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August 16, 2012

State Water Resources Control Board
1001 I St.
Sacramento, CA 95814

Via email: commentletters@waterboards.ca.gov

Subject: Addendum to City of Antioch submittal for the Bay-Delta Workshop 1 – Ecosystem Changes and LSZ
Excerpts from Three Relevant Historical Documents
FSI 064136

Dear Ms. Townsend and Members of the Board,

Our previous letter (dated August 7, 2012) provided information demonstrating that the Delta was historically a freshwater ecosystem (prior to about 1918). In addition, prior testimony (March 22, 2010) included three relevant historical documents that clearly indicate that the Delta was historically fresh. We are resubmitting relevant excerpts from these three documents, since the information regarding the historical freshwater nature of the Delta is important for the Board to consider. These excerpts are attached and are listed below:

- Excerpts from a report by Thomas Means (1928): "Salt Water Problem", pages 9, 10 and 57.
- Excerpts from the Department of Public Works (DPW) (1931) Report: "Variation and Control of Salinity in Sacramento-San Joaquin Delta and Upper San Francisco Bay", pages 22 and 60.
- Excerpts from the DWR (1960) Report: "Delta Water Facilities", page 13.

To facilitate the Board's review we have also provided excerpts of relevant passages from these documents, as follows:

"Under natural conditions, Carquinez Straits marked, approximately, the boundary between salt and fresh water in the upper San Francisco Bay and delta region of the two tributary rivers – the Sacramento and San Joaquin. Ordinarily salt water was present below the straits and fresh water was present above. Native vegetation in the tide marshes was predominantly of salt water types around San Pablo Bay and of fresh water types around Suisun Bay." (Means, 1928, pg. 9).

In response to salt intrusion into the Delta in the dry years of 1918, 1920, 1924 and 1926, Means writes referring to the previous decade (i.e., 1918 through 1928), "It is probable, should all streams be running in a natural way, that salt water would have penetrated no farther in this extremely dry period than Antioch, and then only for a few days at a time." (Means, 1928, pg. 10, emphasis added).

"…salt water under natural conditions did not penetrate higher upstream than the mouth of the river, except in the driest years and then only for afew days at a time, …" (Means, 1928, pg. 10).

The first four points in the Summary of Means (1928, pg. 57) were:

1. "Carquinez Strait marked approximately the boundary between salt and fresh water under natural conditions.
2. Prior to diversions for irrigation, Suisun Bay was brackish in late summer and salt water may have penetrated as far as Antioch, but only for a few days at a time in years of lowest run-off.
3. If the water now diverted for irrigation and held in storage were released, natural conditions would again be brought about.
4. The dry year of 1918, in which the urge of war had encouraged heavy plantings of rice and other crops in the Sacramento Valley, resulted in penetration of salt water into the Delta for a longer time and to a greater distance upstream than ever known before."

"The dry years of 1917 to 1919, combined with increased upstream irrigation diversions, especially for rice culture in the Sacramento Valley, had already given rise to invasions of salinity into the upper bay and lower delta channels of greater extent and magnitude than had ever been known before." (DPW, 1931, pg. 22)

"From 1880 to 1920, Pittsburg (formerly Black Diamond) obtained all or most of its domestic and municipal water supply from New York Slough [near Pittsburg at the confluence of the Sacramento and San Joaquin Rivers] offshore." (DPW, 1931, pg. 60)

"From early days, Antioch has obtained all or most of its domestic and municipal water supply from the San Joaquin River immediately offshore from the city… However, conditions were fairly satisfactory in this respect until 1917, when the increased degree and duration of saline invasion began to result in the water becoming too brackish for domestic use during considerable periods in the summer and fall." (DPW, 1931, pg. 60)

DWR found that freshwater (defined as chloride concentrations less than 350 ppm) was available at San Joaquin at Antioch 88% of the time under "natural" conditions. This had

decreased to 73% by 1920 and 49% by 1960 (DWR, 1960, pg. 13. Percentages estimated from figure on right side of page 13.).

