San-Joaquin Delta, shows data from triaxial shear strength tests in the Delta. The tests show that, on average, soft Holocene deposits in the Delta become firm at around 60 feet, but only become stiff at much depths greater than 80 feet.



As I recommended in my testimony in Part 1 (Exhibit DDJ-163), the project must have adequate geotechnical data. Given this apparent mismatch between the geotechnical assumptions used in the design and the actual geotechnical data, I also believe that my recommendation in Part 1 that the Board require peer review of the project engineering is still warranted.

Liquefaction

Appendix M also states:

> A liquefaction hazard analysis was also performed at the depth of the tunnel near Clifton Court. The results indicate the liquefaction hazard is very low.

(Exhibit SWRCB-1304, Appendix M, p. 22, pdf p. 503.)

This conclusion was based on the assumption of a mean peak ground acceleration of only 0.24g, 36% of the surface pga of 0.66g.

In contrast, DWR's internal 2010 engineering analysis used a seismic event with a peak ground acceleration of over twice that used in Appendix M, and concluded that "substantial, continuous liquefaction could be expected" down to a depth of 100 feet.

> The seismic event assumed for the liquefaction analysis had a magnitude of 7.5 and a peak ground acceleration of 0.49 g. The average shear wave velocity for the uppermost 40 feet of soil (Vs,40) was assumed to be 500 ft/sec.
>
> All of the borings analyzed included soils that are potentially liquefiable, although to different extents. Substantial, continuous liquefaction of the soil column can be expected down to elevation -100 feet, based on the borings analyzed. Below this depth only isolated pockets of liquefaction are observed.

(Exhibit DDJ-161, p. 4-14, pdf p. 38.)

DWR's internal 2010 engineering analysis shows that larger peak ground accelerations results in a much greater liquefaction hazard.

As I previously stated in my Part 1 testimony,

> Given the ground plasticity and potential liquefaction of the soft ground surrounding the tunnels, the issue of differential movement of the tunnels, intakes/outlets, access shaft, and vents is substantial. These must be carefully analyzed and their impacts adequately addressed and mitigated.
>
> Differential movements between the WaterFix tunnels, intakes/outlets, and access shafts also need a differential analysis and appropriate assessment of impacts and required mitigation. This is especially important because the access shafts will be fixed vertically in very large concrete slabs to protect the shafts from flooding, while the tunnels will be bedded in deep alluvial deposits.

(Exhibit DDJ-163, p. 10.)

For the reasons cited in my testimony, the conclusion by Infraterra that liquefaction hazard is low may be dangerously wrong. Not designing the tunnel / shaft interface to withstand liquefaction could result in gaps opening up in a seismic event, and uncontrolled release of water.

Given the lack of an adequate geotechnical and preliminary engineering analysis of the tunnel shaft / tunnel lining interaction, it is also premature for the WaterFix Design and Construction Enterprise to begin construction of the Bouldin Island Tunnel Shaft Pad, as is planned in Exhibit DWR-1309.

Site Specific Seismic Responses

ASCE 7-10 requires site-specific seismic response analyses for all Site Class F soils, which include liquefiable soils and high plasticity clays. (Exhibit DDJ-148, p. 203, pdf p. 246.)

Not only do the Delta soils appear to be liquefiable, according to DWR's internal engineering analysis, some of the soil samples analyzed in the triaxial tests are also plastic, having plasticity indices of 180% - 270%.

The liquefiable soils will also pose significant challenges for engineering the new Byron Tract Forebay embankments. To ensure that the dam is not a hazard to nearby residents, the Board should require an external peer review of both the geotechnical analysis and the seismic analysis for Byron Tract Forebay.

Seepage at Byron Tract Forebay

The 2015 Conceptual Engineering Report documents that the foundation for the Clifton Court Forebay embankments has underseepage and piping, due to layers of silty sand and clean fine sand (Exhibit DWR-212, p. 164.) Given that underseepage and piping are the cause of 50% of all dam failures (FEMA 2015), the Board should require peer review of the design of Byron Tract Forebay to control underseepage.

Boring the South Tunnels

The South Tunnels pass near the Clifton Court Forebay embankments. If a loss of ground happened while tunneling near the Clifton Court Forebay embankments, it could affect the integrity of the embankments, causing an uncontrolled release of water.

The triaxial test data in DDJ-315, Table 3-5 shows silts or silty clays. Silts are difficult to tunnel in, and are known to be subject to running during tunnel boring. Plastic clays can exhibit squeezing during tunnel boring. Both can be causes of loss of ground.

DWR's 2009 internal DHCCP Design Standards, Volume 2, Facility-Specific Design Guidelines, state

> **Anticipated Ground Behavior** Ground conditions will need to be evaluated and grouped into reaches along the tunnel where ground conditions are generally similar. Ground behavior will need to be evaluated and discussed in accordance with the General Categories of Ground Behavior for Soft Ground Tunnels, as presented by Terzaghi, 1950 and modified by Heuer, 1974. This classification system is commonly referred to as the "Tunnelmans Ground Classification" and includes the following categories of ground behavior: firm ground, raveling ground, squeezing ground, running ground, flowing ground, and swelling ground. This classification is well recognized by Contractors and is useful in determining means and methods for shaft construction and tunnel excavation.

(Exhibit DDJ-315, p. 5-4, pdf p. 31.)

It is unclear why these proposed standards were never followed. The Board should require that the WaterFix proponents classify ground conditions along the South tunnel alignment, and the classification should be peer reviewed.

DWR's 2009 internal DHCCP Design Standards, Volume 2, Facility-Specific Design; Guidelines also state

> **Category: Protection of Adjacent Structures and Property**
> **Approach:** A survey of all structures and property along or adjacent to the alignment will need to be performed and any property that needs to be protected will need to be identified. A program of geotechnical instrumentation and monitoring will need to be developed and included in the plans and specifications in order to help evaluate the settlements induced by the tunneling activities. <u>Maximum allowable settlement thresholds should be determined and included in the contract documents.</u>

(Exhibit DDJ-315, p. 5-7, pdf p. 34.)

The Board should require DWR to do a survey of all structures and property along or adjacent to the South Tunnels alignment. The Board should also require that maximum allowable settlement thresholds for the Clifton Court Forebay embankments, and any other structure that needs to be protected during tunnel boring, should be determined and peer reviewed, prior to construction.

B. Changes to Project, Increased Borrow Fill, Water Quality, Hazardous Materials, and Traffic/AQ Impacts

1. Increased Amount of Borrow Fill

The Admin Draft Supplemental EIR/EIS states:

> The amount of material excavated would be less under the proposed project than under the approved project because, although a conveyance facility would be constructed from the new Byron Tract Forebay to the Central Valley Project and State Water Project, Clifton Court Forebay would no longer be dredged.

(Exhibit SWRCB-113, Chapter 4, Hazardous materials, p. 24-5.)

This is misleading and inaccurate, because it does not consider the increased borrow fill needed for Byron Tract Forebay.Based on the 2015 Final Draft Conceptual Engineering Report, the 2017 Incidental Take Permit from the California Department of Fish and Wildlife stated that the 21 million cubic yards of borrow fill would be needed:

> Borrow Fill: The total amount of borrow material for engineered fill used in all aspects of the Project will be approximately 21 million cy. This total amount will include approximately 3 million cy for tunnel shaft pads, 6.5 million cy for the CCF embankments, 2 million cy for the IF embankments, 6.7 million cy at the three intake sites (approximately 2 million cy each), and 2.6 million cy at the CCFPP site.

(Exhibit SWRCB-107, Incidental Take Permit, p. 44.)

The July 2018 Conceptual Engineering Report states that 7.8 million cubic yards of fill will be needed for the Byron Tract Forebay embankments, an addition of 1.3 million cubic yards. The total borrow fill required would be 19 million cubic yards. However, the CER estimates the fill in “bank yards.” How the conversion factor was applied to the previous calculations is not explained. The July 2018 Conceptual Engineering Report states:

> The total amount of borrow material for engineered fill is approximately 19 million cy (bank yards), based on the associated number of intakes, size of forebays, and conveyance requirements. The total amount includes approximately 2 million cy for the tunnel shaft pads, 7.8 million cy for the BTF embankments, 2 million cy for the IF embankments, and 6 million cy at the three intake sites (approximately 2 million cy each), and 1 million cy at the Byron Tract Pumping Plant site (Note: For reference purposes, the multiplier to convert “bank yards” to “truck yards” is 1.3, and the multiplier to convert “bank yards” to “yards compacted in place” is 0.75 (0.85 for RTM)).

(Exhibit DWR-1304, 2018 Conceptual Engineering Report, Section 21.0, Borrow Sites, p. 21-1, pdf p. 167.)

