

3.0 HYDROLOGY AND WATER QUALITY

This chapter describes the existing hydrological resources and water quality conditions within the project area. It identifies potential project-induced changes to local and regional hydrology, as well as impacts to local and regional water quality that could result from implementing the project. Since sediment deposition rates are interdependent with site and regional hydrology, this chapter also includes a discussion of sediment deposition.

3.1 AFFECTED ENVIRONMENT

3.1.1 Regional Hydrology

Petaluma River Watershed

The Petaluma River watershed basin covers an area extending from its headwaters in the Coast Range Mountains to San Pablo Bay where the river discharges. The Petaluma River is tidal along its lower reach. The river's hydraulic cross-section (i.e., its profile, or the width and depth of the river at any given time) is dependent upon these factors: 1) base flow (flow that is generated by groundwater and spring discharge), 2) storm water runoff, 3) circulating tidal waters from San Pablo Bay, and 4) transport of watershed and Bay sediments. Mean annual rainfall in the project vicinity is 21 inches (USGS, 1971), occurring primarily from November through March (winter rainy season). Storm water runoff during this season raises the river's discharge. Watershed sediment yield and riverine transport of these sediments are also elevated during these months.

Black John Slough and Adjacent Marshes

Tidal prism is the volume of water exchanged between higher high and lower low tides. Scour is the erosional force of moving water within a river (in essence, the ability of a river to clean itself). Sedimentation is the settling out and deposition of sediments suspended in water. The sediment carrying capacity of a channel and the rate at which sediments are deposited in the channel (sedimentation rate) are generally related to the speed of the moving water, the volume of water exchanged (tidal prism), and the amount of sediment in the water. Sediments settle out when flow velocities are low, circulation is poor, and sediment loads are high.

Tidal prism is the hydrologic variable linking scour and sedimentation. An increase in tidal prism can cause scour to increase and sedimentation to decrease. Conversely, a decrease in tidal prism can cause scour to decrease and sedimentation to increase. Reduced tidal prism, decreased scour, and progressive sedimentation diminish the volume of actively circulating tidal water in a channel and therefore reduce the amount of sediments available for deposition. Eventually, equilibrium is reached between scour and sedimentation, where the reduced scouring capability of the channel is balanced with the reduced sediments circulating and depositing in the channel and no net sedimentation occurs. However, there may be considerable loss of tidal range within a channel at the point at which this equilibrium occurs. Both of these variables will adjust gradually with the increase in sea level.

Levee construction along Black John Slough has reduced the tidal prism of the slough. This has reduced channel scour along the slough, increased channel sedimentation, reduced the slough's capacity to convey tides upstream, and reduced tidal range at upstream locations, such as Rush Creek and Cemetery marshes. Increasing the tidal prism and tidal range in Black John Slough is one of the stated objectives of the Proposed Bahia Marsh Project.

HOA West and East Lagoons and HOA Channel

The HOA West and East Lagoons and the HOA channel connecting the lagoons to the Petaluma River, adjacent to the proposed project, were constructed in association with the development of the Bahia subdivision in 1965. The surface areas of the West and East Lagoons are estimated at 17 and 27 acres, respectively (does not include the surface area of the connecting channel; City of Novato, 1999).

Water in the West Lagoon is supplied and circulated from San Pablo Bay and the Petaluma River through tidal action via the HOA channel. Natural circulation in the lagoon is also assisted to some degree by wind shear forces on the water surface. Note that since the West Lagoon and channel have substantially silted in, tidal exchange is now quite limited.

The East Lagoon is enclosed by three undeveloped peninsulas (East Bahia Project Site), created from fill materials in 1965 and is connected to the channel by a 21-inch culvert, which provides for limited flushing of the enclosed lagoon for purposes of water quality maintenance.

In addition to some measure of tidal exchange, the West and East Lagoons receive storm water runoff from developed portions of the Bahia subdivision and from the undeveloped peninsulas. Direct winter storm water runoff and dry season irrigation runoff also contribute to freshwater influx to the West Lagoon.

3.1.2 Project Site Hydrology

Perimeter levees extend along the northern and eastern boundaries of the project site. The perimeter levees prevent regular tidal exchange between the site and adjacent tidal channels. There is limited tidal exchange between Black John Slough and the Bahia HOA channel, which divides the project site, but is not actually a part of the project site. Portions of the site's perimeter levee are overtopped during spring high tides and allow for limited inundation. The project site also receives freshwater runoff from the oak woodlands along the southern boundary of the site.