We respectfully request that this letter and the attached documents be included in the administrative record for the Bay-Delta Workshop 1 – Ecosystem Changes and LSZ.

Sincerely,

Al Preston, Ph.D., P.E.
Senior Scientist

SALT WATER PROBLEM

SAN FRANCISCO BAY *and* DELTA *of* SACRAMENTO *and* SAN JOAQUIN RIVERS

APRIL, 1928

THOMAS H. MEANS, *Consulting Engineer*
216 PINE STREET · SAN FRANCISCO, CALIFORNIA

PENETRATION OF SALT WATER IN UPPER BAY AND LOWER RIVER REGION

Under natural conditions, Carquinez Straits marked, approximately, the boundary between salt and fresh water in the upper San Francisco Bay and delta region of the two tributary rivers—the Sacramento and San Joaquin. Ordinarily salt water was present below the straits and fresh water was present above. Native vegetation in the tide marshes was predominantly of salt water types around San Pablo Bay and of fresh water types around Suisun Bay.

In tidal waters, into which run fresh water streams of variable flow, there is an ebb and flow of salt water and the zone of mixing will move up and down stream as the fresh water flow increases and decreases. For short intervals in late summer of years of minimum flow, salt water penetrated the lower river and delta region, and in wet seasons the upper bay was fresh, part of the time, to the Golden Gate. This variation in quality of water was not, however, of sufficient duration to affect the characteristic vegetation growth of the regions on each side of the straits, nor to change the designation of Suisun Bay as ordinarily a fresh water body and San Francisco Bay as salt water.

The works of man have changed conditions in many ways. The most important changes have been brought about gradually,—so slowly as to be hardly noticeable. The dry season of 1918,—when large summer diversions for irrigation in the Sacramento Valley resulted in the sudden penetration of salt water farther upstream than ever known before, at such an early period in summer,—first brought the salt water problem to public notice. The slow effects of increasing diversions in previous years had escaped notice, but were brought prominently to the attention of the inhabitants of the upper bay and delta regions in this year. Since 1918, the dry years of 1920, 1924 and 1926 have more convincingly demonstrated the importance of the salt water problem.

An accurate picture of natural conditions is not possible, because no records have been collected on which such a picture can be based, but very close approximations can be made. The log of the distance traveled by the water barge of the California Hawaiian Sugar Company in going upstream to obtain fresh water has been kept since 1908. These figures give the means of determining approximately the conditions during that period. In 1908 irrigation had been extensively developed in both valleys and conditions then were not natural. For an estimate of earlier conditions we must go to the stream flow records of the tributary streams before important diversions are taken out.

It is the practice of the Sugar Company to send the barge upstream until water of approximately 50 to 70 parts per million chlorine is reached. The crew of the barge are equipped with apparatus by which water is analyzed until this degree of purity is reached. Since trips are made nearly every day during the summer months, the record is a very good indication of the point reached by salt water. A summary of the complete records shows the fluctuation of the line between fresh and salt water. Records of the Sugar Company are attached. (Table 1.)

The Sugar Company requires water of great purity. For irrigation, domestic or ordinary industrial uses, water of a lesser degree of purity may be used. A comparison of the point where the Sugar Company's barge is filled with the point where the remaining uses could be satisfied, indicates that from five to ten miles downstream from the place where the barge turns, water could be obtained satisfactory for domestic supply. Making an allowance of 7½ miles in the average records, we find

that an average flow of 5,000 second feet in both streams will maintain fresh water at Collinsville; 7,000 second feet will maintain fresh water at the San Francisco-Sacramento ferry.

If we sum up the flow of the important tributaries of the Sacramento and San Joaquin rivers at the points where these streams leave the mountains and assume that this flow under natural conditions would have reached the head of the Suisun Bay, we will find that at no time in the past ten years would the average monthly flow have been less than 5,100 second feet. It is probable, should all streams be running in a natural way, that salt water would have penetrated no farther in this extremely dry period than Antioch, and then only for a few days at a time.