Converting “Bank yards” to “truck yards” gives a total of 24.7 million cubic yards of borrow fill for the project.

2. Sources of Borrow Fill

Page 27-5 of the Draft Supplemental EIR/EIS states:

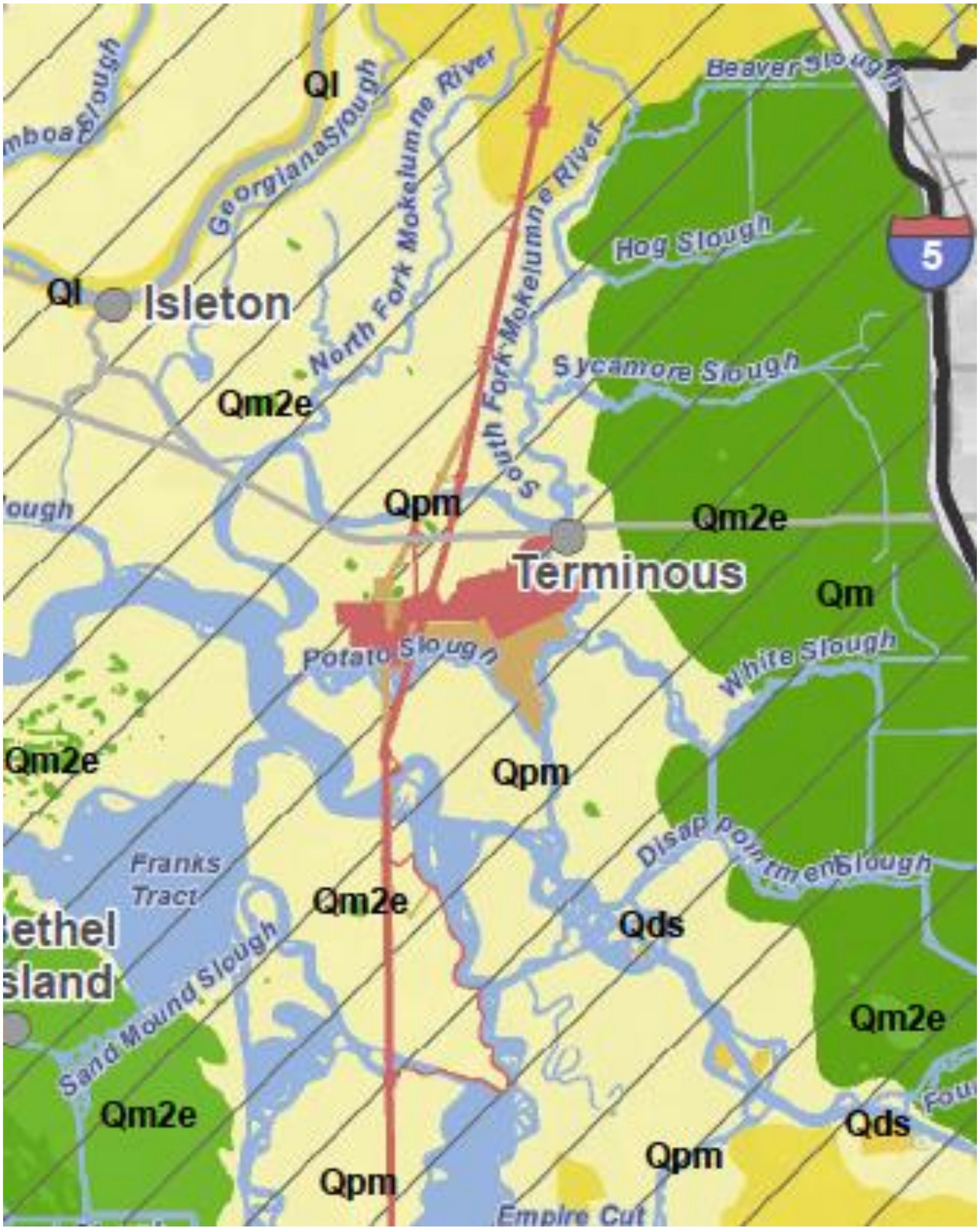
> Borrow material would be needed primarily for the new Byron Tract Forebay embankments, as well as for access roads. Borrow material would be excavated

> from targeted units described in the engineering report (California Department of Water Resources 2010.)

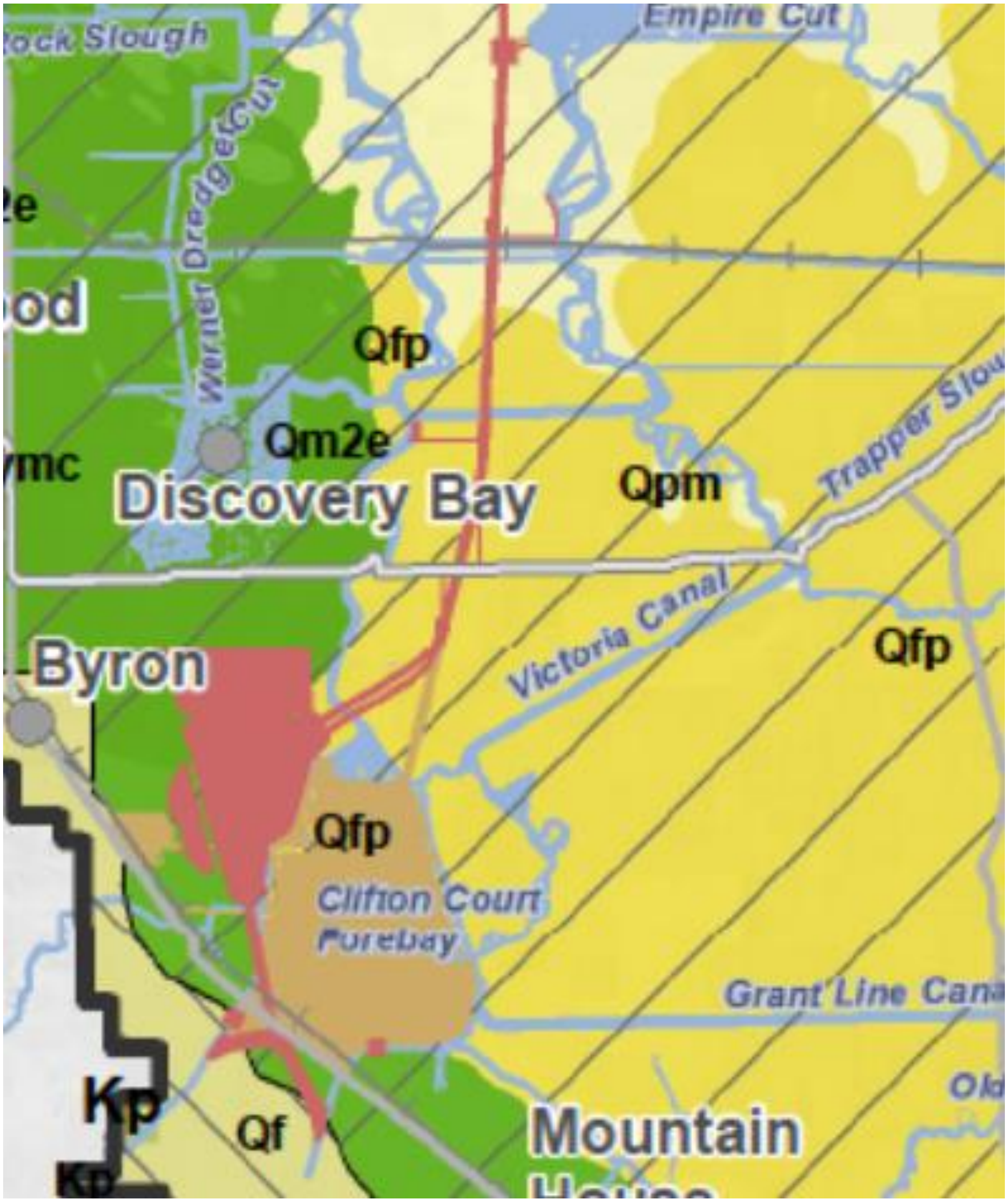
The July 2018 Conceptual Engineering Report states in Section ES-4.1, Borrow fill (pdf p. 24):

> Borrow materials will be required for forebay and overflow containment area embankments at the Intermediate Forebay, Byron Tract Forebay, Intake Facility site fill, tunnel shaft site fill pads, and other features. The primary borrow material needed will be soil suitable for use as engineered embankment fill, but rock, gravel, and sand will also be required.
>
> At this point in project development, sufficient geotechnical information is not available to fully assess the suitability of borrow areas near the WaterFix BTO alignment to determine if adequate quantities of borrow material are actually available. However, several potential borrow sites are specifically identified in this CER that may be able to meet all, or some, of the borrow requirements at the various facility sites. These are shown in CER Volume 3 (Map Book). Also, several commercial borrow sites are available in the general vicinity of the project alignment and could be used. Additional explorations, land ownership considerations, and engineering analyses are needed to better define the actual borrow sites and associated borrow quantities that will be used for the work. Borrow material can be transported over land by truck or earth moving equipment and over water by barge.