The amount and duration of ponding at the site has increased since the site's pump facility stopped functioning in 2003. For the past three winters (2004 through 2006), ponded water typically covered most of the project site, with several ponds 2 to 3 feet deep, and extensive ponding persisting throughout much of the site well into the summer and fall (Philip Williams and Associates [PWA], Project Ecologist, Peter Baye, and Life

Science! Inc. [LSI] field observations, 2004-2006). PWS survey the project site levees in January of 2006 and did not find evidence of any breaches. Several small PVC culverts through the interior levee that separates Central and West Bahia provide limited exchange between these two parcels via gravity flow.

Deep water in the relict channels and borrow ditches persists throughout the year. The largest of these ditches runs along the western side of the internal levee that divides West and Central Bahia. A smaller borrow ditch extends along the southern portion of West Bahia.

An approximately 1-acre freshwater pond has evolved at the site of the former decant pond. A small breach in the levee between the pond and Central Bahia appears to have reduced the amount of runoff impounded in the pond (PWA field staff observed minimal ponding during a site visit on July 14, 2004).

The dredge material disposal area south of Central Bahia is drained by a culvert through the internal levee that separates this area from the rest of the site. The RV parking lot in the southeast corner of Central Bahia is well-drained, with runoff directed toward the 1-acre former decant pond.

Subsidence at the project site has lowered ground elevations by up to 6 feet or more below natural elevations for tidal marsh. Site topography has been mapped using both aerial photogrammetry and ground-based surveys. Due to an abundance of vegetation and some ponded water on the site during aerial mapping, detailed site topography was collected with land-based methods.

Elevations within the project site vary due to the differences in land use and the time of diking. West Bahia is the most heavily subsided portion and is close to the level of the average low tides in the Petaluma River. The least subsided areas are found at Mahoney Spur, where existing elevations are close to the mean tide level in the Petaluma River. Elevations in Central Bahia vary, with the portion to the northeast of the internal levee approximately 1 to 2 feet higher than the portion to the southwest. The existing depressions that occur throughout the site are a mix of relict tidal channels and differentially subsided marsh peats or pans on the drainage divides. The diked seasonal wetland immediate south of Central Bahia was created by the placement of dredged material, and its existing grade slopes away from the former discharge points. Elevations at this former dredge disposal site and at the former RV lot are the highest within the western portion of the site.

Table 3-1 describes elevations across the site in three ways: 1) relative to the North American Vertical Datum 1988 (NAVD) datum conversion using North American Vertical Datum Conversion (Vertcon) algorithms; 2) relative to the natural tidal marsh; 3) relative to tides. With respect to the tides, from lowest to highest elevations, the reference points used are: 1) for low tides - mean lower low water (MLLW), mean low water (MLW), and mean high low water (MHLW); 2) mean tide level (MTL); 3) for high tides - mean high water (MHW) and mean higher high water (MHHW). The tidal frame

elevations in Table 3-1 were taken from published National Oceanic and Atmospheric Administration (NOAA) data for the lower Petaluma River. Based on a survey of fringe marsh and other reference sites, the natural tidal marsh at the site is the MHHW, or approximately 6 feet NAVD.

Table 3-1. Typical Elevations of Baylands within Project Site

	Typical Elevations		
	(NAVD)	Relative to Natural Tidal Marsh	Relative to Tidal References
Mahoney Spur	3 to 4 ft	-3 to -2 ft	~ MTL
West Bahia	0 to 2 ft	-6 to -4 ft	~ MLLW to MHLW
Central Bahia (northeast of internal levee)	2 to 3 ft	-4 to -3 ft	~ 1 ft below MTL
Central Bahia (southwest of internal levee)	1 to 2 ft	-5 to -4 ft	~ MLW to MHLW
Existing Seasonal Wetland & RV lot	8 to 10 ft	+2 to +4 ft	2 - 4 ft above MHHW
East Bahia Peninsulas	9 to 10 ft	+3 to +4 ft	3 - 4 ft above MHHW
HOA East Lagoon*	-1 to -5.4 ft	-7 to -11.4 ft.	~1 – 5 ft below MLLW

*Note that HOA East Lagoon is owned by the Bahia HOA and is included here because its presence influences the East Bahia Peninsulas.

The elevations of the Western Peninsula are 7 to 9 feet NAVD and 1 to 3 feet above natural tidal marshplain. The elevations the Central Peninsula are 7 to 8 feet NAVD and 1 to 2 feet above natural tidal marshplain. The southern shoreline of the HOA East Lagoon is 9 to 11 feet NAVD and 3 to 5 feet above natural tidal marshplain. Elevations in the East Lagoon range from -1 to -5.4 feet NAVD (-7 to -11.4 feet below natural tidal marsh plain) depending on location.