It is not possible to make a more detailed study of this condition without making a number of assumptions as to speed of flow from the gaging stations to the head of the bay, and there is little accurate information on which the assumptions may be made. The definite statement that salt water under natural conditions did not penetrate higher upstream than the mouth of the river, except in the driest years and then only for a few days at a time, is warranted. (See Table 2 for monthly flow of tributary streams.)

At present salt water reaches Antioch every year, in two-thirds of the years running further upstream. It is to be expected that it will continue to do so in future, even in years of greatest runoff. In other words, the penetration of salt water has become a permanent phenomenon in the lower river region.

CAUSE OF CHANGE IN SALT WATER CONDITIONS

The cause of this change in the salt water condition is due almost entirely to the works of man. If natural changes have had any effect, it is too small to be measured. The most important natural condition is the sequence of dry and wet periods. Since 1917 the State has experienced dry years with low runoff in nearly all streams. During this period two years have exceeded normal stream flow in some streams (1921 and 1927). In each of these years excessive salinity (over 100 parts chlorine per 100,000) was present at Antioch about two months.

Irrigation

Storage and diversion of water have been the principal causes of salinity increase in the upper bay country. The area irrigated varies from year to year; in 1926 the acreage of lands on the floor of the valley was approximately as follows:

Estimate of Diversions and Area Irrigated 1926—Sacramento and San Joaquin Valleys, Not Including Mountain Areas

	Acre Feet Diverted	Acres Irrigated
Sacramento and tributaries above Sacramento, including rice, 128,439 acres	1,644,973	235,995
Delta uplands	146,906	53,649
Delta area		264,479
San Joaquin Valley estimated	2,100,000	700,000
	3,891,879	1,254,123

In addition to this area on the valley floor, there is a large acreage in the mountains which uses water from the streams tributary to the rivers that drain through Suisun Bay. The acreage irrigated in the mountains is not so accurately known as the area on the valley floor, but it is large and, particularly in low flow season, very

SUMMARY

1. Carquinez Strait marked approximately the boundary between salt and fresh water under natural conditions.
2. Prior to diversions for irrigation, Suisun Bay was brackish in late summer and salt water may have penetrated as far as Antioch, but only for a few days at a time in years of lowest run-off.
3. If the water now diverted for irrigation and held in storage were released, natural conditions would again be brought about.
4. The dry year of 1918, in which the urge of war had encouraged heavy plantings of rice and other crops in the Sacramento Valley, resulted in penetration of salt water into the Delta for a longer time and to a greater distance up-stream than ever known before.
5. Examination of available information shows that the yearly increased diversion of water which had been going on since irrigation commenced in the valleys of California, had been gradually affecting the movements of salt water. This slow effect was hardly noticed until 1918.
6. Irrigation and storage are not solely responsible for the influx of salt water. The load of hydraulic mining debris deposited in the streams draining the Sierra Nevadas is a minor factor in the problem. As the sediment moves down-stream the tidal prism is changed and the movement of water is affected.
7. Leveeing and reclamation of marsh lands, around the bays and in the delta region, have had a slight effect upon tidal movements. The net effect of leveeing marsh land has been to decrease the tendency of salt water to flow up-stream.
8. Leveeing of basin lands and diversion of floods through by-pass channels has had an important effect in sending floods rapidly to tide water and in reducing the late summer flow of water which under natural conditions was stored and slowly released from basins.
9. Dredging, particularly in lower portions of the rivers and in the navigation channels of San Pablo Bay, has increased the tendency for salt water to flow up-stream. Dredging in Suisun Bay and in the deep water channels to Stockton may have the same tendency. All increases in channel depth and in straightening of approach have a tendency to increase up-stream flow of salt water, though a quantitative estimate of this tendency cannot be made.
10. Irrigation now diverts the entire low flow of all streams entering the San Joaquin Valley. The only flows reaching tide water in late summer and early fall are return waters—seepage from irrigation.
11. Pumping plants on the west side of the San Joaquin Valley, lifting water to the west side slopes, now divert more water during late summer than enters tide-levels from the river. The San Joaquin delta under present conditions is dependent in late summer of dry years on flow from the Sacramento River. Additional pumping plants are being installed and there will be a greater tendency in the future than in the past for salt water to flow up-stream into the delta channels.
12. Irrigation in the Sacramento Valley in late summer diverts practically all the flow of streams entering the valley floor. The flow of the river at Sacramento, the head of tide water, is now largely return seepage or waste from canals. The low flow at Sacramento was 500 second feet in 1920; 2750 in 1921;