But an examination of the soil map on the first page in the Section 17, Paleontology Figures shows that many of the soils in the Central Delta are peat and muck (Qpm) or dredge spoils (Qds), which are not suitable for borrow material. Below are two closeups of the map on the first page, showing that much of the soils are Qpm or Qds.



Ql
Georgiana Slough
North Fork Mokelumne River
South Fork Mokelumne River
Beaver Slough
Hog Slough
5
Ql
Isleton
Sycamore Slough
Qm2e
Qpm
Qm2e
Terminous
Qm
Potato Slough
White Slough
Qm2e
Qpm
Disappointment Slough
Franks Tract
Qm2e
Qds
Sand Mound Slough
Qm2e
Qm2e
Qds
Qpm
Qpm
Empire Cut



Rock Slough
Empire Cut
Werner Dredger Cut
Qfp
Qm2e
Discovery Bay
Qpm
Trapper Slou
Victoria Canal
Qfp
Byron
Qfp
Clifton Court
Forebay
Grant Line Cana
Kp
Qf
Mountain

Detailed Geologic Map Units

Qds	Dredge soils—post 1900
Qpm	Peat and muck—Holocene

Alluvium of Supratidal Floodplains—Holocene

Qb, Qfp, Ql	Alluvial floodbasin deposits, Alluvial floodplain deposits, Natural levee deposits

Eolian Deposits—Pleistocene

Qoe	Older eolian deposits
Qmz	Montezuma Formation
Qe, Qm2e	Eolian deposits, undivided and upper member of Modesto Formation

Alluvial Fans from Glaciated Basins—Pleistocene

Qr, Qry, Qro	Riverbank Formation, younger and older
Qm	Modesto Formation

Alluvial Fans and Terraces from Unglaciated Drainage Basins—Holocene and Pleistocene

Qya, Qia, Qoa	Youngest, intermediate, and oldest alluvium of Antioch and vicinity
Qcr	Alluvium of Calaveras River
Qymc, Qom	Younger and older alluvium of Montezuma Hills and vicinity
Qomc	Older alluvium of Marsh Creek
Qyp, Qop	Younger and older alluvium of Putah Creek
Qch	Alluvium of creeks from the Corral Hollow Drainage to Brushy Creek

There are significant issues even with the Qm2e and Qm soils. According to Table 21-1 in the 2018 Conceptual Engineering Report, shown below, these soils would likely require dewatering. In addition, maps show that the thickness of organic materials is enough that there would be significant overburden of organic materials, requiring fairly deep borrow pits.
The map on the following page is from the Delta Risk Management Strategy Risk Analysis Report, and the second map is from the California Department of Water Resources' 1995 Delta Atlas[3]. Both maps show thick Delta soils.

[3] Exhibit DDJ-348 is a true and correct copy of California Department of Water Resources, Sacramento San Joaquin Delta Atlas, 1995.

Table 21-1: Summary of Potential Borrow Source Characteristics

Unit Name	Symbol	Age	Description	General Location	Potential Borrow Material	Suitability for Borrow	Rippability	Construction Considerations
Yuba River Gold Fields	YGF	Modern	Well-graded gravel.	East of Yuba City.	Gravel	High	High	Unit consists of washed river rock, which may not be suitable for many applications.
Floodplain Basin Deposits	Qb	Holocene	Fine-grained silt and clay derived from the same sources as modern alluvium. Distal facies of unit Qa. Thickness varies from 1 or 2 meters to 60 meters.	Found throughout the Sacramento and San Joaquin Valleys; prevalent in the Delta. A number of different Quaternary deposits have been grouped with this single unit based upon similar geotechnical characteristics as potential borrow material.	Silt and clay	Variable	High	Most areas underlain by Quaternary basin deposits have extensive surface development, either agricultural or urban. Localized units may have highly variable grain-size distribution. Although satisfactory borrow sites may exist throughout this formation, generally in pre-historic fluvial channels, the reserves at a specific location are typically limited. Depth to groundwater is highly variable. The highly variable nature of this unit over short distances indicates this unit would not be a suitable source for large quantities of borrow material.
Modesto Formation (alluvium)	Qm	Late Pleistocene	Gravely sand, silt, and clay.	Alluvial deposits in the center of the Sacramento and San Joaquin Valleys.	Sand, silt, gravel, and clay	Medium	High	Shallow groundwater is also associated with this unit in some areas. Dewatering of even small borrow areas would likely be required and there is a potential for cross-contamination of near-surface aquifers.
Montezuma Formation (poorly consolidated, clayey sand)	Qmz	Early Pleistocene	Poorly stratified clayey sand and pebbly sand.	Montezuma Hills, southwest of Rio Vista.	Clay and sand	High	High	The Montezuma Hills property is currently owned by an environmental land trust. A 500-kV line transects the property, which also overlies the producing Rio Vista gas field. Numerous producing gas wells and collection piping that would need to be addressed. Purchase of alternative property would be required.