The perimeter levees that extend along the northern and eastern boundaries of the site have elevations typically ranging from +6.5 to +9.5 feet NAVD. The interior levee separating West and Central Bahia has an elevation of approximately +14 feet NAVD. Other internal levees along the southern edge of West Bahia are much lower, about +4 feet NAVD, and are not continuous.

3.1.3 Sedimentation

The hydrologic relationship between sedimentation, tidal prism, and channel scour was discussed briefly above in Section 3.1.1. Characteristics of sedimentation in the project area are discussed further in this section.

Tidal waters in the lower Petaluma River region are laden with high concentrations of fine suspended sediment. At the Petaluma River mouth, a large body of sediment moves back and forth between the river and San Pablo Bay with the ebb and flood tides. Suspended sediment concentrations vary greatly, both with the daily (diurnal) and monthly spring-neap tide cycles, and also seasonally and annually depending on rainfall and storm or wind-wave conditions. Generally, suspended sediment concentrations are highest for spring tides and wet years (Schoellhamer et al, 2003).

The sources of sediment for the project site are watershed delivery from the upstream Petaluma River, the extensive mudflats in San Pablo Bay they get stirred up by wind and waves, and outflow from the Delta. Suspended estuarine sediments deposit in subtidal and intertidal areas during slack tides and may accumulate in areas where tidal or wind-driven currents are low, causing subtidal channels to shoal and intertidal mudflats to build in elevation.

The availability and delivery of estuarine sediments are critical to establishment of marsh vegetation at breached baylands such as Bahia. Through the deposition of estuarine sediments, subtidal shallows and intertidal mudflats increase in elevation until vegetation establishes through either natural seedling recruitment or regeneration of vegetative fragments. Natural seeding recruitment of dominant tidal marsh plants in San Pablo Bay is generally restricted to elevations near MHW or above, while regeneration of vegetation fragments can potentially occur as low as the local MTL (see VHMP in Appendix B).

Vegetation colonization is governed by the frequency and duration of tidal inundation, so restricted channels that reduce the tide range may alter the elevations at which vegetation occurs or delay site evolution. At the nearby Green Point (a.k.a., Toy Property) Marsh, sedimentation was delayed for several years until the tidal range and sediment exchange increased. The rate of site evolution also depends on the potential of wind waves to hinder estuarine sedimentation or even re-suspend previously deposited material under high-energy conditions. Once vegetation establishes, the rate of estuarine sedimentation may increase as vegetation traps sediments and slows down wave energy.

Sedimentation has been observed for three sites in the vicinity of the Bahia Marsh Restoration Project site: (1) Petaluma River Marsh (formerly known as Carl’s Marsh), (2) Green Point (a.k.a. Toy Property) Marsh, and (3) the Bahia HOA channel and lagoon. Examination of sedimentation rates and the factors that affect sedimentation rates over time at these nearby sites is useful in the context of the proposed Bahia Marsh Project because it can be used to predict sedimentation rates and site evolution at the project site.

Table 3-2 lists estimated rates of sedimentation for Petaluma River Marsh, southeast of the project site on the east side of the Petaluma River. Sedimentation rates were initially very high at this site (initial sedimentation rates in open water of approximately 1.6 feet/year) due to high suspended sediment concentrations during the wet El Niño year of 1997 to 1998 (Schoellhamer et al, 2003). Sedimentation rates slowed after approximately 3 years due to the decrease in suspended sediment concentrations after the El Niño event, and due to the increase in elevation of the mudflat/marsh surface, which decreased the frequency of inundation and compacted low-density sediment deposits. Sedimentation modeling results indicate that the annual average suspended sediment concentrations were initially very high during the first three years (1994 to 1997) and subsequently decreased to approximately 250 milligrams per liter (mg/L). The latter estimate agrees with average measured suspended sediment concentrations from 1998 and 1999 (WWR, 2003).