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS

PUBLICATIONS OF THE
DIVISION OF WATER RESOURCES
EDWARD HYATT, State Engineer

Reports on State Water Plan Prepared Pursuant to Chapter 832, Statutes of 1929

BULLETIN No. 27

VARIATION AND CONTROL
OF
SALINITY
IN
SACRAMENTO-SAN JOAQUIN DELTA
AND
UPPER SAN FRANCISCO BAY

1931

municipal and agricultural use in the upper bay region will necessitate the importation of supplies from some suitable source to supplement the local water resources which are capable of economic development. The nearest source of supply would be the lower Sacramento and San Joaquin rivers. The studies of water supply, yield and demand in the operation of the initial and ultimate developments of the State Water Plan show that most of the water supply required to be imported to the upper San Francisco Bay region could be furnished from this source. Therefore, the industrial, municipal and agricultural developments adjacent to Suisun and San Pablo bays are directly interested in the investigation of salinity, and particularly in the determination of a means of controlling saline invasion in such a way that water supplies now available or hereafter made available in the lower Sacramento and San Joaquin rivers would be maintained fresh at all times for diversion to supply the future needs of the upper bay region.

Previous Investigations.

The first investigations of salinity by the State were made in the fall of 1916 when a preliminary study and a few samples and analyses of the water were made by the State Water Commission. At this time, the potential seriousness of the salinity problem began to be recognized. Again in 1918 and 1919 some samples and analyses of the water at Antioch were made by the State Board of Health and the State Water Commission. However, the investigation of salinity in the upper bay and delta channels was not started on any extensive scale until 1920. The dry years of 1917 to 1919, combined with increased upstream irrigation diversions, especially for rice culture in the Sacramento Valley, had already given rise to invasions of salinity into the upper bay and lower delta channels of greater extent and magnitude than had ever been known before. At the beginning of 1920, it was evident that another dry year was impending which might result in serious water shortage and a possibly greater saline invasion. Accordingly, in February 1920, the State Water Commission and the State Engineer in cooperation with an organization of the delta land owners, designated the River Lands Association, arranged a cooperative program for a detailed investigation of the salinity conditions. Funds were provided partly by the State and partly by the River Lands Association. The State Water Commission furnished most of the personnel and equipment. Actual field work was started on May 25, 1920. Salinity observation stations, 28 in number, were established at various points in the delta channels and a regular schedule initiated for sampling of water. The samples were tested for salinity in terms of chlorine content by standard titration methods. The water samples were generally taken about every two days at about the time of high tide. In addition to these regular observation stations, a few special surveys were made to determine the variation of salinity through a tidal cycle and also the variation with depth, but these were not extensive enough to come to any definite conclusions. However, it was discovered that the highest degree of salinity usually occurred about one and one-half to two hours following high-high tide and the minimum salinity about the same time after low-low tide. In addition to the investigations made by the State in 1920, a large amount of additional investigational work was done by

not greatly increase the expense of cooling water to the industries and the actual cost per 1000 gallons is small. Over 80 per cent of the total amount of water used by industries in the upper bay region is for cooling and condensing purposes. The use of saline water from the bay channels for cooling and condensing is satisfactory and little, if any, advantage would be gained if fresh water were available for this purpose.