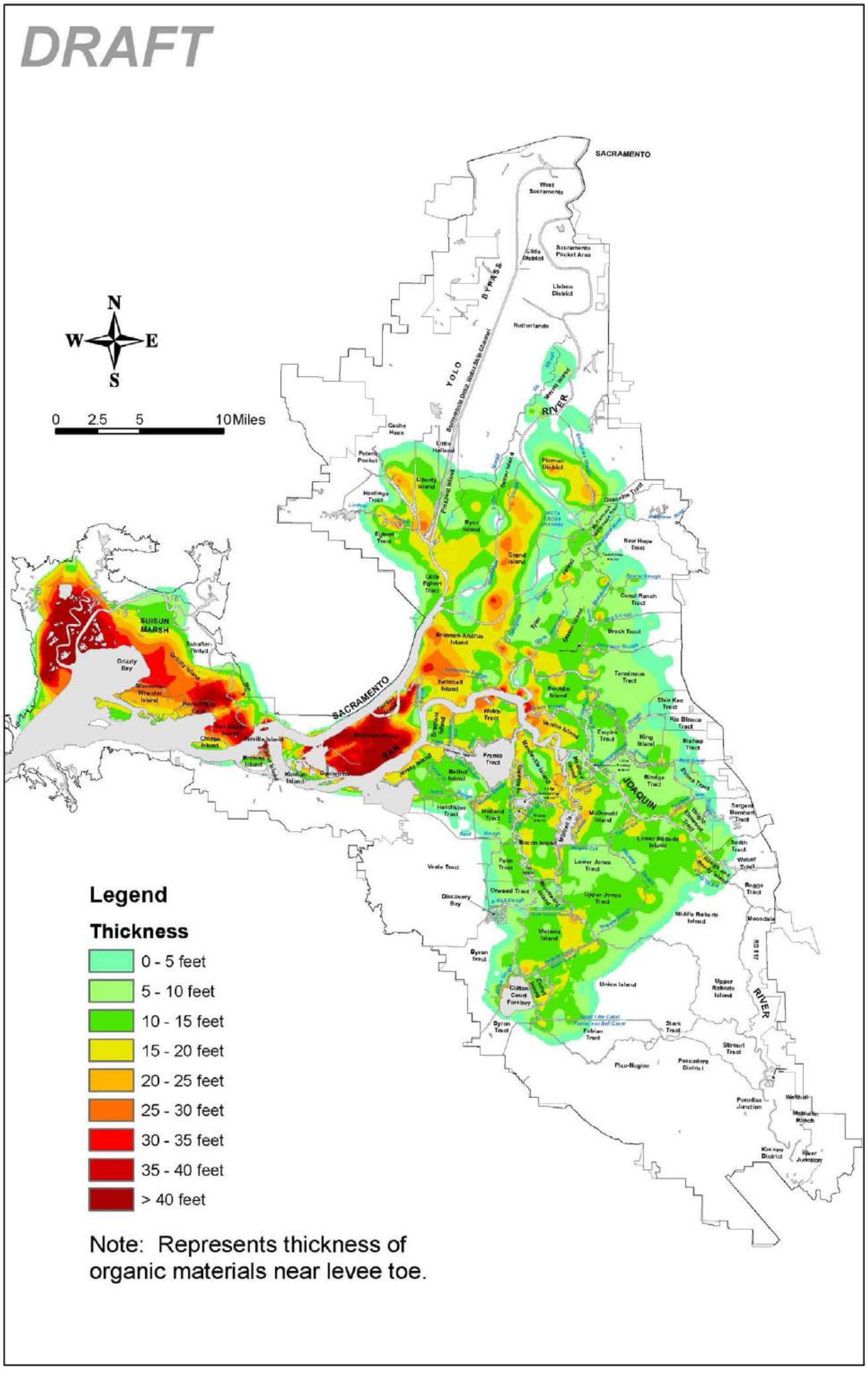
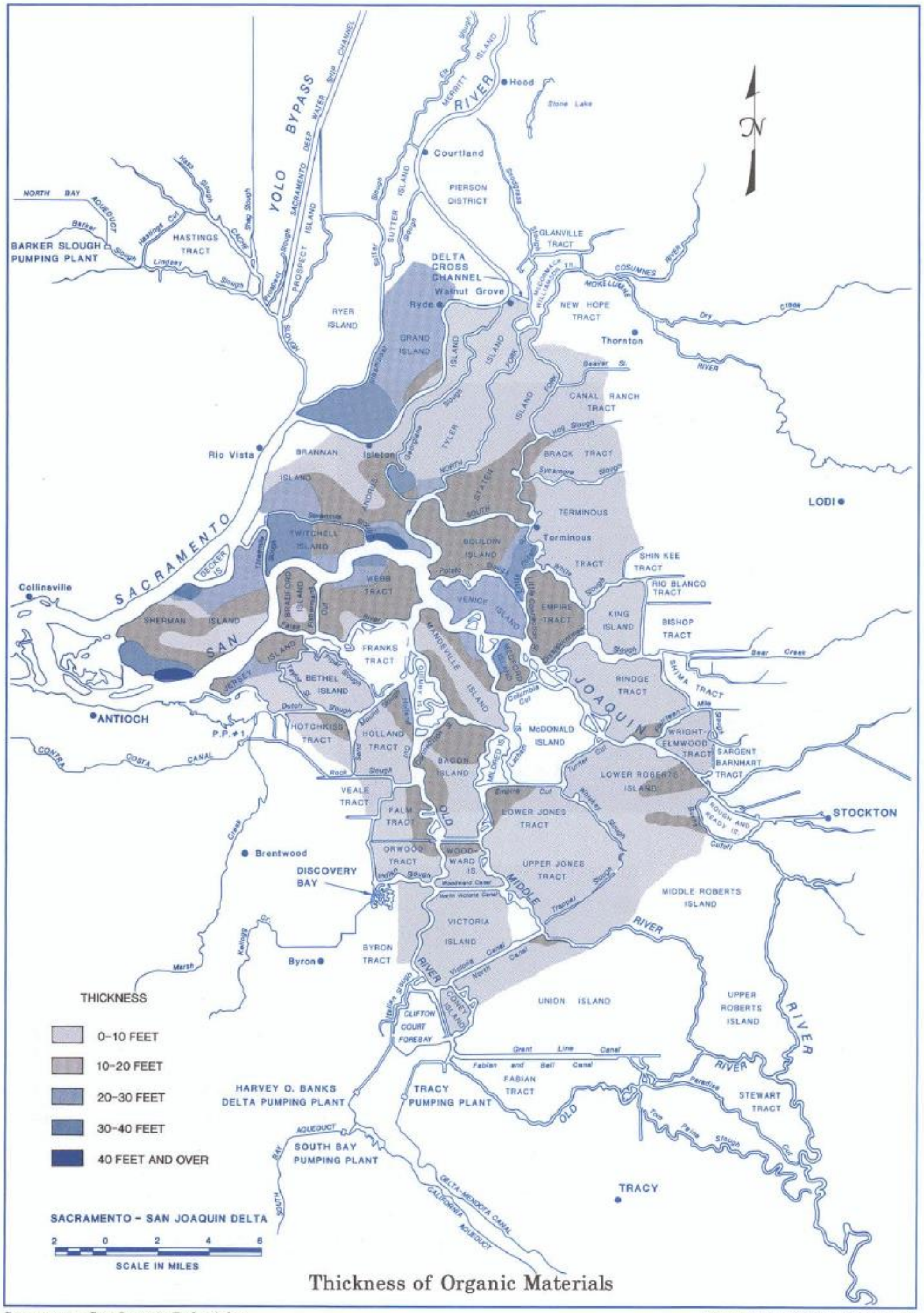


Figure 7-50 from the Chapter 7 of the Delta Risk Management Strategy Risk Analysis Report.



Sacramento–San Joaquin Delta Atlas *Department of Water Resources*

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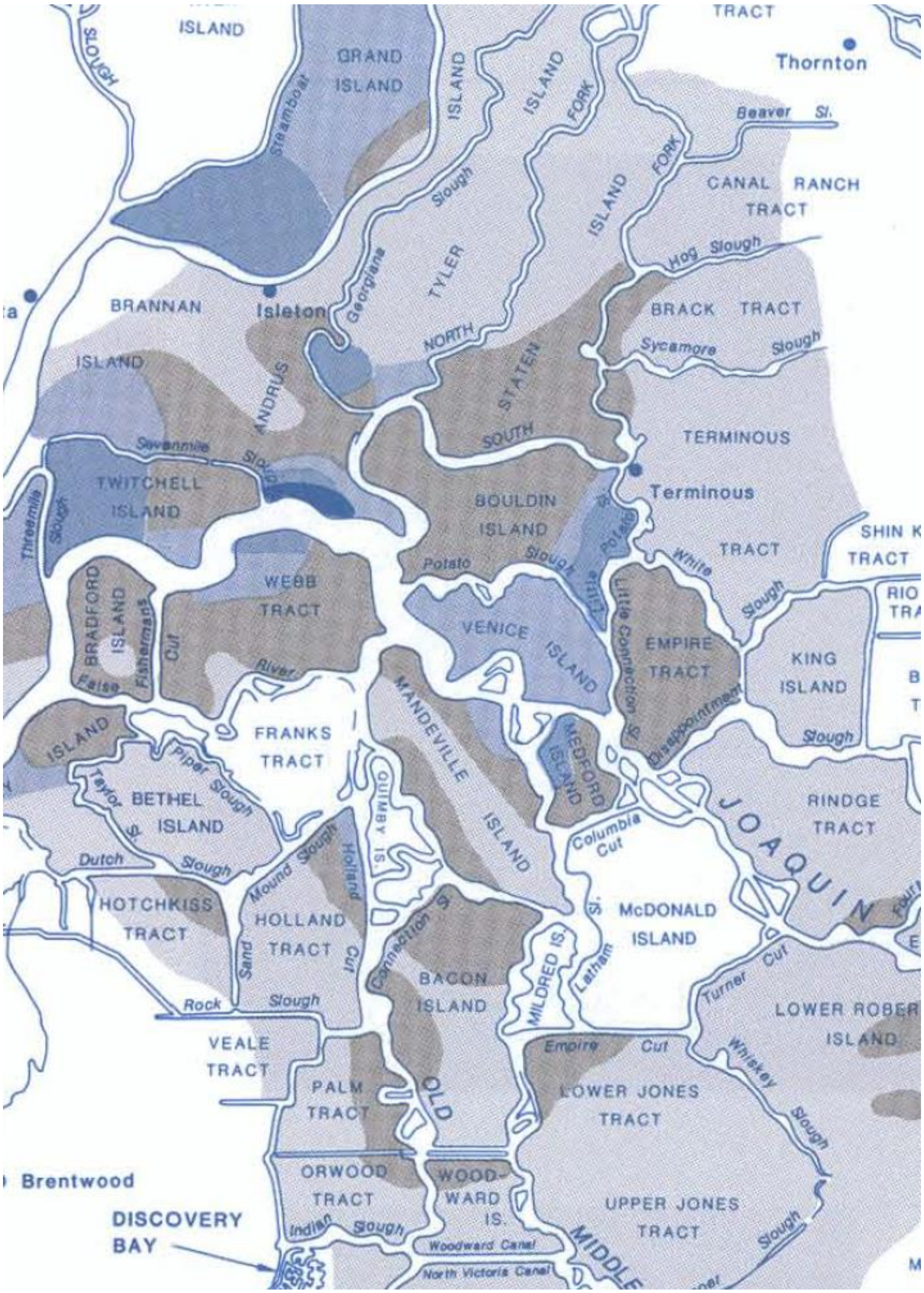
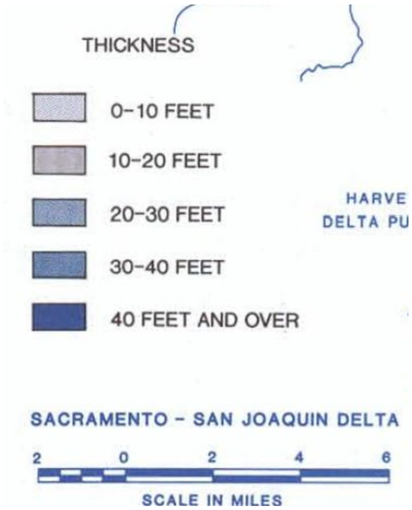
Delta Atlas, p. 26



Closeup of Delta Atlas organic soils map, p. 26



Closeup of Delta Atlas organic soils map legend, p. 26.