Table 3-2. Sedimentation at Petaluma River Marsh (formerly Carl’s Marsh)

Date	Years of Restoration	Average Elevation (ft NAVD)	Sedimentation Rate (ft/yr)	<i>Source</i>
Aug.-1994	0	0.0		PWA, unpublished data; cited in PWA 2004
March-1997	2.6	4.1	1.6	WWR, 2003
Sept.-1998	4	5.1	0.6	WWR, 2003
Aug. 1999	5	5.0	0.0	WWR, 2003
Aug. 2002	8	5.4	0.1	PWA, unpublished data; cited in PWS, 2004

For Green Point Marsh, the average long-term rate of sedimentation is estimated at approximately 0.2 feet/year over 16 years (PWA, unpublished data; cited in PWA, 2004). Lower sedimentation rates at Green Point are likely due to the lower long-term average sediment concentrations and to limited sediment supply through the narrow channel that connects the site to the Petaluma River.

Rapid sedimentation also occurred in the Bahia HOA lagoon and HOA Channel following the last dredging operations there in 1987. Historical sedimentation rates within the lagoon and channel have ranged between approximately 1.0 and 1.5 feet/year (Krone & Associates, 1994; Systech Engineering letter to Danny Fred, Fred Consulting,

1991). Most sediments deposited in the lagoon and channel arrive from San Pablo Bay via the Petaluma River. Storm water runoff accounts for only 0.7 inch per year of sediment from the Petaluma River.

Sedimentation since the last dredging has dramatically reduced the depths and open water areas in the lagoon and channel. No recent elevation data are available to accurately estimate current sedimentation rates; however, simple arithmetic extrapolation over the years since the last lagoon/channel dredging indicates that the sedimentation rate has slowed and is approaching an equilibrium condition in conjunction with the available tidal prism. The tidal prism for the open lagoon and entrance channel at its juncture with the closed lagoon outlet was computed to be 116 acre-feet, representing a reduction in tidal prism of approximately 28 percent relative to the 1987 dredge condition (City of Novato, 1999).

3.1.4 Tidal Hydrology

PWA installed three tidal gages around the project site for a six-week period from December 2003 through January 2004. The gages were positioned to characterize tidal conditions in Black John Slough, Rush Creek, and the Bahia HOA channel, adjacent to the proposed Bahia Marsh project site. Measurements from these gages were compared to long-term tidal characteristics for the Petaluma River mouth at the NOAA station 9415252.

The tide ranges measured by PWA reveal significant differences in the present tidal hydrology of Rush Creek, Black John Slough, and the HOA channel. The tides measured within the HOA channel had the largest range and were representative of the tidal ranges along the Petaluma River at the confluence of Black John Slough and the HOA channel. (The minimum low tides in the HOA channel were not captured since the gage could not be placed in the channel thalweg [i.e., the lowest point in the channel]). The measurements show a substantial reduction of tide range in Black John Slough and even greater reduction of tide range in Rush Creek, with low water surface elevations approximately 1 to 2 feet higher at the Black John Slough gage and 2 to 3 feet higher at the Rush Creek gage, compared to measurements in the HOA channel which are representative of tide ranges along the Petaluma River at the confluences of Black John Slough and the HOA channel. Since Black John Slough and the HOA channel discharge into the Petaluma River in close proximity, the tide ranges at these confluences would be nearly the same. Model simulations show that this reduction of the tidal range is primarily caused by discharge from Rush Creek and Cemetery Marshes, combined with the limited capacity of Black John Slough to convey tides upstream, due to the slough's reduced tidal prism (a consequence of levee construction, as discussed above).

As a result, the mean diurnal tidal range during the monitoring period at Rush Creek is approximately 4.0 feet compared to 5.3 feet in Black John Slough and 6.0 ft in the Petaluma River. PWA measured a similar trend from limited tide data collected in 1985 for the *Rush Creek Marsh Enhancement Plan* (PWA, 1985).

3.1.4 Flooding

High tides in combination with major rainstorms can result in major flooding episodes within the Petaluma River watershed, overtopping levees and inundating adjacent low-lying lands. The Flood Insurance Rate Map (FIRM) published by the Federal Emergency Management Agency (FEMA) delineates the 100-year flood hazard zone in the vicinity of the project area. The 100-year base flood elevation is 7.0 feet National Geodesic Vertical Datum (NGVD), which refers to the water surface reached during a combined flooding and high tide event and/or storm surge that could be expected to occur on the average of once every 100-year period. The probability of such an event occurring within any given year is 1 percent. According to the U.S. Army Corps of Engineers, the 100-year highest estimated tide level at the Petaluma River mouth is 6.5 feet NGVD (City of Novato, 1999).

Within the Bahia Marsh project site, the mapped flood hazard zone indicates that portions of the East Bahia peninsulas and all of West and Central Bahia and Mahoney Spur are subject to flooding during a 100-year event. The depth and extent of flooding that would occur at the site during a 100-year event would depend on the timing and duration of the river's flood peak and on the coincidence of this peak with tides, as well as levee failures that may occur due to high seepage pressures.