From 1880 to 1920, Pittsburg (formerly Black Diamond) obtained all or most of its domestic and municipal water supply from New York Slough offshore. Although the records show that the water became too brackish to be suitable for domestic use during certain periods in the summer and fall months even before 1917 (See Table 34 for record of salinity, 1910 to 1916), the degree and duration of salinity greatly increased from 1917 on and necessitated the provision of a new source of supply. After providing temporary expedients, including the hauling of water in barges filled at points upstream where fresh water was available, the use of the river as a source of domestic and municipal water supply was discontinued in 1920 and since that time the supply has been obtained from local wells. From early days, Antioch has obtained all or most of its domestic and municipal supply from the San Joaquin River immediately offshore from the city. This supply also has always been affected to some extent by saline invasion with the water becoming brackish during certain periods in the late summer and early fall months. However, conditions were fairly satisfactory in this respect until 1917, when the increased degree and duration of saline invasion began to result in the water becoming too brackish for domestic use during considerable periods in the summer and fall. To meet this change in conditions, Antioch finally constructed a reservoir which is filled with fresh water from the river in the winter and spring and which is designed to supply the city during the period of the year when the water in the river is too brackish for municipal use.

The remaining cities and towns in the upper bay region have obtained fresh-water supplies from various local sources such as surface streams and wells and hence have not been affected by recent changes in salinity conditions. One public utility, serving the cities and towns of Contra Costa County from Pittsburg to Oleum as well as several industrial plants, has recently completed a new water supply development, pumping water from the lower river near Mallard Slough about two miles west of Pittsburg and piping the same to a storage reservoir at Clyde just south of Bay Point. Water is pumped when fresh and free from saline invasion and the storage capacity is designed to supply the demands during the remainder of the year when the water at the intake is too salty for fresh-water purposes.

The marshlands adjacent to Suisun Bay, especially the portion thereof in the upper half of the bay, have been affected to some extent by the more prolonged invasions of salinity of high degree since 1917. Although the area farmed is relatively small in extent, comprising only 5000 acres in 1929, water suitable in quality for irrigation has been available for much shorter periods during the last ten to fifteen years than in former years. This not only has curtailed irrigation diversions to crops, but also has limited the development of these marshlands because of the lack of availability for a sufficient period of time of fresh water for leaching the salts from the soils to make them fit for crop