3. Toxic constituents in borrow fill and borrow overburden

The Hazardous Materials Chapter of the Admin Draft Supplemental EIR/EIS states:

> The decreased excavation would result in a slightly decreased possibility of impact from potentially contaminated sediment, which could adversely affect soil, groundwater, or surface water.

(Exhibit SWRCB-113, Chapter 24, p. 24-5:23.)

It is true that sediments in Clifton Court Forebay could be contaminated. Dredging records show that Delta riverine channel sediments have significant contaminants, including Cadmium, Chromium, Copper, Mercury, Nickel, Zinc, PCBs, and DDT, DDD, and DDE. The following table is from the Delta Dredging and Reuse Strategy prepared by the Central Valley Regional Water Quality Control Board in 2002, Chapter 5, Characterization and Assessment of Delta Sediments Based on the Dredge Database, p. 5-37.[4]

[4] Exhibit DDJ-343 is a true and correct copy of Central Valley Regional Water Quality Control Board, California Department of Fish and Game, and Delta Protection Commission. June 2002. Delta Dredging and Reuse Strategy. Volume I. Sacramento, CA. Chapters 5-7. Obtained from http://www.deltaltms.com/docs/VOL%20I_Chapter%205%20thorugh%207.pdf

Table 5-11. Number of Bulk Sediment Samples with Concentrations above Detection Limits and Percentage of Those Samples That Exceeded the SQAGs for Aquatic Disposal

Contaminant	Marina N	Marina >SQAGs (%)	Riverine N	Riverine >SQAGs (%)	Ship Channel N	Ship Channel >SQAGs (%)
Metals (ppm)						
Arsenic	27	37.04	156	49.36	126	1
Cadmium	12	100.0	59.0	94.92	19	100
Chromium	29	45.0	211	49.76	27	81.48
Copper	39	46.15	210	45.71	136	37.50
Lead	28	3.57	176	0	127	3.15
Mercury	29	51.72	111	69.37	111	20.75
Nickel	34	91.18	210	81.43	34	97.06
Zinc	37	18.92	206	19.42	127	15.75
Total PCBs (ppb)	1	100.0	1	100.0	0	0
Polycyclic aromatic hydrocarbons (ppb)						
Phenanthrene	2	50.0	1	0	4	0
Benzo(a)anthracene	1	100.0	1	100.0	3	0
Benzo(a)pyrene	1	100.0	1	100.0	2	0
Chrysene	1	100.0	1	100.0	1	0
Fluoranthene	1	100.0	4	50.0	4	0
Pyrene	3	33.3	1	100	4	0
Pesticides (ppb)						
Chlordane	0	0	0	0.0	0	0
Dieldrin	0	0	0	0	0	0
Pp-DDD	1	0	3	66.67	0	0
Pp-DDE	1	100.0	5	100	2	100.0
Total DDT	0	0	5	80.0	2	0
Endrin	0	0	0	0	0	0
Heptachlor epoxide	0	0	0	0	0	0
Lindane	0	0	0	0	0	0

Notes:

N = Number of samples.
PCBs = Polychlorinated biphenyls.
ppb = Parts per billion.
ppm = Parts per million.
SQAGs = Sediment quality assessment guidelines.

The State Water Resources Control Board is developing criteria for aquatic disposal. The SQAGs in this table are based on Smith et al. 1996.

There is no analysis in the Supplemental EIR/EIS of the potential increase in impacts to soil, groundwater or surface water from toxic constituents in dredged sediments or locally obtained borrow fill. Neither the Conceptual Engineering Report nor the Admin Draft Supplemental EIR/EIS show any testing for toxic constituents in surface soils which are moved during excavation, including excavation for borrow fill. Since the Delta levees were constructed by dredging, the same contaminants in riverine channels of the Delta will likely be in Delta surface soils near the levees.

A study by Drexler et. al. for the US Geological Survey of lead (Pb), mercury (Hg), and Titanium in Delta peat wetlands[5] found high concentrations near the surface, associated with the gold rush. The following map, from Drexler et. al., is from Browns Island:

[5] Exhibit DDJ-344 is a true and correct copy of Drexler, J., Alpers, C., Neymark, L., Paces, J., Taylor, H., Fuller, C. A millennial-scale record of Pb and Hg contamination in peatlands of the

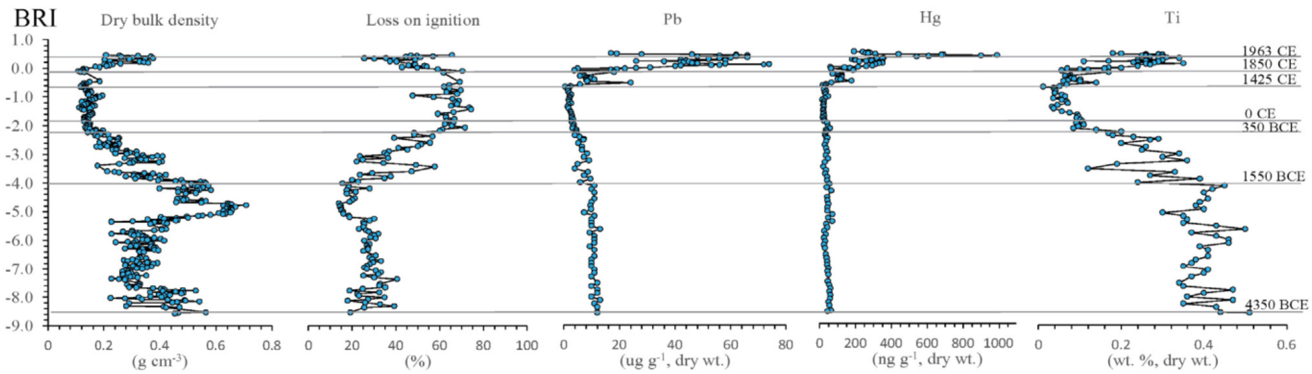


Fig. 2. Dry bulk density, loss on ignition, and Pb, Hg, and Ti concentrations in the BRI core. Land surface is at 0.51 m MSL.

The following map, from Drexler et. al. is from Franks Wetland:

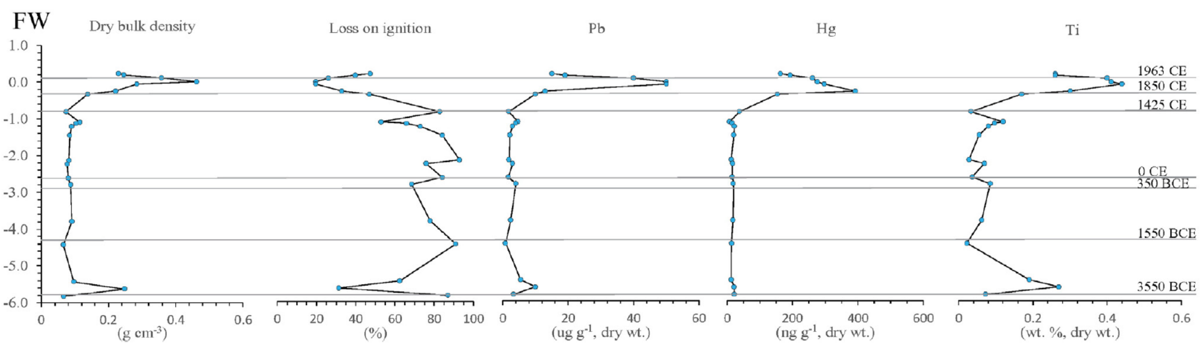


Fig. 3. Dry bulk density, loss on ignition, and Pb, Hg, and Ti concentrations in the FW core. Land surface is at 0.27 m MSL.

There might be similarly high levels of lead and mercury in Delta Island soils dating back to the gold rush.

The Admin Draft Supplemental EIR/EIS states that:

> However, implementation of Mitigation Measures HAZ-1a and HAZ-1b, UT-6a, and UT-6c (described in Final EIR/EIS Chapter 20, *Public Services and Utilities*), and TRANS-1a (described in Final EIR/EIS 4 Chapter 19, *Transportation*), along with environmental commitments to prepare and implement SWPPPs, HMMPs, SPCCPs, Sampling and Analysis Plans (SAPs), and a Barge Operations Plan (described in Appendix 3B, *Environmental Commitments, AMMs, and CMs*) would reduce these impacts to a less-than-significant level by identifying and describing potential sources of hazardous materials so that releases can be avoided and materials can be properly handled.

(Exhibit SWRCB-113, Admin Draft Supplemental EIR/EIS, Chapter 24, p. 24-6.)