3.1.5 Sea Level Rise

The BCDC's study of sea level rise and its impacts on San Francisco Bay indicates that global sea level rise during the 19th century was about 0.0039 feet/year, but that land elevations in the project vicinity remained unchanged during this time (Moffat & Nichol Engineers and Wetlands Research Associates for BCDC, 1988). However, from 1964 to 1982, the rate of global sea level rise nearly doubled to roughly 0.0072 feet/year. Based on this rate, BCDC and its consultants estimated mean sea level in the project vicinity to rise from approximately +0.78 feet NGVD in the late 20th century to +1.14 feet NGVD by 2036 (an estimated 0.005- to 0.05-foot rise in sea level per year). BCDC and its consultants also predicted a highest estimated tide level of 6.9 feet NGVD for the year 2036 (compared to the present 100-year estimated tide level at the Petaluma River mouth of 6.5 feet NGVD).

3.1.6 Water Quality

Surface water quality in the project area is affected by the water quality of upstream runoff to the Petaluma River watershed, the quality of tidal waters circulating from San Pablo Bay, quality of local surface runoff and shallow groundwater seepage from the adjacent Bahia residential development, as well as atmospheric deposition.

Point sources (e.g., sewage treatment sites, industrial outfalls) and non-point sources (e.g., cultivated and urbanized lands) contribute contaminants to the watershed and land uses throughout the Petaluma River watershed affect the river's water quality. Watershed land uses are diverse and include protected conservation lands in the upper watershed,

diked agriculture and floodwater storage lands in the lower watershed, and urban commercial and residential uses throughout the system (Petaluma River Watershed Master Drainage Plan, 1986). The amount of water received at the project site from the upper reaches of the Petaluma River is negligible under all but peak flow conditions. The lower Petaluma River carries treated domestic waste-water from the City of Petaluma and some of this treated waste water may make its way into the project site via tidal circulation.

The quality of Bay tidal waters is dependent on a number of factors, including the timing and magnitude of freshwater Delta outflow, complex circulation patterns in the Bay, wind-driven mixing and re-suspension of fine-grained sediments, time-varying salinity gradients and water temperature, and nutrient loading. Point and non-point sources also contribute to pollution in San Pablo Bay. Pollution from urban runoff presents a major water quality problem in the Bay. Runoff from urbanized areas carries with it various types of pollutants that may affect the quality of receiving waters. Some of the more significant pollutants include sediment, organic debris, oil and other hydrocarbons, chemicals such as fertilizers and pesticides, and heavy metals from petroleum products. Irrigation runoff from agricultural lands, which is at a peak during the dry season, can carry nutrients, contaminants related to various biocides, and their degradation products.

The quality of local runoff and groundwater seepage is affected largely by the input of nutrients and degradation byproducts from fertilizers, herbicides, and pesticides. Natural geologic materials can also contribute small amounts of trace elements classified as potential contaminants.

A water quality sampling study performed by the San Francisco Regional Water Quality Control Board (RWQCB) in 1971 on the lower Petaluma River and Bahia HOA channel indicates that water in the Bahia HOA channel and lagoon is essentially identical to water in San Pablo Bay in terms of the concentration of chemical constituents. Overall, measurements of water quality parameters in San Pablo Bay, the Petaluma River, and the Bahia Lagoon do not indicate any major water quality problems.

Surface water at the site is brackish. However, because of dilution by fresh water (upstream Petaluma River and local runoff) and protection of the site from tidal inundation, the surface water at the site is less saline than water in adjacent tidal zones. Algal growths and anaerobic conditions occur in portions of the site during summer and fall. Oceanic colonies of the phytoplankton species *Skeletonema costatum* occur in the northern San Pablo Bay and the shallows of the northern Bay offer good light penetration, a supply of limiting nutrients (primarily nitrogen), and relatively warm water temperatures, all of which create an ideal environment for rapid population growth of these colonies. Warmer temperatures and greater solar radiation in the summer and fall can result in algal blooms. Algal blooms and subsequent die-off in any water body can severely depress dissolved oxygen concentration and result in fish kills. Such events have been documented in the Bahia HOA lagoon and Petaluma River.