Preliminary Edition

Bulletin No. 76

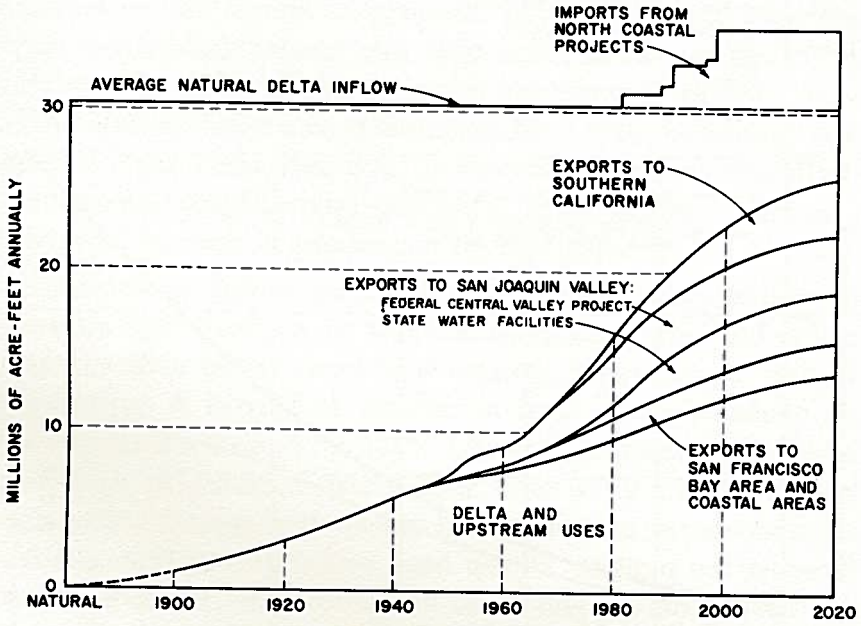
DELTA WATER FACILITIES

EDMUND G. BROWN
Governor
State of California

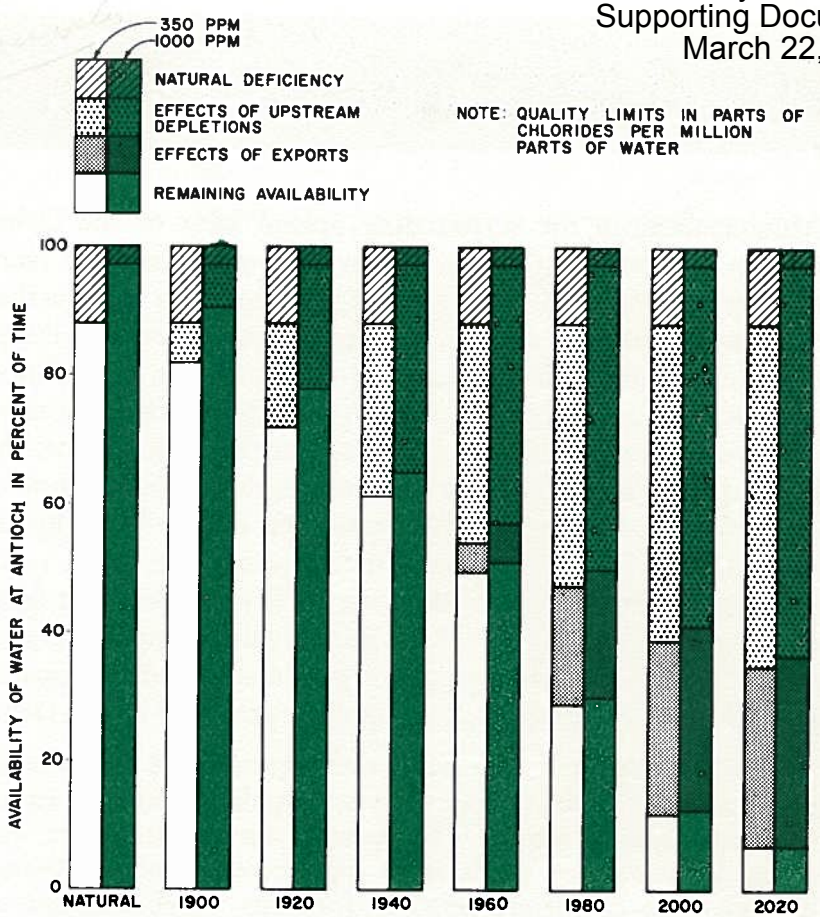
December, 1960

HARVEY O. BANKS
Director
Department of Water Resources

The natural availability of good quality water in the Delta is directly related to the amount of surplus water which flows to the ocean. The graph to the right indicates the historic and projected availability of water in the San Joaquin River at Antioch containing less than 350 and 1,000 parts chlorides per million parts water, under long-term average runoff and *without* specific releases for salinity control. It may be noted that even under natural conditions, before any significant upstream water developments, there was a deficiency of water supplies within the specified quality limits. It is anticipated that, without salinity control releases, upstream depletions by the year 2020 will have reduced the availability of water containing less than 1,000 ppm chlorides by about 60 percent, and that exports will have caused an additional 30 percent reduction.



USE OF DELTA WATER SUPPLIES



DELTA WATER QUALITY WITHOUT SALINITY CONTROL

The magnitude of the past and anticipated future uses of water in areas tributary to the Delta, except the Tulare Lake Basin, is indicated in the diagram to the left. It may be noted that, while the present upstream use accounts for reduction of natural inflow to the Delta by almost 25 percent, upstream development during the next 60 years will deplete the inflow by an additional 20 percent. By that date about 22 percent of the natural water supply reaching the Delta will be exported to areas of deficiency by local, state, and federal projects. In addition, economical development of water supplies will necessitate importation of about 5,000,000 acre-feet of water seasonally to the Delta from north coastal streams for transfer to areas of deficiency.