Sacramento–San Joaquin Delta of California, USA. In Science of the Total Environment 551–552 (2016) 738–751.

However, the draft contract for construction of the Bouldin Island Tunnel Shaft Pad (Exhibit DWR-1306) shows no provision for sampling and analysis of soils on Bouldin Island, prior to construction.

4. Effects of placing Tunnel Muck in the borrow pits

There is also analysis of the potential impacts to groundwater or surface water from placing Tunnel Muck (aka "Reusable Tunnel Material" in the borrow pits. Since enormous amounts of borrow will be needed for Byron Tract Forebay embankments, this is an issue.
In the Incidental Take Permit, the Department of Fish and Wildlife and the Department of Water Resources agreed to preferentially put the tunnel muck in the borrow fill sites, stating:

> Permittee will store spoils and RTM according to the following requirements:
> […]
>
> > Temporarily place spoils, as needed, in borrow pits or temporary spoil laydown areas pending completion of embankment or levee construction. Borrow pits created for the Project will be the preferred spoil location.
>
> (Exhibit SWRCB-107, WaterFix Incidental Take Permit, p. 45.)

The WaterFix Incidental Take Permit clearly did not consider that the borrow pits would be deeper than the groundwater table. Placing tunnel muck in the borrow pits would likely create hydraulic conductivity between the reusable tunnel material storage area and the groundwater, because the borrow pits would be filled with water to the groundwater level. The Incidental Take Permit directed that the bottom of the Reusable Tunnel Material storage area be lined with impervious material (p. 46), but obviously if the impervious liner is below the groundwater table, it would provide little protection.

Once the RTM is wet and in contact with groundwater, the semicontinous discharge pumps from the Delta islands would discharge the water from the RTM piles into the Delta channels, as shown in the figure below.[6]

[66] Exhibit DDJ-345 is a true and correct copy of US Geological Survey, Delta Subsidence in California: the Sinking Heart of the State. April 2000.

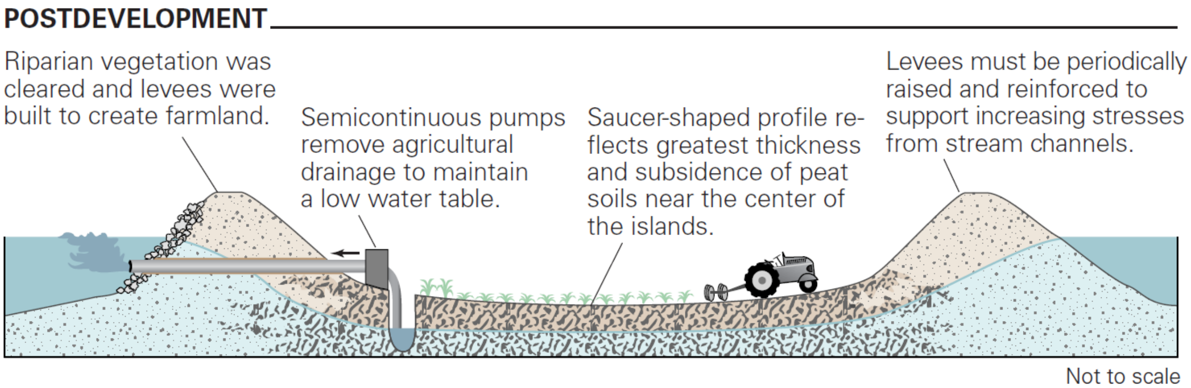


Exhibit DWR-207, the testing report for Tunnel Muck (aka Reusable Tunnel Material) shows a number of potentially toxic constituents, including Chromium, Copper, Vanadium and Zinc in the tunnel test borings.   Tests show that Copper, Vanadium, and Zinc were found at concentrations toxic to birds. Cadmium was found at levels toxic to mammals.   Arsenic and Hexavalent Chromium, a potent carcinogen, were also a concern

Exhibit DWR-207, Reusable Tunnel Material Testing Report, Table 3-5, p. 51:

Table 3-5. Ecological Screening Guidelines for Detected Analytes

Analyte	Maximum Detected Concentration in Soil (mg/kg)					USEPA Eco-SSLs[a] (mg/kg)			
	Baseline	Condat-Conditioned	BASF-Conditioned	Normet-Conditioned	Normet-Conditioned (with 3% Lime)	Plant	Soil Invertebrate	Bird	Mammal
Inorganic Constituents									
Ammonia	16	0.738	0.831	--	2.31	**	**	**	**
Antimony	--	--	0.229	0.27	0.262	**	78	**	0.27
Arsenic	4.37	4.03	4.51	4.23	4.03	18	**	43	46
Barium	207	200	172	197	188	**	330	**	2,000
Beryllium	0.591	0.642	--	0.538	0.519	**	40	**	21
Cadmium	0.579	0.348	0.342	0.439	0.466	32	140	0.77	0.36
Chromium (total)	62.3	60.3	50.1	56.6	54.3	**	**	**	**
Cr(III)	--	--	--	--	--	**	**	26	34
Cr(VI)	--	--	--	--	--	**	**	**	130
Cobalt	18.3	19.1	14.3	15	14.3	13	**	120	230
Copper	38.4	37.5	34.7	31.5	29.1	70	80	28	49
Lead	7.28	7.75	6.9	8.03	7.11	120	1,700	11	56
Mercury	0.0398	--	--	0.0246	--	**	**	**	**
Molybdenum	1.16	0.282	0.315	0.384	0.439	**	**	**	**
Nickel	72.5	75.7	68	66	60.8	38	280	210	130
Nitrate/Nitrite	12.7	0.45	0.315	0.315	--	**	**	**	**
Selenium	0.579	0.153	0.183	0.175	0.19	0.52	4.1	1.2	0.63
Silver	--	--	--	0.139	--	560	**	4.2	14
Thallium	0.579	0.165	0.159	0.169	0.161	**	**	**	**
Vanadium	65.6	63.8	53.5	60.8	63.2	**	**	7.8	280
Zinc	67.6	NA	64	66.9	62.6	160	120	46	79
Organically Complexed Metals									
Methylmercury[d]	0.00005	--	--	--	--	**	<0.001	**	0.00158
Organochlorine Pesticides									
4,4'-DDE	0.00075	--	--	--	--	**	**	0.093	0.021
Volatile Organic Compounds (VOCs)									
Naphthalene[e]	0.0032	--	--	--	--	**	29	**	100

Notes:
[a] U.S. Environmental Protection Agency (USEPA) Ecological Soil Screening Levels (Eco-SSLs) (http://www.epa.gov/ecotox/ecossl/index.html)
[b] Efroymson, R.A., M.E. Will, G.W. Suter II, and A.C. Wooten. 1997a. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision. ES/ER/TM-85/R3. Prepared for the U.S. Departmer Management. Prepared by Lockheed Martin Energy Systems, Inc., for the East Tennessee Technology Park, Oak Ridge National Laboratory, Oak Ridge, TN.
[c] Efroymson, R.A., M.E. Will, and G.W. Suter II. 1997b. Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Processes: 1997 Revision. ES/ER/TM-126/R2. Prepared for the Environmental Management. Prepared by Lockheed Martin Energy Systems, Inc., for the East Tennessee Technology Park, Oak Ridge National Laboratory, Oak Ridge, TN.
[d] USEPA Region 5 Eco screening levels (www.epa.gov/reg5rcra/ca/)
[e] Assessed as a low molecular weight PAH
shaded cells indicate concentration exceeds at least one ecological screening guideline
** = no published screening value
-- = not detected

Exhibit DWR-207, Reusable Tunnel Material Testing Report, Table 3-3, p. 39:

Table 3-3. Analytical Results Summary for Baseline and Conditioned Soil Samples

Group Analyte	Screening-Level Surrogate	Human Health, Unrestricted-Use Soil (mg/kg)				Sample Results (mg/kg)									
		USEPA RSL[a]		CA-modified Screening Level[b]		Baseline		Condat-Conditioned		BASF-Conditioned		Normet-Conditioned		Nomet-Conditioned (with 3% Lime)	
		Carcinogenic	Non-carcinogenic	Carcinogenic	Non-carcinogenic	Maximum Detected	Maximum MDL	Maximum Detected	Maximum MDL	Maximum Detected	Maximum MDL	Maximum Detected	Maximum MDL	Maximum Detected	Maximum MDL
Inorganic Constituents															
Ammonia	Nitrite	**	7,800	**	**	16	--	0.738	--	0.831	--	--	0.689	2.31	--
Antimony		**	31	**	**	--	1.16	--	1.1	0.229	--	0.27	--	0.262	--
Arsenic		0.61	34	0.062	**	4.37[c]	--	4.03[c]	--	4.51[c]	--	4.23[c]	--	4.03[c]	--
Barium		**	15,000	**	**	207	--	200	--	172	--	197	--	188	--
Beryllium		1400	160	1400	16	0.591	--	0.642	--	--	0.541	0.538	--	0.519	--
Cadmium		1800	70	788	4	0.579	--	0.548	--	0.342	--	0.439	--	0.466	--
Chromium	Chromium(III)	**	120,000	**	**	62.3	--	60.3	--	50.1	--	56.6	--	54.3	--
Chromium (VI)		0.29	230	**	**	--	0.594	--	0.547	--	0.552	--	0.568	--	0.645
Cobalt		370	23	**	**	18.3	--	19.1	--	14.3	--	15	--	14.3	--
Copper		**	3,100	**	**	38.4	--	37.5	--	34.7	--	31.5	--	29.1	--
Lead		**	400	**	**	7.28	--	7.75	--	6.9	--	8.03	--	7.11	--
Mercury		**	10	**	**	0.0398	--	--	0.0219	0.0368	--	0.0246	--	--	0.0258
Molybdenum		**	390	**	**	1.16	--	1.1	--	0.315	--	0.384	--	0.439	
Nickel		13,000	1,500	**	**	72.5	--	75.7	--	68	--	66	--	60.8	--
Nitrate/Nitrite	Nitrite	**	7,800	**	**	12.7	--	0.45	--	0.315	--	0.315	--	--	0.258
Selenium		**	390	**	**	0.579	--	0.548	--	0.183	--	0.175	--	0.19	--
Silver		**	390	**	**	--	0.579	--	0.548	--	0.108	0.139	--	--	0.129
Thallium		**	1	**	**	0.579	--	0.548	--	0.159	--	0.169	--	0.161	--
Vanadium		**	390	**	**	65.6	--	63.8	--	53.5	--	60.8	--	63.2	--
Zinc		**	23,000	**	**	67.6	--	NA	--	64	--	66.9	--	62.6	--

5. Sulfides from organic soils

The maps in the Admin Draft Supplemental EIR/EIS show a large tunnel muck pile adjacent to the new Byron Tract Forebay, and not far from Discovery Bay, which has 13,352 people in 2010, according to the U.S. Census. The maps also show the tunnel muck pile on Bouldin Island being moved north to near the town of Terminous, a census designated area which had a population of 381 in 2010, according to the U.S. Census.

The construction of Byron Tract Forebay, and the construction of the Bouldin Island Tunnel Shaft Pad and associated movement of borrow fill involves an enormous amount of soils handling: for excavation, transport, placement, compaction and disposal of soils.

The soils near the surface are high in organics, especially the peat soils. The peat soils are good for farming in the uppermost soil horizon, but they can pose problems when excavated from deeper, anaerobic levels below the surface. Under anaerobic conditions, sulfur is naturally reduced to sulfide compounds, including hydrogen sulfide.

Sulfides commonly cause odors, which can sometimes become public nuisances, and one compound in particular, hydrogen sulfide (H_2S), can cause acute symptoms and even death. Hydrogen sulfide has a strong "rotten egg" odor, but after continued exposure the victim loses the ability to detect it. Since it is heavier than air, it can travel along the ground and accumulate in low areas.

The excavation and handling of anaerobic peat soils for the proposed Water Fix project, will likely result in significant emissions of sulfides. The potential for nuisance odors is cited in Chapter 22 of the Admin Draft Supplemental EIR/EIS under "Impact AQ-12: Potential Temporary Exposure of Sensitive Receptors to Asbestos and Odors as a Result of Constructing the Water Conveyance Facilities." (p. 22-39.)

The Admin Draft Supplemental EIR/EIS Chapter on Air Quality states:

> Likewise, organic constituents and VOC in Plan 15 Area soil are below the method detection limits, indicating that organic decay of exposed RTM and 16 sediment would be relatively low (URS 2014). (p. 22-39.)

and concludes

> Accordingly, as with the approved project, the impact of exposure of sensitive receptors to potential odors would be less than significant. No mitigation is required. (p. 22-39.)

However, the geotechnical tests appear to refer only to the Reusable Tunnel Material Testing Report by URS, Exhibit DWR-207. The RTM soil samples are from significant depths. There are no tests of soils from the surface and near-surface layers. Published studies show very high levels of organic materials in surface and near-surface soils in the Delta, consistent with their known peat content. The map on the following page is Figure 1 from Deverel and Leighton, 2010.[7] The maps of percent of organic matter in the Admin Draft Supplemental EIR/EIS, derived from the project's Constructibility Report, show percentages roughly half that of peer-reviewed geologic studies.

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[7] Deverel, S., Leighton, D., Historic, Recent, and Future Subsidence, Sacramento-San Joaquin Delta, California, USA, January 2010. San Francisco Estuary and Watershed Science, 8(2). Obtained from https://escholarship.org/uc/item/7xd4x0xw

The Deverel and Leighton map is consistent with significant risks from near-surface soils.