Historic water quality data from the years 1961 to 1985 were compiled for several nutrients (ammonia, nitrate, and phosphate) in the Bahia HOA lagoon and compared to reference sites in the Petaluma River and San Pablo Bay. The data indicated that nutrient concentrations in the lagoon were within the ranges established for ambient concentrations in the Petaluma River and San Pablo Bay, with the exception of phosphate. Phosphate in the lagoon, measured at three to ten times the reference concentrations, was believed to derive from lawn fertilization on adjacent properties (Systech Engineering letter to Danny Fred, Fred Consulting, *op. cit.*, cited in City of Novato, 1999).

Brown & Caldwell performed a water quality study of the Bahia HOA channel and lagoon in 1985. Water quality parameters analyzed included temperature, pH, dissolved oxygen, total coliform bacteria, and nutrients. The lack of strong vertical stratification of temperatures in lagoon waters was attributed to mechanical mixing of the lagoon waters by winds. The pH of lagoon waters was within the normal range found in Bay tidal waters, while total coliform concentrations were relatively low. Locally high phosphorus concentrations and elevated biological productivity were measured in the East Bahia lagoon; however, nitrogen levels were found to be acceptable and similar to background concentrations in the Petaluma River and San Pablo Bay. Except for occasional nuisance algal growth in the summertime (see discussion below), water quality at the project site has been considered good (Revised Draft EIR for the 1990 Bahia Master Plan Revision, City of Novato, 1992, cited in City of Novato, 1999).

The Brown & Caldwell study only included the Bahia channel and lagoon adjacent to the Bahia Marsh Restoration Project site. A more recent compilation of water quality data for the Petaluma River from 1989 to 1996 indicated no long-term trends for any of the trace elements or trace organics monitored by regulatory agencies and research institutions. The data did indicate consistently high nickel concentrations in the Petaluma River during the winter and spring months, with the peak concentrations occurring with peak river flows and therefore attributed to upstream watershed sources (RMP: Regional Monitoring Program for Trace Substances – 1996 Annual Report, *op. cit.*, cited in City of Novato, 1999).

No other water quality studies have been conducted within the immediate project site area and the 1985 Brown & Caldwell data are the most recent available for the site area. However, since the channel and lagoons included in the Brown & Caldwell study are hydrologically connected to the project site, and since there has been no additional development in the Bahia area since 1985, the water quality for the project site can be inferred from the 1985 Brown & Caldwell study and 1989-1996 Petaluma River study.

In addition to the water quality studies cited above, in 1993, chemical, physical, and bioassay testing of sediments in the Bahia HOA West Lagoon and entrance channel determined that constituents of concern (COCs; i.e., poly-aromatic hydrocarbons, petroleum hydrocarbons, and metals) in the lagoon sediments were at or below background levels of COCs found in the sediments at the mouth of the Petaluma River and were similar to the median concentrations for these substances at multiple stations

monitored in the North Bay (*Results of Chemical, Physical and Bioassay Testing of Sediments at Bahia Lagoon*, MEC Analytical, September 3, 1993; cited in City of Novato, 1999).

As there has been no development within the Bahia area since 1993, the chemical characteristics of sediments in the lagoon are unlikely to have changed, and these data are believed to remain representative for the Bahia site as a whole.

3.3 CRITERIA FOR DETERMINING SIGNIFICANCE OF EFFECTS

Criteria for determining the significance of hydrology and water quality impacts are based upon professional judgment, review of previous studies, and *CEQA Guidelines*. A project would have a significant hydrologic impact if it would:

- Violate any water quality standards or waste discharge requirements.
- Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level.
- Create or contribute runoff water that would exceed the capacity of existing or planned storm water drainage systems or provide substantial additional sources of polluted runoff.
- Otherwise substantially degrade water quality.
- Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river (or by altering or otherwise affecting flow to adjacent marshes that are not a part of the proposed project site), in a manner that would result in substantial erosion or siltation on- or off-site.
- Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, by altering or otherwise affecting flow to adjacent marshes that are not a part of the proposed project site, or by substantially increasing the rate or amount of surface runoff in a manner that would result in flooding on or off-site.
- Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or FIRM or other flood hazard delineation map.
- Place within a 100-year flood hazard area structures that would impede or redirect flood flows.
- Expose people or structures to a significant risk of loss, injury, or death involving flooding, including flooding as a result of the failure of a levee or dam, inundation by seiche, tsunami, or mudflow.

3.4 ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

The proposed project is not expected to cause significant adverse hydrological or water quality impacts. Although proposed construction activities could cause some short-term and relatively minor impacts to water quality, in the long term the project will actually benefit local and regional hydrology in a number of ways.

Under current conditions, if the levees at the project site were breached simultaneously, or breaches were placed at inappropriate locations, sedimentation patterns would be adversely impacted. Sediments would be eroded from nearby mudflats and tidal marsh habitat in the project vicinity would be adversely impacted. Given the reduced tidal prism of Black John Slough, an accidental or un-phased breach of the Bahia site levees has the potential to capture all or most of the tidal signal from the slough and to adversely impact sedimentation in areas that have a hydrologic connection to the Bahia site (e.g., at Cemetery and Rush Marshes). Changes in sedimentation patterns can cause impacts on human-made structures within the water bodies, alter water quality, and affect aquatic habitat important to vegetation, aquatic organisms, and terrestrial wildlife that depend on the aquatic habitat.

Under the proposed project, levee breaches and pilot channels are designed and phased to allow the altered system to equilibrate with minimal disturbance to regional hydrology. The proposed phased approach to lowering and breaching the Bahia site levees would gradually increase the tidal prism within Black John Slough and consequently increase the tidal range in the slough and other marshes upstream from Bahia (i.e., Rush Creek and Cemetery Marshes). By preempting an accidental or un-phased breach of the Bahia levees, the project would prevent possible negative impacts to the HOA channel, Black John Slough, and upstream marshes. Furthermore, the project proposes an adaptive management approach that includes proposed monitoring of Black John Slough and flexibility in the timing and location of breaches to prevent any negative hydrologic impacts.

Levee and channel modifications that are implemented or result from implementation of the project may also alter flooding patterns within the project site, Black John Slough, and the HOA channel. Changing the tidal prism may cause small changes in the pattern of flood flow within the Petaluma River. The changes are expected to be small and result in minor changes to other resource issues such as inundation patterns, changes to habitat features, and exposure of structures to flooding velocities or inundation patterns. Their impacts are considered less than significant. Because the area is very level and located essentially at sea level, the potential changes to flooding conditions during a 100-year flow are expected to be less than significant.

The project area is an undeveloped area of the tidal floodplain of San Pablo Bay proposed for habitat restoration. No housing would be placed within the 100-year floodplain. Although the project site may be currently exposed to inundation because it lies within a floodplain and is adjacent to San Pablo Bay, the project would not alter the hazards to people or structures from flooding.

The proposed project will increase tidal circulation at the site and greatly reduce standing stagnant water. In the recent past, standing water at the site has provided mosquito breeding habitat and odors (see discussions in Chapters 9 [Public Health] and 7 [Air Quality]). Algal blooms have also occurred in these relatively warm, shallow, and still waters. Improvements in water circulation at the site will eliminate or significantly

reduce mosquito habitat, and potentially conditions that favor avian botulism and other ongoing issues related to poor circulation.

In addition, the project is designed to increase the rate at which estuarine sediments are deposited at the project site, which will permit relatively rapid marsh vegetation of the site. According to aerial photography and ground-based surveys, subsidence has lowered ground elevations at the site by up to 6 feet or more below natural elevations for tidal marsh. By reintroducing full tidal exchange to the site, and assuming negligible wind-wave agitation following the levee breaching, the project is expected to result in an increased sedimentation rate such that high marsh vegetation will become established throughout the majority of the site within approximately 30 years (low marsh vegetation would colonize much earlier).

The project area is currently exposed to storm events. As a result of opening areas to tidal exchange with the Petaluma River, the receiving waters (Petaluma River and San Pablo Bay) will be exposed to storm water runoff from the re-inundated areas and hydrologically connected uplands within the Bahia area. There would not be any appreciable effects on storm water conveyance or management practices because the project area is not associated with developed storm water facilities. The storm water quality impacts are considered less than significant. Marsh vegetation, which will begin to establish immediately under the Proposed Project, can filter out many COCs and therefore can have a beneficial impact on the quality of storm water runoff.

Groundwater will not be affected as a result of implementing the project because no groundwater will be used, and there will not be any substantial excavations that could intercept groundwater or alter groundwater flow paths. Therefore, no impacts on groundwater are anticipated.

3.4.1 Proposed Project

As noted above, the project is expected to have primarily beneficial long-term impacts to hydrology and water quality. Minor short-term construction impacts are noted below.

Water Impact-1. Short-term construction impacts to water quality (elevation of suspended sediment and turbidity levels or hazardous materials).