AUGUST 2010

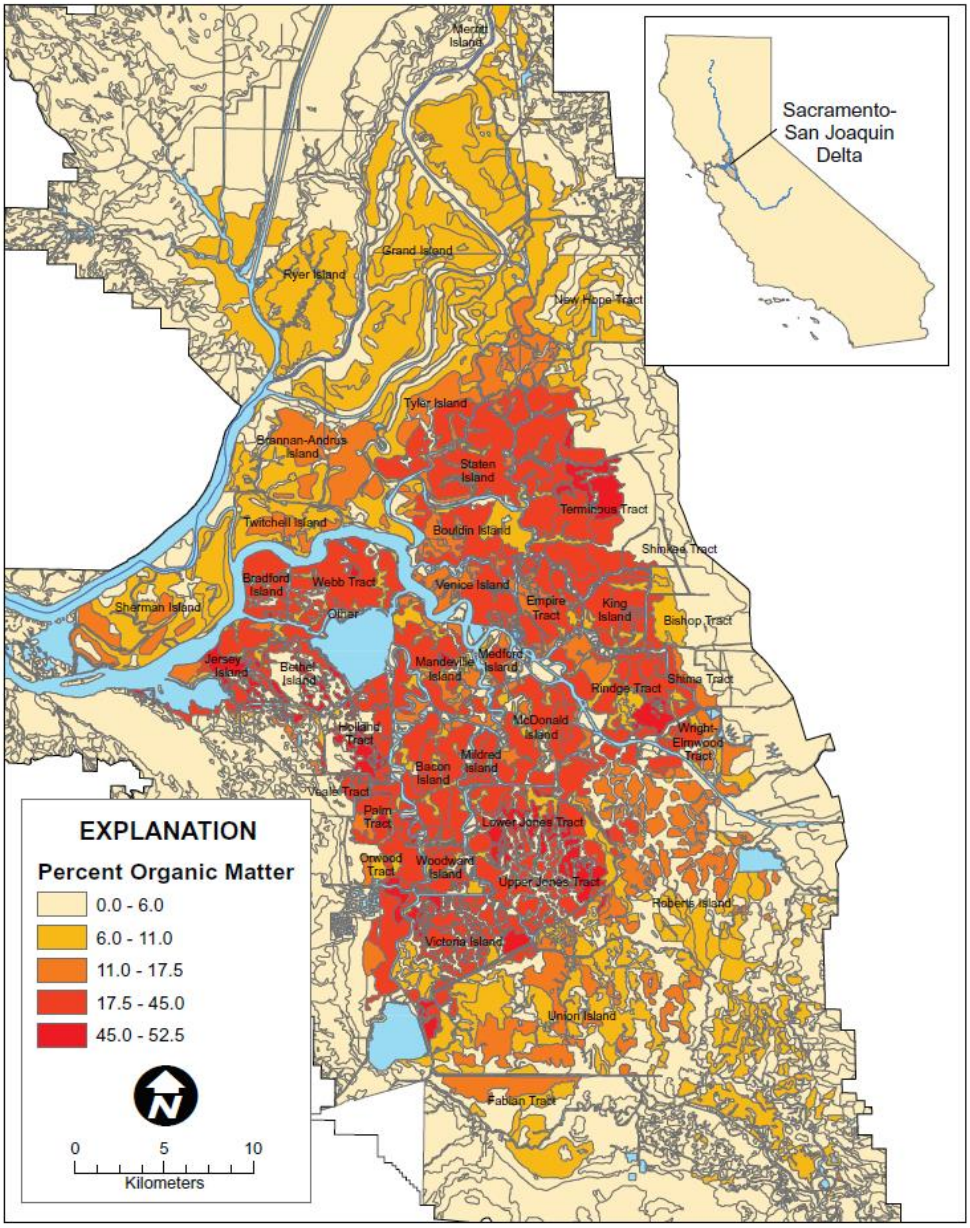
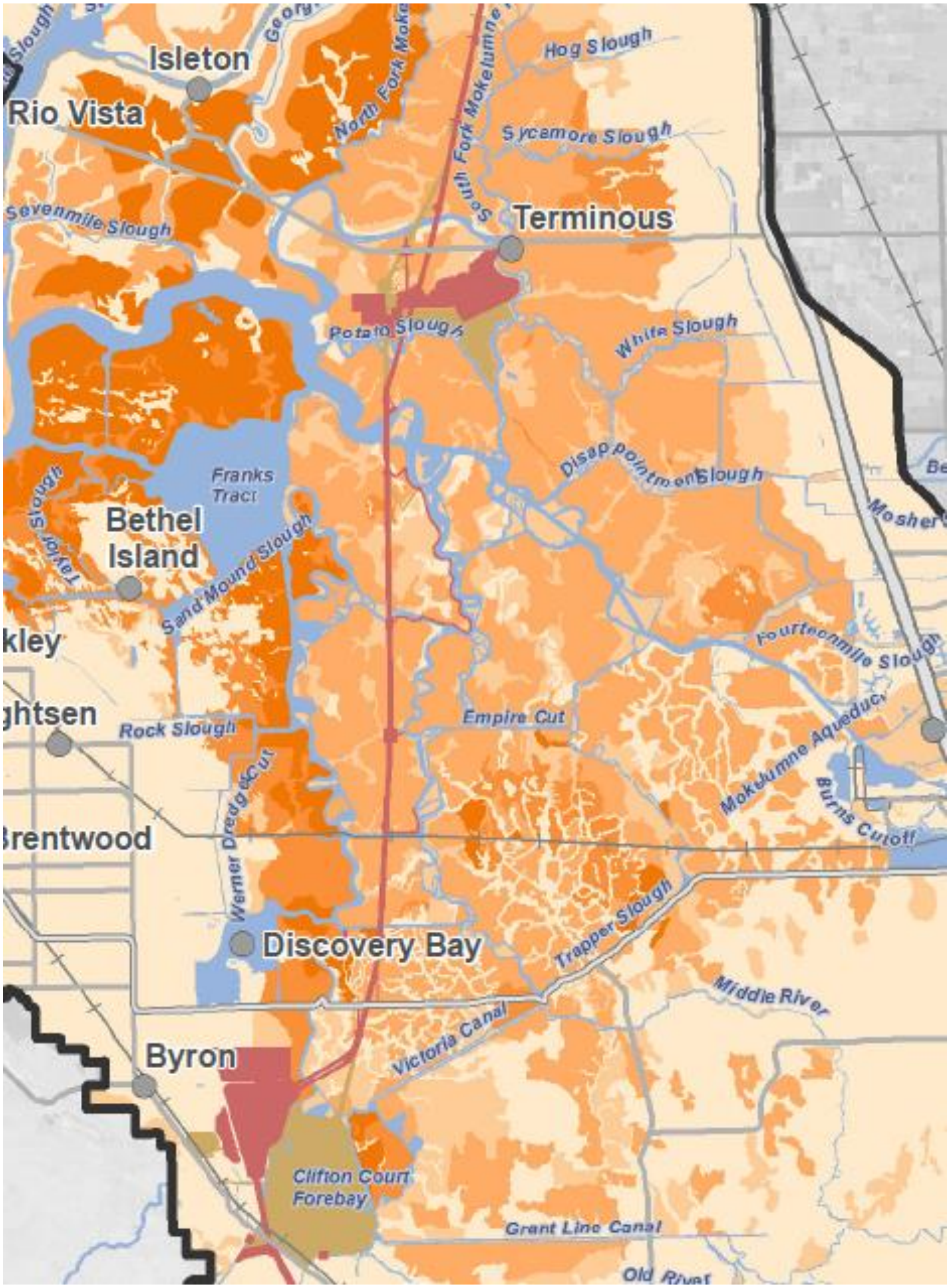
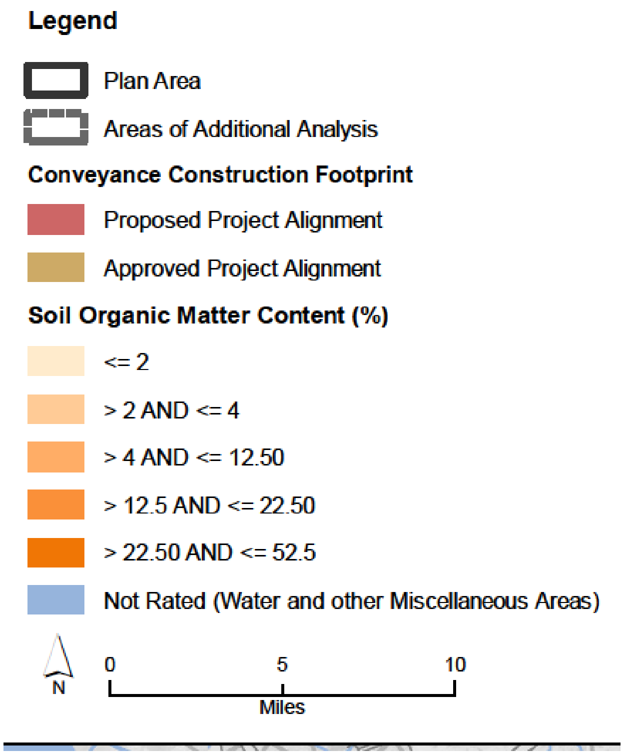


Figure 1 Distribution of percent soil organic matter in the Sacramento–San Joaquin Delta

3



Admin Draft Supplemental EIR/EIS, closeup of Figure 10-2, Organic Matter in Near-Surface Soils



Admin Draft Supplemental EIR/EIS, legend from Figure 10-2, Organic Matter in Near-Surface Soils

Toxic hazards from sulfides, especially hydrogen sulfide, are another issue. The creation of confined spaces which the project necessarily entails, gives rise to serious health hazards from sulfides. The humans most at risk would be those working on the project.

Every year hydrogen sulfide causes deaths, mostly from occupational exposure in confined spaces like tunnels or pump stations. The table of symptoms below is from the Occupational Safety and Health Administration (OSHA) web page on Hydrogen Sulfide.[8]

[8] Exhibit DDJ-347 is a true and correct copy of the Occupational Safety and Health Administration (OSHA) Safety and Health Topic web page on Hydrogen Sulfide. Obtained from https://www.osha.gov/SLTC/hydrogensulfide/hazards.html

Concentration (ppm)	**Symptoms/Effects**
0.00011-0.00033	Typical background concentrations
0.01-1.5	Odor threshold (when rotten egg smell is first noticeable to some). Odor becomes more offensive at 3-5 ppm. Above 30 ppm, odor described as sweet or sickeningly sweet.
2-5	Prolonged exposure may cause nausea, tearing of the eyes, headaches or loss of sleep. Airway problems (bronchial constriction) in some asthma patients.

20	Possible fatigue, loss of appetite, headache, irritability, poor memory, dizziness.
50-100	Slight conjunctivitis ("gas eye") and respiratory tract irritation after 1 hour. May cause digestive upset and loss of appetite.
100	Coughing, eye irritation, loss of smell after 2-15 minutes (olfactory fatigue). Altered breathing, drowsiness after 15-30 minutes. Throat irritation after 1 hour. Gradual increase in severity of symptoms over several hours. Death may occur after 48 hours.
100-150	Loss of smell (olfactory fatigue or paralysis).
200-300	Marked conjunctivitis and respiratory tract irritation after 1 hour. Pulmonary edema may occur from prolonged exposure.
500-700	Staggering, collapse in 5 minutes. Serious damage to the eyes in 30 minutes. Death after 30-60 minutes.
700-1000	Rapid unconsciousness, "knockdown" or immediate collapse within 1 to 2 breaths, breathing stops, death within minutes.
1000-2000	Nearly instant death

The hazards from Hydrogen Sulfide should be included in the Supplemental EIS/EIR, and factored into any decisions taken on whether the project should proceed.

6. Barge and Truck Traffic and Air Quality Analyses

The Draft Supplemental EIR/EIS, Appendix 22B, Air Quality Assumptions, Table 22-B-9 has a list of the quantities of borrow for each tunnel reach. Table 22-B-9 Appendix 22B adds up to 158,524 cubic yards. This is less than 1/100th of the total of 24.7 million cubic yards (truck yards) of borrow fill estimated in the 2018 WaterFix Conceptual Engineering Report.

With these construction assumptions, it is likely that the truck traffic and barge traffic analyses in the Admin Draft Supplement EIR/EIS are grossly inaccurate, as well as the Air Quality impact analysis.

Executed on this 21st day of September, 2018 in Los Angeles, California.

Clyde Thomas (aka Tom) Williams