Localized temporary elevation of suspended sediment and turbidity levels or hazardous materials is expected to result from the levee breaching and construction activities planned for the project. However, these elevated levels will be temporary. Disturbances will be timed and the project will be designed to conserve sediment for use in elevating the subsided interior portions of the levees and wetlands. This will further minimize discharges of turbid water to waters draining to the Petaluma River and San Pablo Bay. Construction management practices that reduce turbidity and suspended sediment will be used (Best Management Practices [BMPs]).

Significance: Potentially significant (short-term)

Mitigation Measure for Water Impact-1: The following mitigation measures will be implemented as applicable.

Siltation Controls

Install silt fences, localized silt barriers or other erosion control measures during construction in wetland and aquatic habitats located in creeks and sloughs. No sediment controls will be applied when runoff is directed toward pond interiors unless sensitive wildlife resources are identified.

Maintain siltation controls in properly functioning condition in accordance with the manufacturer's specifications and good engineering practices. Controls will be removed after construction. Should sediment escape the construction site, accumulations of sediment will be removed and placed in a location where it can not impact water quality.

Hazardous Materials

All wastes created during construction (e.g. trash, excess construction material, etc.) would be removed from the construction area and disposed of in an approved disposal site. No trash or other solid waste pollutants will be buried within the construction area or discharged into waters of the United States. The project will comply with all applicable State and or local waste disposal regulations.

Generation of fugitive dust would be minimized by accepted practices. If precipitation occurs during construction, vehicular traffic along the construction corridor will be minimized to reduce the potential for erosion.

Gasoline, diesel fuels, lubricants and other potential pollutants would be stored in containers that would prevent their accidental release. Any unused lubricants or used engine oil will be removed from the site and disposed of at an approved facility. Additional steps to prevent the accidental discharge of potential pollutants will be described in a project-specific spill prevention plan.

Overnight or out-of-use equipment will be parked on impervious mats/tarps to capture leaking oil and lubricants.

Routine maintenance of equipment will be limited to fueling and lubricating equipment. No major cleaning or major equipment repairs would be conducted at the construction site.

Prior to construction, an environmental inspector will verify the limits of authorized construction work areas and identify any additional stabilization or special construction management needed to protect sensitive wildlife. During construction, if conditions are identified that would impair water quality or harm wildlife, the construction activity will be stopped and rescheduled or the construction design will be changed to prevent reoccurrence.

Post-mitigation Significance: Less than significant

3.4.2 No Project Alternative

Under the No Project Alternative, existing issues related to poor water circulation (mosquito habitat, avian botulism, odors, etc.) would remain or could potentially worsen. Since these are existing conditions, they are not listed as No Project impacts.

Water Impact-2 Substantial adverse changes in rates of sedimentation or erosion

Under the No Project Alternative, unmaintained levees at the project site could be breached simultaneously in an unplanned event. If this occurs, sedimentation patterns would be adversely impacted. Sediments would be eroded from nearby mudflats and tidal marsh habitat in the project vicinity would be adversely impacted. Given the reduced tidal prism of Black John Slough, an accidental or un-phased breach of the Bahia site levees has the potential to capture all or most of the tidal signal from the slough and to adversely impact sedimentation in areas that have a hydrologic connection to the Bahia site (e.g., at Cemetery and Rush Marshes). Changes in sedimentation patterns can impact water quality and aquatic habitat important to vegetation, aquatic organisms, and terrestrial wildlife.

Significance: Potentially significant. (Since this alternative will result in the project not being implemented, no mitigation measures are proposed.)

3.4.3 Alternative 1 (Reduced Fill Removal from East Bahia)

Under this alternative, a reduced quantity of fill material excavated from the Western Peninsula of East Bahia would be transported through the Bahia community to Central. Similar to the Proposed Project, by preempting an accidental or un-phased breach of the Bahia levees, this alternative would prevent possible negative hydrological impacts to Black John Slough and upstream marshes. However, the earth-moving activities proposed under this alternative still have the potential to cause the short-term water quality impacts identified for the Proposed Project (Section 3.4.1, above). Mitigation for these impacts and post-mitigation significance are also the same as that identified for the Proposed Project.

3.4.4 Alternative 2 (No Fill Removal from East Bahia)

Under this alternative, fill material would not be transported from East Bahia through the Bahia community to Central Bahia. Similar to the Proposed Project, by preempting an accidental or un-phased breach of the Bahia levees, this alternative would prevent possible negative hydrological impacts to Black John Slough and upstream marshes. However, the earth-moving activities proposed under this alternative still have the potential to cause the short-term water quality impacts identified for the Proposed Project

(Section 3.4.1, above). Mitigation for these impacts is also the same as that identified for the Proposed Project.